GAMS 24.1.3 r41464 Released Jul 26, 2013 WEX-WEI x86\_64/MS Windows 01/19/16 16:16:30 Page 1

G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

C o m p i l a t i o n

This codes tests the new idea of using volume treated as a variable and ge

tting

rid of the binary variables. This way the industry can decide to treat dif

ferent

volumes of waste using different technologies and trade simultaneously to

achieve

reduction targets.

The code solves the stochastic programming formulation of the mercury trad

ing problem.

It solves the mercury trading problem using a two stage approach.

The problem is divided as follows:

- The first stage decision variables are volumes treated by each industry

using each

technology. Once these are decided, binary parameters reflecting the se

lection of

a technology (for non-zero volume) are decided and used for second stag

e problem.

The objective is minimization of the

compliance cost by considering linear approximations of the cost functio

ns.

- The second stage variables are the technology design decisions. These de

cisions

are taken to minimize cost in the presence of extensive nonlinear cost f

unctions.

Some parameters in these nonlinear relatioships are considered as uncert

ain.

Note:The question is: Can you actually optimize the design? Right now, all

the design

equations are equalities and hence it is the direct computation of the non

linear

cost.

The choice is between a set of possible treatment options and the option o

f

trading.

The details of the three treatement technologies are:

1. Coagulation and Filteration

2. Activated Carbon

3. Ion Exchange

The code takes the value of TMDL and does the rest of the calculations aut

omatically.

The health care cost is calculated after the optimization problem solution

.

Declaration of units:

TMDL = Kg/year

HSC = nano grams per liter (parts per trillion)

TC= $ per 1000 Gallons

q = nano grams per liter

water\_intake = liters per day per person

fish\_intake = Kg per person per day

safe\_Hg = mg/Kg

LC50 = micro grams per liter

$Offdigit

$Offlisting

$Offsymxref

$Offsymlist

$Offuelxref

$Offuellist

$Offupper

options Limcol=0;

options Limrow=0;

options profile=0;

option sysout=off;

option solprint=on;

56

57 \*

58 \* Option to govern the display of values in the results.

59 \*

60 option decimals = 5;

61 \*=========================================================================

======

62 \*

63 \* Set declarations related to model

64 \*

65 Sets i Number of industries /1\*29/

66 \* Restricting the size of the problem by including only a subset of indust

ries in the problem

67 j Number of treatment options /1\*3/

68 alias(i,k);

69 \*

70 \* Set declarations related to the code

71 \*

72 Sets s1 Set for the declaration of sub-problem matrices /1\*2/

73 s2 Set for the declaration of sub-problem matrices /1\*7/

74 n Maximum number of possible iterations /1\*10/

75 m Number of samples /1\*10/;

76 \*=========================================================================

======

77 \*=========================================================================

======

78 \*

79 \* Declaration of model related parameters

80 \*

81 Parameter TMDLMean Total Maximum Daily Load - Mean

82 TMDL TMDL vector for the given samples /32/

83 HSC Highest Segment Concentration (ng per lit) /5.0/

84 CAL Current Annual Load (Kilograms per year) /58.8/

85

86 r trading ratio /1.1/

87 \* F trading transaction cost (dollars per Kg) /400000000/

88 F trading transaction cost (dollars per Kg) /1500000/

89 TC Plant costs for the three technologies /1 0.953E-5,2 1.334E-5

,3 0.882E-5/

90

91 \* TC Plant costs for the three technologies (in $ per 1000 gallon

s) /1 1.0,2 1.55,3 0.65/

92 \* Trying new values derived from nonlinear averages

93 \* TC Plant costs for the three technologies (in $ per 1000 gallon

s) /1 0.953, 2 1.334, 3 0.882/

94 q Reductions possible by the treatment technologies (in ng per l

iter)/1 2,2 3,3 1/

95

96 water\_intake Intake of water by an average individual per day in

liters /2.0/

97 fish\_intake Intake of fish food by an everage individual in kg p

er day /0.0175/

98 safe\_hg Safe concentration of Hg in fishes in mg per kg /0.4/

99 LC50 The LC50 value of HG (taken from fishes) in micrograms per

liter /350/

100

101 Compensation Compensation for each dead person in dollar /300000

0/

102 population total population consuming the water /10000/;

103 \*

104 \* Declaration of scalars in the problem

105 \*

106 scalar k1 conversion from gallons to liters /3.7845/

107 k2 scalar used as a counter

108 U Big value for the either-or constraint modeling /10/;

109 \*

110 \* Declaration of parameters in the problem for intermediate calculations

111 \*

112 Parameter Cost cost incurred by each industry due to waste treatment setup

113 CostTechnology The cost incurred by each industry due to technol

ogy implementation only

114 CostTotal The total overall cost incurred which is to be minimiz

ed

115 CostCombined Combined cost including the technology cost and hea

lth care cost

116 CostHealth The actual health cost incurred due to the pollutant

discharge

117 ReductionTarget Desired reduction in grams per year for the indi

vidual industries

118 ReductionTargetTotal The total targetted reduction from all the

industries

119 ReductionFinal Final reduction in the discharge achieved by each

industry after optimization

120 ReductionFinalTotal The final combined reduction achieved by all

the industries

121 ReductionTechnology The final reduction achieved by each industr

y due to technology implementation only

122 WQS Water Quality Standard (ng per lit)

123 Mortality The number of people dying due to the contamination

124

125 TechnologyReductionCost Reduction cost per unit mass of the poll

utant for each technology ($ per grams)

126

127 \* NonlinearTechCost The nonlinear technology implementation cost

for each industry

128

129 CostTechSolution cost incurred by each industry for each technol

ogy due to waste treatment setup

130 CostTechSolutionPS cost incurred by each industry due to waste t

reatment setup

131 CostTechSolutionTotal The total overall cost incurred which is t

o be minimized

132 CostTechSolutionMax The maximum value for the nonlinear technolo

gy implementation costs for each industry from all samples;

133 \*

134 \* Declaration of parameters to store results

135 \*

136 Parameters TotalTrading Total amount of mercury traded

137

138 OptObjectiveSet Vector to store the Optimality results

139

140 bSet Stores the binary decision for each sample

141 Saving Saving through trading implementation

142 Results Summary of cost related values;

143 \*

144 \* Declaration of parameters related to two stage problem solution

145 \*

146 scalar iter iteration count

147 FirstIteration First iteration indicator - To control the solution

of feasibility problem

148 k3 Count for the solution of both subproblems for each sample

149 epsilon Scalar to terminate the feasibility cut generation;

150

151 epsilon = 1E-5;

152

153 parameter

154 WOpt Matrix for the second stage problem- Optimality Cut

155 TOpt The T matrix in the generation of optimality cut

156 hOpt The h vector for the second stage problem solution - optimal

ity cut

157 G2 Parameter used to generate cuts after second stage is solved

158 G1 Parameter used to generate cuts after second stage is solved

159 E1 Temporay Parameter used to generate cuts after second stage is

solved

160 E2 Temporary Parameter used to generate cuts after second stage i

s solved

161 E1Set Parameter used to store optimality cut data for each sample

162 E2Set Parameter used to store optimality cut data for each sample

163 ThetaExact Variable for comparison with thetal.l

164 a Temporary storage parameter of the first stage decision values

165 objective\_dual stores the objective value of dual solution for th

e various samples in the second stage

166

167 ThetaSet Values of Theta.l

168 ThetaExactSet Values of ThetaExact;

169 \*=========================================================================

======

170 \*

171 \* Declaration of the industry data

172 \*

173 Table Data Data related to the industries

174 \*Data(i,1) is the total volumetric discharge in MGD

175 \*Data(i,2) is the current discharge concentration in nanograms/liter

176 \*Data(i,3) is the available capital with the industry in Million Dollars

177 1 2 3

178 1 46.1 4.65 68

179 2 1.5 3.7 8

180 3 4.6 4.3 15

181 4 1.5 3.4 5

182 5 2 3.88 10

183 6 2.24 3.7 12

184 7 1.2 3.9 9

185 8 27 4.83 30

186 9 4.5 4.0 15

187 10 1 3.1 5

188 11 1 3.06 5

189 12 1 3.22 5

190 13 2 3.31 9

191 14 3.765 4.8 10

192 15 18 4.33 60

193 16 7.2 5.1 20

194 17 58.6 4.87 100

195 18 23 4.52 40

196 19 1.152 5.05 10

197 20 0.362 4.14 5

198 21 108 4.58 130

199 22 4.68 5.2 12

200 23 28.09 4.41 45

201 24 1.921 3.9 10

202 25 0.544 4.5 7

203 26 0.5 3.95 10

204 27 0.003 3.72 5

205 28 1.246 4.1 5

206 29 0.054 3.4 3;

207 \*=========================================================================

======

208 \*

209 \* Calcuation of the derived parameters:

210 \* Reduction cost for each technology in $ per gram

211 \*

212 TechnologyReductionCost(j)=0.001\*TC(j)/(10\*\*(-12)\*k1\*q(j));

213 \*

214 \* Water quality standard in nano grams per liter

215 \*

216 WQS=(HSC/CAL)\*TMDL;

217 \*

218 \* Reduction target for each industry based on the current discharge concen

tration in grams per year.

219 \* And total Targeted reduction

220 \*

221 ReductionTarget(i)=((Data(i,'2')-WQS)\*10\*\*(-12))\*Data(i,'1')\*k1\*10\*\*(6)\*36

5;

222 ReductionTargetTotal=sum(i,ReductionTarget(i));

223 \*=========================================================================

======

224 \* Declaration of parameters for the process models: The equations are writ

ten later

225 \* The parameters that are to be sampled are sampled at this stage.

226 \*=========================================================================

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227 \* Model for Coagulation and filtration (CF) process

228 \*=========================================================================

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229 \* Note: The model implemented here is only for the filtration process. It

does not

230 \* include the model for the coagulation process. The filtration model is f

or

231 \* a general water treatment process.

232 \*

233 \* Basic Parameters for the process

234 \*

235 Parameter

236 \*

237 \* Process Input

238 \*

239 CF\_PlantAvailability Plant availability in percent /100/

240 CF\_PlantOpTime Plant operation time in percent /100/

241 CF\_MembraneModuleEqCost Membrane module equipment cost in $ /370000/

242 \* This value is changed from the spreadsheet (original value 27000)

243 CF\_ModularFlowRate Modular system flow rate in GMP /600/

244 CF\_NoOfMembranesPerModule Number of membranes per module /90/

245 CF\_PumpEfficiency Pump efficiency in percent /80/

246 CF\_MotorEfficiency Motor efficiency in percent /93/

247 CF\_DesignFeedPressure Design feed pressure in PSI /30/

248 CF\_BackflushPressure Backflush pressure in PSI /29/

249 CF\_BackwashInterval Backwash interval in minutes /15/

250 CF\_BackwashBackflushDuration Backwash and backflush duration /0.1/

251 \* Uncertain parameters in this catagory

252 CF\_CostPerMembraneMean Mean cost per membrane in $ /650/

253 \* Sampled parameters are stored in a parameter used later in the loop (bas

ed on the mean value defined above)

254 CF\_CostPerMembraneSet Cost per membrane in $ - To be sampled

255 \* Sampled parameter value from the set defined above

256 CF\_CostPerMembrane Cost per membrane in $

257 \*

258 \* Operations and Maintenance cost Input

259 \*

260 CF\_DesignDosage Design dosage in mg per liter /200/

261 CF\_NaOClSpecGravity Sodium Hypochlorite specific gravity /1.168/

262 CF\_NaOClConc Sodium Hypochlorite solution concentration in percent /12/

263 CF\_StaffDays Staff days /5/

264 CF\_LaborRate Labor rate per unit hour (salary and benefits) in $ per hours

/36.2/

265 CF\_AmortizationTime Amortization time in years /20/

266 CF\_InterestRate Interest rate in percent /8/

267 CF\_BuildingAreaCost Building area cost in $ per m2 /1076/

268 CF\_PerModuleInstallationCost Per Module Installation Cost /70000/

269 \* Uncertain parameters in this catagory

270 CF\_ElectricityRateMean Mean electricity rate (cost) in $ per kWh /0.095/

271 CF\_NaOClCostMean Mean Sodium hypochlorite cost in $ per liter for 12% solu

tion /0.43/

272 CF\_MembraneLifeMean Mean membrane life in years /5/

273 \* Sampled parameters are stored in a parameter used later in the loop (bas

ed on the mean value defined above)

274 CF\_ElectricityRateSet Mean electricity rate (cost) in $ per kWh - To be sa

mpled

275 CF\_NaOClCostSet Mean Sodium hypochlorite cost in $ per liter for 12% solut

ion - To be sampled

276 CF\_MembraneLifeSet Mean Membrane life in years - To be sampled

277 \* Sampled parameter value from the set defined above

278 CF\_ElectricityRate Mean electricity rate (cost) in $ per kWh

279 CF\_NaOClCost Mean Sodium hypochlorite cost in $ per liter for 12% solution

280 CF\_MembraneLife Mean Membrane life in years;

281 \*

282 \* Sampling of the uncertain parameters: Using uniform sampling available i

n GAMS

283 \*

284 CF\_CostPerMembraneSet(m)=uniform[CF\_CostPerMembraneMean\*0.8, CF\_CostPerMem

braneMean\*1.2];

285 CF\_ElectricityRateSet(m)=uniform[CF\_ElectricityRateMean\*0.8, CF\_Electricit

yRateMean\*1.2];

286 CF\_NaOClCostSet(m)=uniform[CF\_NaOClCostMean\*0.8, CF\_NaOClCostMean\*1.2];

287 CF\_MembraneLifeSet(m)=uniform[CF\_MembraneLifeMean\*0.8, CF\_MembraneLifeMean

\*1.2];

288 \*

289 \* Computed Parameters for the process

290 \*

291 Parameter CF\_RecoveryRate Recovery rate for the water flow in percent;

292

293 Positive Variables

294 CF\_NoOfModules Number of modules

295 CF\_BackwashFlow Backwash flow

296 \*CF\_RecoveryRate Recovery rate for the water flow in percent

297 CF\_FeedPumpHP Feed pump horsepower

298 CF\_FeedPumpPower Feed pump power requirement in kWh

299 CF\_BackflushPower Backflush power requirement in kWh

300 CF\_MFF Microfiltration feed flow in liters per sec

301 CF\_NoOfMembranes Number of membranes used

302 CF\_BuildingArea Building area for the process implementation

303 \* Direct and indirect construction costs

304 CF\_MembraneModuleCost Membrane module cost

305 CF\_BuildingCost Building cost - based on the building area

306 CF\_InstallationCost Installation cost for the process

307 CF\_MiscCost Miscellaneous cost (taken as 5% of the module cost)

308 CF\_PlantPipingCost Plant piping cost (taken as 5% of the module and misc c

ost)

309 CF\_EngineeringCost Engineering cost (taken as 10% of the module and misc c

ost)

310 CF\_DirectCapitalCost Total direct capital cost

311 CF\_ConstructionInterest Expense on interest during construction (taken as

6% of total direct capital cost)

312 CF\_Contingencies Contingencies (taken as 20% of total direct capital cost)

313 CF\_ProjectManagement Fees and project management (taken as 10% of total di

rect capital cost)

314 CF\_WorkingCapital Working capital (taken as 4% of total direct capital cos

t)

315 CF\_IndirectCapitalCost Total indirect capital cost

316 CF\_TotalConstructionCost Total (direct and indirect) construction cost

317 \* Operating and maintenance costs

318 CF\_ElectricityCost Electricity cost for the implementation of the process

319 CF\_LaborCost Labor cost for the implementation of the process

320 CF\_ChemicalCost Chemical cost for the process

321 CF\_MembraneReplacementCost Membrane replacement cost for the process

322 CF\_CleaningChemicalCost Cleaning chemical (NaOCl) cost

323 CF\_Repairs Repairs replacement and misc cost (taken as 2% of the direct ca

pital cost)

324 CF\_TotalOMCost Total operating and maintenance cost

325

326 CF\_CapitalRecovery Capital recovery - calculate from the total captical co

st

327 CF\_AnnualCost Annual cost depending on the Capital recovery and OM cost;

328 \*

329 \*=========================================================================

======

330 \* Model for Granular Activated Carbon (GAC) Process

331 \*=========================================================================

======

332 \*

333 \* Basic Parameters for the process

334 \*

335 Parameter GAC\_CapitalCostK1Mean Mean of constant 1 for the capital cost ca

lculation /1948.8/

336 GAC\_CapitalCostK2 Constant 2 for the capital cost calculation /0

.2569/

337 GAC\_OMCostK1Mean Mean of constant 1 for the operating and mainte

nance cost calculation /225.42/

338 GAC\_OMCostK2 Constant 2 for the operating and maintenance cost c

alculation /0.1692/

339 \* Sampled parameters are stored in a parameter used later in the loop (bas

ed on the mean value defined above)

340 GAC\_CapitalCostK1Set Constant 1 for the capital cost calculation

- To be sampled

341 GAC\_OMCostK1Set Constant 1 for the operating and maintenance cos

t calculation - To be sampled

342 \* Sampled parameter value from the set defined above

343 GAC\_CapitalCostK1 Constant 1 for the capital cost calculation

344 GAC\_OMCostK1 Constant 1 for the operating and maintenance cost c

alculation ;

345 \*

346 \* Sampling of the uncertain parameters: Using uniform sampling available i

n GAMS

347 \*

348 GAC\_CapitalCostK1Set(m)=uniform[GAC\_CapitalCostK1Mean\*0.8, GAC\_CapitalCost

K1Mean\*1.2];

349 GAC\_OMCostK1Set(m)=uniform[GAC\_OMCostK1Mean\*0.8, GAC\_OMCostK1Mean\*1.2];

350 \*

351 \* Computed Parameters for the process

352 \*

353 Positive Variables

354 GAC\_CapitalCost Capital cost for the activated carbon process

355 GAC\_OMCost Operational and maintenance cost for the activated carbon proce

ss

356 GAC\_TotalCost Total cost for the activated carbon process implementation;

357 \*

358 \*=========================================================================

======

359 \* Model for Ion Exchange Process

360 \*=========================================================================

======

361 \*

362 \* Basic Parameters for the process

363 \*

364 Parameters

365 IX\_CationEqv Equivalents per liter of cations /0.00362/

366 IX\_AnionEqv Equivalents per liter of anions /0.00737/

367 IX\_ResinCationEqv Cation Equivalents per liter of resin /20/

368 IX\_ResinAnionEqv Anion Equivalents per liter of resin /11/

369 IX\_DesiredRunCycle Desired run cycle in days /1/

370 IX\_ServiceFlowRate Service flow rate (lit per hour per Lit of resin) /20/

371 IX\_ResinExpCoeff Resin expansion coefficient /2/

372 IX\_VesselAspectRatio Aspect ratio for the vessel /4/

373 IX\_CostFactor Cost factor for the operating pressure /2/

374 IX\_NaClMassPerResin Mass of NaCl per unit volume of resin in Kg per m3 /15

0/

375 IX\_NaClCost Cost of NaCl per kg /0.02/

376 IX\_NaClConc Concentration of the regeneration chemical in percent /10/

377 IX\_PlantAailabilityFactor Plant availability due to down time /1/

378 IX\_PlannedOpTimePerDay Planned operation time per day /1/

379 \* Uncertain parameters in this catagory

380 IX\_ResinPriceMean Mean nominal resin price in $ per m3 /1607/

381 IX\_CostSlopeMean Mean slope for the logarithmic equation for the vessel co

st calculation /0.562/

382 IX\_CostInterceptMean Mean intercept for the logarithmic equation for the v

essel cost calculation /3.446/

383 \* Sampled parameters are stored in a parameter used later in the loop (bas

ed on the mean value defined above)

384 IX\_ResinPriceSet Mean nominal resin price in $ per m3

385 IX\_CostSlopeSet Mean slope for the logarithmic equation for the vessel cos

t calculation

386 IX\_CostInterceptSet Mean intercept for the logarithmic equation for the ve

ssel cost calculation

387 \* Sampled parameter value from the set defined above

388 IX\_ResinPrice Mean nominal resin price in $ per m3

389 IX\_CostSlope Mean slope for the logarithmic equation for the vessel cost c

alculation

390 IX\_CostIntercept Mean intercept for the logarithmic equation for the vesse

l cost calculation;

391 \*

392 \* Sampling of the uncertain parameters

393 \*

394 IX\_ResinPriceSet(m)=uniform[IX\_ResinPriceMean\*0.8, IX\_ResinPriceMean\*1.2];

395 IX\_CostSlopeSet(m)=uniform[IX\_CostSlopeMean\*0.8, IX\_CostSlopeMean\*1.2];

396 IX\_CostInterceptSet(m)=uniform[IX\_CostInterceptMean\*0.8, IX\_CostInterceptM

ean\*1.2];

397 \*

398 \* Computed Parameters for the process

399 \*

400 Positive variables

401 IX\_MinResinVolume Minimum volume of the medium in m3

402 IX\_MinVolExhaustionTime Minimum volume exhaustion time in days

403 IX\_RunCycleResin Resin for the desired run cycle in m3

404 IX\_ExhaustionTimeResinVolume Resin volume in m3 for the minimum exhaustion

time

405 IX\_VesselVolume Total vessel volume in m3

406 IX\_ResinCost Total resin cost (in $ per day -- need to check)

407 IX\_BedArea Bed area for the vessel in m2

408 IX\_TankTotalCost Total Tank cost in $

409 IX\_NaClReq NaCl requirement in Kg per day

410 IX\_TotalChemCost Total chemical cost per year

411 IX\_RegFluidReq Regeneration fluid requirement

412 IX\_StorageTankCost Storage tank cost

413 IX\_ConstructionCost Construction cost

414 IX\_OMCost Operating and maintenance cost

415 IX\_TotalCost Total cost for the implementation of ion exchange process for

each industry;

416 \* This cost is the sum of the construction and vessel cost which are one t

ime expenses

417 \* and annual operating-maintenance cost and the annual resin cost.

418 \*=========================================================================

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419

420 \*=========================================================================

======

421 \*

422 \* Declaration of the model variables

423 \*

424 \* Technology only problem solution decision variables

425 \*

426 Variable Tobj Objective function for the technoogy only problem;

427 \*

428 \* First stage decision variable

429 \*

430 Parameter b binary parameter specifying the process selection based on fir

st stage decision variables;

431 Positive Variable t Variable deciding the amount of mercury traded between

various industries;

432 Variable Theta Linear approximation of the recourse function

433 MasterObjective Objective function of the master problem;

434 Positive Variable Volume volume of waste treated by each industry using ea

ch technology (defined over i and j);

435

436 \*

437 \* Second stage decision variable

438 \*

439 Variables SubObjective Objective function of the second stage sub-problem

440 WQS\_final Final water standard achieved after reduction;

441

442 \*=========================================================================

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443 \* Describing all the model computations as equations rather than simple pa

rameter

444 \* computations. The computed parameters in the model are converted into va

riables.

445 \*=========================================================================

======

446 \*

447 \* Desired flow rate in L/sec. The original unit is MGD. And the emperical

equations

448 \* use the units L/sec. So instead of using a conversion factor in all equa

tions,

449 \* generating a new parameter in the desired unit for the flow.

450 \*

451 Positive Variable DFR Desired flow rate for the industry in liters per sec

;

452 Equation DFREq;

453 DFREq(i,j).. DFR(i,j) =e= Volume(i,j)\*10\*\*(6)\*k1/86400 ;

454 \*=========================================================================

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455 \* Model for Coagulation and filtration (CF) process

456 \*=========================================================================

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457 Equations CF01, CF03, CF04, CF05, CF06, CF07, CF08, CF09, CF10, CF11, CF12

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458 CF13, CF14, CF15, CF16, CF17, CF18, CF19, CF20, CF21, CF22, CF23

, CF24, CF25,

459 CF26, CF27, CF28, CF29, CF30, CF31;

460 \* Removing the round function to avoid discontinuity in the model

461 CF01(i).. CF\_NoOfModules(i) =e= (Volume(i,'1')\*10\*\*6/(24\*60

\*CF\_ModularFlowRate)) ;

462

463 \* An approximation is used in this equation. The original equation had div

ision by DFR which might be a problem.

464 \* So here, that part is solved using previous equation so that now there i

s only parameter part remaining.

465 \* This approximation is possible only because we have removed the round fu

nction from the previous equation.

466 \*CF02(i).. CF\_RecoveryRate(i) =e= 100-(24\*3600/(CF\_Backwash

Interval\*60))\*(CF\_BackwashBackflushDuration\*60)

467 \* \* (CF\_ModularFlowRate\*k1/60)\*(1/(24

\*60\*CF\_ModularFlowRate\*k1))\*100 ;

468

469 \* Declaring recovery rate as a parameter instead of a variable

470 CF\_RecoveryRate(i) = 100-(24\*3600/(CF\_BackwashInterval\*60))\*(

CF\_BackwashBackflushDuration\*60)

471 \* (CF\_ModularFlowRate\*k1/60)\*(1/(24\*

60\*CF\_ModularFlowRate\*k1))\*100 ;

472

473 CF03(i).. CF\_MFF(i) =e= (DFR(i,'1')/(CF\_RecoveryRate(i)/100

));

474

475 CF04(i).. CF\_BackwashFlow(i) =e= (CF\_MFF(i)-DFR(i,'1'));

476

477 CF05(i).. CF\_FeedPumpHP(i) =e= (CF\_MFF(i)\*60/k1)\*(2.31\*CF\_D

esignFeedPressure)/(3960\*CF\_PumpEfficiency/100);

478

479 CF06(i).. CF\_FeedPumpPower(i) =e= CF\_FeedPumpHP(i)\*365\*24\*0

.746 ;

480 \* Note: The original equation has the term 'planned operati

on time per day' and

481 \* 'plant availability due to downtime'.

482 \* The values are 1 and hence it is ignored in the equation

above.

483

484 CF07(i).. CF\_BackflushPower(i) =e= CF\_FeedPumpHP(i)\*((CF\_Ba

ckwashBackflushDuration\*60\*86400/900)/3600) \* 365\*0.745 ;

485

486 CF08(i).. CF\_NoOfMembranes(i) =e= CF\_NoOfModules(i) \* CF\_No

OfMembranesPerModule ;

487

488 CF09(i).. CF\_BuildingArea(i) =e= (DFR(i,'1')\*86400/1000) \*

(1.227244/100) ;

489 \*

490 \* Computation of the Direct Capital Cost

491 \*

492 CF10(i).. CF\_MembraneModuleCost(i) =e= CF\_MembraneModuleEqC

ost \* CF\_NoOfModules(i) ;

493

494 CF11(i).. CF\_BuildingCost(i) =e= CF\_BuildingAreaCost \* CF\_

BuildingArea(i) ;

495

496 CF12(i).. CF\_InstallationCost(i) =e= CF\_PerModuleInstallat

ionCost \* CF\_NoOfModules(i) ;

497

498 CF13(i).. CF\_MiscCost(i) =e= CF\_MembraneModuleCost(i)\*0.0

5 ;

499

500 CF14(i).. CF\_PlantPipingCost(i) =e= (CF\_MembraneModuleCost

(i)+CF\_MiscCost(i))\*0.05 ;

501

502 CF15(i).. CF\_EngineeringCost(i) =e= (CF\_MembraneModuleCost

(i)+CF\_MiscCost(i))\*0.10 ;

503

504 CF16(i).. CF\_DirectCapitalCost(i) =e= CF\_MembraneModuleCos

t(i) + CF\_BuildingCost(i) + CF\_InstallationCost(i)

505 + CF\_MiscCost(i) + CF\_PlantPipingCost(

i) + CF\_EngineeringCost(i) ;

506 \*

507 \* Computation of the indirect Capital Cost

508 \*

509 CF17(i).. CF\_ConstructionInterest(i) =e= CF\_DirectCapitalC

ost(i) \* 0.06 ;

510

511 CF18(i).. CF\_Contingencies(i) =e= CF\_DirectCapitalCost(i)

\* 0.20 ;

512

513 CF19(i).. CF\_ProjectManagement(i) =e= CF\_DirectCapitalCost

(i) \* 0.10 ;

514

515 CF20(i).. CF\_WorkingCapital(i) =e= CF\_DirectCapitalCost(i)

\* 0.04 ;

516

517 CF21(i).. CF\_IndirectCapitalCost(i) =e= CF\_ConstructionInt

erest(i) + CF\_Contingencies(i)

518 + CF\_ProjectManagement(i) + CF\_W

orkingCapital(i) ;

519

520 CF22(i).. CF\_TotalConstructionCost(i) =e= CF\_DirectCapital

Cost(i) + CF\_IndirectCapitalCost(i) ;

521

522 \*

523 \* Operations and Maintenance cost estimates

524 \*

525 CF23(i).. CF\_ElectricityCost(i) =e= (CF\_FeedPumpPower(i)+C

F\_BackflushPower(i))\* CF\_ElectricityRate ;

526

527 CF24(i).. CF\_LaborCost(i) =e= CF\_StaffDays \* 365 \* 8 \* CF

\_LaborRate ;

528 \* Note: The original equation has the term 'planned operati

on time per day' at the end.

529 \* The value is 1 and hence it is ignored in the equation ab

ove.

530 \* Also, the rounding operation to the third place is ignore

d since it is not

531 \* necessary to have this as a integer variable.

532

533 CF25(i).. CF\_ChemicalCost(i) =e= (0.0025 \* (DFR(i,'1')\*864

00/k1) - 333.333) \* 2 \* CF\_NaOClCost ;

534

535 CF26(i).. CF\_MembraneReplacementCost(i) =e= CF\_NoOfMembra

nes(i) \* CF\_CostPerMembrane / CF\_MembraneLife ;

536 \* Note: The membrane replacement cost is taken by consideri

ng that membrane life is

537 \* 5 years and assuming uniform degradation of the membrane

every year.

538

539 CF27(i).. CF\_CleaningChemicalCost(i) =e= (0.0005 \* (DFR(i,

'1')\*86400/k1)+66.667) \* 2 \* CF\_NaOClCost ;

540

541 CF28(i).. CF\_Repairs(i) =e= CF\_DirectCapitalCost(i) \* 0.02

;

542

543 CF29(i).. CF\_TotalOMCost(i) =e= CF\_ElectricityCost(i) + CF

\_LaborCost(i) + CF\_ChemicalCost(i)

544 + CF\_MembraneReplacementCost(i) + CF\_Clea

ningChemicalCost(i) + CF\_Repairs(i) ;

545

546 CF30(i).. CF\_CapitalRecovery(i) =e= CF\_TotalConstructionCo

st(i)

547 \*(((CF\_InterestRate/100)\*(1+CF\_InterestRa

te/100)\*\*CF\_AmortizationTime)/((1+CF\_InterestRate/100)\*\*CF\_AmortizationTim

e-1)) ;

548

549 CF31(i).. CF\_AnnualCost(i) =e= (CF\_CapitalRecovery(i) + CF

\_TotalOMCost(i))\*2 ;

550

551 \*=========================================================================

======

552 \* Model for Granular Activated Carbon (GAC) Process

553 \*=========================================================================

======

554 Equations GAC01, GAC02, GAC03;

555

556 GAC01(i).. GAC\_CapitalCost(i) =e= 1948.8 \* (Volume(i,'2')

\* 3785.4118)\*\*(1-0.2569) ;

557 GAC02(i).. GAC\_OMCost(i) =e= 225.42 \* (Volume(i,'2')

\* 3785.4118)\*\*(1-0.1692) ;

558 \* Note: The constant in these equations multiplying the flow parameter is

to

559 \* convert the flow rate from MGD to m3/day.

560 GAC03(i).. GAC\_TotalCost(i) =e= GAC\_CapitalCost(i) + GAC\_O

MCost(i) ;

561 \*=========================================================================

======

562 \* Model for Ion Exchange Process

563 \*=========================================================================

======

564 \*

565 \* Computation of the Ion Exchange process parameters

566 \*

567 Equations IX01,IX02,IX04,IX05,IX06,IX07,IX08,IX09,IX10,IX11,IX12,IX13,IX14

,IX15;

568

569 IX01(i).. IX\_MinResinVolume(i) =e= (DFR(i,'3')\*3600/(IX\_Se

rviceFlowRate\*1000));

570 \* The constants are to convert the units.

571

572 IX02(i).. IX\_MinVolExhaustionTime(i) =e= IX\_ResinCationEqv\*3600/(IX\_Servi

ceFlowRate\*IX\_CationEqv\*86400);

573 \* Note: The formula is different in the document and spreadsheet! Need to

clarify.

574

575 \*\*\*\* Additional if condition as given in the spreadsheet and the document

576 \*IX03(i)$(IX\_MinVolExhaustionTime(i)>IX\_DesiredRunCycle).. IX\_ExhaustionTi

meResinVolume(i) =e= IX\_MinResinVolume(i) ;

577 \*IX04(i)$(IX\_MinVolExhaustionTime(i)<=IX\_DesiredRunCycle).. IX\_Exhaustio

nTimeResinVolume(i)

578 \* =e= IX\_DesiredRunCycle\*DFR(i,'3')\*86400\*(IX\_C

ationEqv)/(1000\*(IX\_ResinCationEqv));

579

580 IX04(i).. IX\_ExhaustionTimeResinVolume(i)

581 =e= IX\_DesiredRunCycle\*DFR(i,'3')\*86400\*(IX\_Ca

tionEqv)/(1000\*(IX\_ResinCationEqv));

582

583 IX05(i).. IX\_VesselVolume(i) =e= IX\_ExhaustionTimeResinVo

lume(i) \* IX\_ResinExpCoeff ;

584

585 IX06(i).. IX\_ResinCost(i) =e= IX\_ExhaustionTimeResinVolu

me(i) \* IX\_ResinPrice ;

586 \* Note: The resin cost is per day -- probably.

587

588 IX07(i).. IX\_TankTotalCost(i) =e= 10\*\*(IX\_CostIntercept+IX

\_CostSlope\*log10(IX\_VesselVolume(i)+epsilon))

589 \* IX\_CostFactor ;

590 \* Note: This calculation is different in the document and excel sheet. Thi

s equation

591 \* is taken from the excel sheet.

592 \*

593 \* Regeneration requirements

594 \*

595 IX08(i).. IX\_NaClReq(i) =e= IX\_ExhaustionTimeResinVolume(i

) \* IX\_NaClMassPerResin ;

596

597 IX09(i).. IX\_RegFluidReq(i) =e= IX\_NaClReq(i)/((IX\_NaClCon

c/100)\*1000);

598

599 IX10(i).. IX\_TotalChemCost(i) =e= IX\_NaClReq(i) \* IX\_NaC

lCost

600 \* (365\*IX\_PlantAailabilityFactor\*

IX\_PlannedOpTimePerDay/(IX\_DesiredRunCycle+1)) ;

601

602 \* Storage tank cost according to the spreadsheet

603 IX11(i).. IX\_StorageTankCost(i) =e=0.25\*1000\* IX\_RegFluidR

eq(i);

604 \*

605 \* Regeneration and backwashing pump

606 \*

607 IX12(i).. IX\_BedArea(i) =e= (3.14/4)\*((4\*IX\_VesselVolume(i

))/(IX\_VesselAspectRatio\*3.14))\*\*(2/3) ;

608

609 IX13(i).. IX\_ConstructionCost(i) =e= (36000 + 1254.21\* IX\_

BedArea(i) - 0.1212\*IX\_BedArea(i)\*\*2) ;

610 \* Note: The construction cost is one time -- probably.

611

612 IX14(i).. IX\_OMCost(i) =e= (73.3 \* IX\_BedArea(i)\*\*(0.75) +

2200) ;

613 \* Note: The operating and maintenance cost is annual.

614

615 IX15(i).. IX\_TotalCost(i) =e= IX\_ConstructionCost(i) + IX

\_StorageTankCost(i)

616 + IX\_TankTotalCost(i) + IX\_ResinCost(i)\*24

+ IX\_TotalChemCost(i)

617 + IX\_OMCost(i) ;

618 \*=========================================================================

======

619 Positive Variable NonlinearTechCost;

620 Equations NonlinearTechCost01, NonlinearTechCost02, NonlinearTechCost03;

621 NonlinearTechCost01(i).. NonlinearTechCost(i,'1') =e= CF\_AnnualCost(i)\*1E

-5;

622 NonlinearTechCost02(i).. NonlinearTechCost(i,'2') =e= GAC\_TotalCost(i)\*1E

-5;

623 NonlinearTechCost03(i).. NonlinearTechCost(i,'3') =e= IX\_TotalCost(i)\*1E-

5;

624 \*=========================================================================

======

625 \*

626 \* First Technology only model is solved to generate constraints for the tr

ading problem.

627 \* The constraint states that no industry should be required to spend more

as a results

628 \* of trading.

629 \*

630 \* Definig the Technology only problem

631 \*

632 Equations Tobjective

633 Tc1

634 Tc2;

635 \*

636 \* Objective: Minimization of the compliance cost. 10\*\*(-3) factor from TC(

j) and

637 \* 10\*\*(6) factor from Data(i,1) result in 1000.

638 \*

639 Tobjective.. Tobj =e= sum((i,j), NonlinearTechCost(i,j));

640 \*

641 \* Restriction on the number of technologies that can be implemented (varie

s from 1-3)

642 \*

643 Tc1(i).. sum(j,Volume(i,j)) =l= Data(i,'1');

644 \*

645 \* The reduction achieved should be atleast equal to the desired reduction.

646 \* The reduction constraint is multiplied by 1000 on both sides to avoid

647 \* numerical errors arising due to small values. In LHS, 10\*\*(-12) factor f

or q(j)

648 \* and 10\*\*6 factor for Data(i,1) result in 10\*\*(-6).

649 \*

650 Tc2(i).. 10\*\*(-6)\*k1\*365\*sum(j,q(j)\*Volume(i,j)) =g= ReductionTarget(i);

651 \*

652 \* Use a single value of reduction (probably the mean or worst value) for t

his problem solution

653 \*

654 Model TechProblem /Tobjective, Tc1, Tc2, DFREq,

655 CF01, CF03, CF04, CF05, CF06, CF07, CF08, CF09, CF10, CF11, CF12

,

656 CF13, CF14, CF15, CF16, CF17, CF18, CF19, CF20, CF21, CF22, CF23

, CF24, CF25,

657 CF26, CF27, CF28, CF29, CF30, CF31,GAC01, GAC02, GAC03,

658 IX01,IX02,IX04,IX05,IX06,IX07,IX08,IX09,IX10,IX11,IX12,IX13,IX14

,IX15,

659 NonlinearTechCost01, NonlinearTechCost02, NonlinearTechCost03/;

660 \*=========================================================================

======

661 \*

662 \* Declaration of the master problem: The the problem is the simultaneous t

echnology

663 \* and trading selection decisions.

664 \*

665 Equations Mobj Objective function for the master problem

666 Mc1 Limitation on the number of technologies per industry

667 Mc2 No trading within the industry

668 Mc3 Constrain on the objective based on linear approximation

669 Mc4 Constraint to satisfy the minimum reduction requirement

670 Mc5 Constraint not to exceed the Tech only reduction cost

671 Mc6 Lower bound on the reduction

672 Mc7 Constraint for the first master problem solution

673 Mc8 Optimality cut for the first stage problem

674 Mc9 Triel constraint;

675 \*

676 \* The objective function is the sum of the reduction cost (implementation

and

677 \* trading cost). Since trading cost is not really incurred for the watersh

ed taken

678 \* together, the objective reflects only the technology implemntation cost.

679 \*

680 \* In this problem, the master problem objective function is the linear app

roximation

681 \* of the technology implementation costs. In the second stage problem, thi

s linear

682 \* approximation is refined using nonlinear and exact equations. So in that

sense,

683 \* theta is actually the total master problem objective. One idea therefore

is to use

684 \* theta as the objective function. where theta is defined through an equal

ity constraint

685 \* to be equal to the linear tech cost. In the first stage there is no cons

traint on

686 \* theta. After the first iteration, the optimality cut is introduced in th

e master

687 \* problem on theta.

688 \*

689 Mobj.. MasterObjective =e= Theta;

690 \*

691 \* Restriction on the number of technologies that can be implemented (varie

s from 1-3)

692 \*

693 Mc1(i).. sum(j,Volume(i,j)) =l= Data(i,'1');

694 \*

695 \* No industry can trade with itself.

696 \*

697 Mc2(i).. t(i,i) =e= 0;

698 \*

699 \* Putting a constraint on the objective variable based on linear approxima

tion: NEED TO CHECK IF THIS IS RIGHT

700 \*

701 Mc3$(iter>1).. Theta =g= 1000\*365\*sum((i,j),TC(j)\*Volume(i,j));

702 \*

703 \* The reduction achieved should be atleast equal to the desired reduction.

704 \* The reduction constraint is multiplied by 1000 on both sides to avoid

705 \* numerical errors arising due to small values. In LHS, 10\*\*(-12) factor f

or q(j)

706 \* and 10\*\*6 factor for Data(i,1) result in 10\*\*(-6).

707 \*

708 Mc4(i).. 10\*\*(-6)\*k1\*365\*sum(j,q(j)\*Volume(i,j))+(sum(k,t(i,k))-r\*su

m(k,t(k,i))) =g= ReductionTarget(i);

709 \*

710 \* The cost incurred due to trading can not be higher than that due to tech

nology implementation (in $ per year).

711 \* The technology only implementation cost is the highest from given set (a

chieved through solution for each sample).

712 \*

713 Mc5(i).. CostTechSolutionMax(i) =g= 1000\*365\*sum(j,Volume(i,j)\*TC(j)

)+F\*(sum(k,t(i,k))-sum(k,t(k,i)))/1000;

714 \*

715 \* This constraint ensures that the minimim reduction is zero. Thus if some

industry already has emission

716 \* level below the regulation, then it is not allowed to increase its emiss

ion.

717 \*

718 Mc6(i).. 10\*\*(-6)\*k1\*365\*sum(j,q(j)\*Volume(i,j))+(sum(k,t(i,k))-r\*su

m(k,t(k,i))) =g= 0;

719 \*

720 \* Fixing the approximation of the second stage recourse function for the f

irst iteration

721 \*

722 Mc7$(iter=1).. Theta =e= -9999999;

723 \*

724 \* Optimality cut

725 \*

726 \*Mc8(n)$(ord(n)<iter).. Theta =g= G1(n)-sum((i,j),G2(i,'1',n,j)\*Volume(i,

j))-sum((i,k),G2(i,'2',n,k)\*t(i,k));

727 Mc8(n)$(ord(n)<iter).. Theta =g= G1(n)-sum((i,j),G2(i,'1',n,j)\*b(i,j))-su

m((i,k),G2(i,'2',n,k)\*t(i,k));

728 \*

729 \* Lower bound on the trading variable

730 \*

731 t.lo(i,k) = 0;

732 Mc9(i).. Volume(i,'1') =g= 1.0;

733

734 Model MasterProblem /Mobj, Mc1, Mc2, Mc3, Mc4, Mc5, Mc6, Mc7, Mc8, DFREq,

735 CF01, CF03, CF04, CF05, CF06, CF07, CF08, CF09, CF10, CF11, CF12

,

736 CF13, CF14, CF15, CF16, CF17, CF18, CF19, CF20, CF21, CF22, CF23

, CF24, CF25,

737 CF26, CF27, CF28, CF29, CF30, CF31,GAC01, GAC02, GAC03,

738 IX01,IX02,IX04,IX05,IX06,IX07,IX08,IX09,IX10,IX11,IX12,IX13,IX14

,IX15/;

739 \*=========================================================================

======

740 \*

741 \* Generation of the Matrices for second stage dual problem.

742 \*

743 \* In this problem, the second stage objective is the minimization of healt

h care cost.

744 \* This depends on the uncertain realization of actual discharge allocation

s (targeted reduction).

745 \* The constraints are the equality constraints that compute the final wate

r quality

746 \* standard using the first stage decision variables.

747 \* Since the first stage decisions are always second stage feasible (proble

m with

748 \* complete recourse) the feasibility cut is not introduced in this problem

.

749 \*

750 \* Matrices for the optimality cut:

751 \*

752 \* Initializing the Wopt matrix to 0.

753 \*

754 WOpt(i,s1,k)=0;

755 \*

756 \* Declaring nonzero values for those corresponding to tech selection binar

y decisions

757 \*

758 WOpt(i,'1',k)=1;

759 \*

760 \* Declaring hOpt which is always zero.

761 \*

762 hOpt(i,s1,k)=0;

763 \*

764 \* Initialize the G1 and G2 matrices for the master problem: If not initial

ized,

765 \* GAMS gives error on compilation

766 \*

767 G1(n)=0;

768 G2(i,s1,n,k)=0;

769 \*=========================================================================

======

770 \* Second stage : Formulation for the Optimality Cut

771 \*=========================================================================

======

772 \* Declaration of variables and equations for the dual (second stage) probl

ems

773 Positive variable pi simplex variable (one in number);

774 Variable OptObjective Objective function for the Optimality problem;

775 Equation OptObj Objective function for the optimality problem

776 Optconst1 Constraint for the optimality problem;

777 \*

778 \* For the second stage primal problem, the objective is the pure sum of th

e nonlinear

779 \* costs which are taken as the decision variables. So the coefficient matr

ix

780 \* consists of just 1.

781 \*

782 Optobj.. OptObjective =e= sum((i,s1,k),pi(i,s1,k)\*(hOpt(i,s1,k)- TOpt(i,

s1,k)\*a(i,s1,k)));

783 Optconst1(i,s1,k).. WOpt(i,s1,k)\*pi(i,s1,k) =l= 1;

784

785 Model Optimality /Optobj, Optconst1/;

786 \*=========================================================================

======

787 \* Start the Execution of various problem solutions.

788 \*=========================================================================

======

789 \*

790 \* Parameter/Scalar initialization

791 \*

792 \* Iteration count

793 iter=1;

794 \* Indicator of the first iteration

795 FirstIteration=1;

796 \*

797 \* The outermost loop of solving the problem iteratively will start here

798 \*

799 \* Initializing theta.l and ThetaExact to some arbitrary numbers so that th

e code

800 \* enters the loop in the first iteration. These numbers are overwritten on

ce the

801 \* Master and subproblem are solved during the first iteration.

802 \*

803 Theta.l=10;

804 ThetaExact=Theta.l+1;

805 \*

806 \* While loop to iteratively solve master problem and the optimality proble

m till

807 \* the termination criteria is achieved.

808 \* Sometimes, the values of theta.l and ThetaExact are practically same (an

d hence

809 \* the optimal has been achieved). However there is a small difference (ord

er of

810 \* 10^-9, due to which the algorithm does not terminate. This is a numerica

l issue.

811 \* To take care of it, a small number 'epsilon' is added in the comparison.

812 \*

813 \* To ensure that the technology only problem uses nonlinear costs for the

problem

814 \* solution (this will ensure that the master problem solution using the va

lue from

815 \* the tech-only solution in its constraint is second stage feasible), the

nonlinear

816 \* costs for each technology are calculated for each sample within this whi

le loop.

817 \* These costs are calculated without the inclusion of the a.l varaibles.

818 \* The costs are then stored and used for two purposes: 1. To solve the tec

h only problem

819 \* and 2. To formulate the TOpt matrix (the formulation of this matrix uses

the

820 \* first stage decision variables a.l)

821 \*

822 while((Theta.l < ThetaExact-epsilon and iter<3),

823 \*

824 \* If it is decided that new samples are to be taken in each iteration (acc

ording

825 \* to the internal sampling technique) then the sampling should be done her

e.

826 \* If using HSS, the same samples are to be used in each iteration, then th

e sampling

827 \* can be done earlier and the loop for the calculation of the NonlinearTec

hcost can be moved

828 \* outside this while loop.

829 \*

830

831 \*

832 \* Solving the optimality problem for each realization of the uncertain par

ameter

833 \* and then introducing the optimality cut if needed.

834 \*

835 for (k3=1 to card(m) by 1,

836 \*

837 \* Generating nonlinear costs for each process for each samp

le. This is later

838 \* used to generate the TOpt matrix and also to solve the Te

chnology only

839 \* problem using the nonlinear cost values.

840 \* For this, the model equations for the three

841 \* technologies need to be solved to compute the parameter '

NonLinCost'.

842 \* Currently, I do not know how to call one gams code from a

nother. Ideally,

843 \* it is better to have all those equations in another code

which is called here

844 \* iteratively for each sample. That will simplify the repre

sentation.

845 \* However, since I do not know how to do it, currently all

the equations

846 \* are included in this loop. Sorry for the messy representa

tion!

847 \*

848 \* Using the current sample number the appropriate value is

taken from the

849 \* sampled set and assigned to the parameter used in the equ

ation here.

850 \*

851 CF\_CostPerMembrane=sum(m$(ord(m)=k3),CF\_CostPerMembraneSe

t(m));

852 CF\_ElectricityRate=sum(m$(ord(m)=k3),CF\_ElectricityRateSe

t(m));

853 CF\_NaOClCost=sum(m$(ord(m)=k3),CF\_NaOClCostSet(m));

854 CF\_MembraneLife=sum(m$(ord(m)=k3),CF\_MembraneLifeSet(m));

855

856 GAC\_CapitalCostK1=sum(m$(ord(m)=k3),GAC\_CapitalCostK1Set(

m));

857 GAC\_OMCostK1=sum(m$(ord(m)=k3),GAC\_OMCostK1Set(m));

858

859 IX\_ResinPrice=sum(m$(ord(m)=k3),IX\_ResinPriceSet(m));

860 IX\_CostSlope=sum(m$(ord(m)=k3),IX\_CostSlopeSet(m));

861 IX\_CostIntercept=sum(m$(ord(m)=k3),IX\_CostInterceptSet(m)

);

862 \*

863 \* Using this to solve the technology only solution.

864 \* Solve the Technology only problem to generate the required cut fo

r

865 \* the trading problem

866 \*

867 Options Optcr=0.001;

868 Solve TechProblem using nlp minimizing Tobj;

869 \*

870 \* For the final result, the binary parameter is fixed based on the volume

variable

871 \*

872 b(i,j)=0;

873 b(i,j)=1$(Volume.l(i,j)>epsilon);

874 \*

875 \* Post solve computation of the Technology only implementation cost

s (in $/year)

876 \*

877 CostTechSolution(i,m,j)$(ord(m)=k3) = NonlinearTechCost.l

(i,j)\*b(i,j);

878 CostTechSolutionPS(i,m)$(ord(m)=k3) = sum(j,CostTechSolut

ion(i,m,j));

879 CostTechSolutionTotal(m)$(ord(m)=k3)=sum(i,CostTechSoluti

onPS(i,m));

880

881 );

882

883 Display Tobj.l, Volume.l, NonlinearTechCost.l,CostTechSolution;

884 \*

885 \* For the NonlinearTechCost for all the samples, select the maximum

value

886 \* for the solution of the tech only problem

887 \*

888 CostTechSolutionMax(i) = smax(m,CostTechSolutionPS(i,m));

889 \*

890 \* Solving the master problem using the technology only solution in

its constraint.

891 \*

892 \* MasterProblem.OptFile=1;

893 Solve MasterProblem using nlp minimizing MasterObjective;

894 Display MasterObjective.l;

895

896 \*

897 \* The first stage decisions are stored in the temporary variable to be

898 \* used by the second stage. This temporary variable combines the binary (b

) and

899 \* continuous decisions (t) into one matrix.

900 \*

901 \*

902 \* For the final result, the binary parameter is fixed based on the volume

variable

903 \*

904 b(i,j)=0;

905 b(i,j)=1$(Volume.l(i,j)>epsilon);

906

907 a(i,s1,j) = 0 ;

908 a(i,'1',j) = b(i,j);

909 a(i,'2',k) = t.l(i,k);

910

911 ThetaSet(n)$(ord(n)=iter)=Theta.l;

912 Display a;

913 \*

914 \* Solving the optimality problem for each realization of the uncertain par

ameter

915 \* and then introducing the optimality cut if needed.

916 \*

917 for (k3=1 to card(m) by 1,

918 \*

919 \* Generating 'Topt' matrix which is on the RHS of the secon

d stage problem.

920 \* For the generation of the TOpt matrix, the previously cal

culated

921 \* nonlinear technology costs and the first stage decisions

are used.

922 \*

923 \*=========================================================================

======

924 \* Using the costs computed here for the current sample, the TOpt matrix

is declared.

925 \*=========================================================================

======

926 \* Initialize T to zero

927 TOpt(i,s1,k)=0;

928 \* Enter the data for the part corresponding to binary (tech

selection) decisions

929 \* Negative sign is used to take care of the representation

in standard form.

930 TOpt(i,'1','1') = -sum(m$(ord(m)=k3),CostTechSolution(i,'

1',m));

931 TOpt(i,'1','2') = -sum(m$(ord(m)=k3),CostTechSolution(i,'

2',m));

932 TOpt(i,'1','3') = -sum(m$(ord(m)=k3),CostTechSolution(i,'

3',m));

933 \*=========================================================================

======

934

935 Options Optcr=1E-8;

936 Solve Optimality using lp maximizing OptObjective;

937

938 OptObjectiveSet(m)$(ord(m)=k3)=OptObjective.l;

939

940 \* Generation of E1 and E2:

941 E1Set(m)$(ord(m)=k3)=sum((i,s1,k),pi.l(i,s1,k)\*hOpt(i,s1,

k));

942 E2Set(i,s1,m,k)$(ord(m)=k3)=pi.l(i,s1,k)\*TOpt(i,s1,k);

943

944 );

945

946 E1 = sum(m,E1Set(m))/card(m);

947 E2(i,s1,k) = sum(m,E2Set(i,s1,m,k))/card(m);

948

949 G1(n)$(ord(n)=iter)=E1;

950 G2(i,s1,n,k)$(ord(n)=iter)=E2(i,s1,k);

951

952 ThetaExact = E1-sum((i,s1,k),E2(i,s1,k)\*a(i,s1,k));

953

954 ThetaExactSet(n)$(ord(n)=iter)=ThetaExact;

955

956 iter = iter +1 ;

957 \*

958 \* Saving the current binary decisions

959 \*

960 \* bSet(i,n,j)$(ord(n)=iter)=b.l(i,j);

961

962 \*

963 \* 'While' loop ends here.

964 \*

965 );

966

967 \*

968 \* For the final result, the binary parameter is fixed based on the volume

variable

969 \*

970 b(i,j)=0;

971 b(i,j)=1$(Volume.l(i,j)>epsilon);

972

973 ReductionFinal(i) = 10\*\*(-6)\*k1\*365\*sum(j,q(j)\*Volume.l(i,j))+(sum(k,t.l(i

,k))-r\*sum(k,t.l(k,i)));

974 ReductionFinalTotal=sum(i,ReductionFinal(i));

975 ReductionTechnology(i) = 10\*\*(-6)\*k1\*365\*sum(j,q(j)\*Volume.l(i,j));

976

977 Cost(i,'1')=1000\*365\*sum(j,Volume.l(i,j)\*TC(j))+F\*(sum(k,t.l(i,k))-sum(k,t

.l(k,i)))/1000;

978 \*Cost(i,'1')=sum(j,NonlinearTechCost.l(i,j))+F\*(sum(k,t.l(i,k))-sum(k,t.l(

k,i)))/1000;

979 CostTechnology(i,'1')=1000\*365\*sum(j,Volume.l(i,j)\*TC(j));

980 CostTotal = sum(i,Cost(i,'1'));

981

982 Saving(i,'1') = CostTechSolutionMax(i)-Cost(i,'1');

983 Results(i,'1')= CostTechSolutionMax(i);

984 Results(i,'2')= Cost(i,'1');

985 Results(i,'3')= Saving(i,'1');

986

987 option b:0;

988

989 Display ReductionTarget, ReductionFinal, ReductionTargetTotal, ReductionFi

nalTotal, ReductionTechnology;

990

991 Display MasterObjective.l, iter, Volume.l, t.l, Results,CostTechSolutionM

ax, NonlinearTechCost.l, b;

992

993

994 \*Display G1, G2, ThetaSet, ThetaExactSet;

COMPILATION TIME = 0.000 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE TechProblem Using NLP From line 868

---- Tobjective =E=

Tobjective.. Tobj - NonlinearTechCost(1,1) - NonlinearTechCost(1,2)

- NonlinearTechCost(1,3) - NonlinearTechCost(2,1) - NonlinearTechCost(2,2)

- NonlinearTechCost(2,3) - NonlinearTechCost(3,1) - NonlinearTechCost(3,2)

- NonlinearTechCost(3,3) - NonlinearTechCost(4,1) - NonlinearTechCost(4,2)

- NonlinearTechCost(4,3) - NonlinearTechCost(5,1) - NonlinearTechCost(5,2)

- NonlinearTechCost(5,3) - NonlinearTechCost(6,1) - NonlinearTechCost(6,2)

- NonlinearTechCost(6,3) - NonlinearTechCost(7,1) - NonlinearTechCost(7,2)

- NonlinearTechCost(7,3) - NonlinearTechCost(8,1) - NonlinearTechCost(8,2)

- NonlinearTechCost(8,3) - NonlinearTechCost(9,1) - NonlinearTechCost(9,2)

- NonlinearTechCost(9,3) - NonlinearTechCost(10,1)

- NonlinearTechCost(10,2) - NonlinearTechCost(10,3)

- NonlinearTechCost(11,1) - NonlinearTechCost(11,2)

- NonlinearTechCost(11,3) - NonlinearTechCost(12,1)

- NonlinearTechCost(12,2) - NonlinearTechCost(12,3)

- NonlinearTechCost(13,1) - NonlinearTechCost(13,2)

- NonlinearTechCost(13,3) - NonlinearTechCost(14,1)

- NonlinearTechCost(14,2) - NonlinearTechCost(14,3)

- NonlinearTechCost(15,1) - NonlinearTechCost(15,2)

- NonlinearTechCost(15,3) - NonlinearTechCost(16,1)

- NonlinearTechCost(16,2) - NonlinearTechCost(16,3)

- NonlinearTechCost(17,1) - NonlinearTechCost(17,2)

- NonlinearTechCost(17,3) - NonlinearTechCost(18,1)

- NonlinearTechCost(18,2) - NonlinearTechCost(18,3)

- NonlinearTechCost(19,1) - NonlinearTechCost(19,2)

- NonlinearTechCost(19,3) - NonlinearTechCost(20,1)

- NonlinearTechCost(20,2) - NonlinearTechCost(20,3)

- NonlinearTechCost(21,1) - NonlinearTechCost(21,2)

- NonlinearTechCost(21,3) - NonlinearTechCost(22,1)

- NonlinearTechCost(22,2) - NonlinearTechCost(22,3)

- NonlinearTechCost(23,1) - NonlinearTechCost(23,2)

- NonlinearTechCost(23,3) - NonlinearTechCost(24,1)

- NonlinearTechCost(24,2) - NonlinearTechCost(24,3)

- NonlinearTechCost(25,1) - NonlinearTechCost(25,2)

- NonlinearTechCost(25,3) - NonlinearTechCost(26,1)

- NonlinearTechCost(26,2) - NonlinearTechCost(26,3)

- NonlinearTechCost(27,1) - NonlinearTechCost(27,2)

- NonlinearTechCost(27,3) - NonlinearTechCost(28,1)

- NonlinearTechCost(28,2) - NonlinearTechCost(28,3)

- NonlinearTechCost(29,1) - NonlinearTechCost(29,2)

- NonlinearTechCost(29,3) =E= 0 ; (LHS = 0)

---- Tc1 =L=

Tc1(1).. Volume(1,1) + Volume(1,2) + Volume(1,3) =L= 46.1 ; (LHS = 0)

Tc1(2).. Volume(2,1) + Volume(2,2) + Volume(2,3) =L= 1.5 ; (LHS = 0)

Tc1(3).. Volume(3,1) + Volume(3,2) + Volume(3,3) =L= 4.6 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- Tc2 =G=

Tc2(1).. 0.002762685\*Volume(1,1) + 0.00414402749999999\*Volume(1,2)

+ 0.0013813425\*Volume(1,3) =G= 0.122832874808418 ;

(LHS = 0, INFES = 0.122832874808418 \*\*\*\*)

Tc2(2).. 0.002762685\*Volume(2,1) + 0.00414402749999999\*Volume(2,2)

+ 0.0013813425\*Volume(2,3) =G= 0.00202831822193877 ;

(LHS = 0, INFES = 0.00202831822193877 \*\*\*\*)

Tc2(3).. 0.002762685\*Volume(3,1) + 0.00414402749999999\*Volume(3,2)

+ 0.0013813425\*Volume(3,3) =G= 0.0100326811806122 ;

(LHS = 0, INFES = 0.0100326811806122 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- DFREq =E=

DFREq(1,1).. - 43.8020833333334\*Volume(1,1) + DFR(1,1) =E= 0 ; (LHS = 0)

DFREq(1,2).. - 43.8020833333334\*Volume(1,2) + DFR(1,2) =E= 0 ; (LHS = 0)

DFREq(1,3).. - 43.8020833333334\*Volume(1,3) + DFR(1,3) =E= 0 ; (LHS = 0)

REMAINING 84 ENTRIES SKIPPED

---- CF01 =E=

CF01(1).. CF\_NoOfModules(1) - 1.15740740740741\*Volume(1,1) =E= 0 ; (LHS = 0)

CF01(2).. CF\_NoOfModules(2) - 1.15740740740741\*Volume(2,1) =E= 0 ; (LHS = 0)

CF01(3).. CF\_NoOfModules(3) - 1.15740740740741\*Volume(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF03 =E=

CF03(1).. CF\_MFF(1) - 1.00671140939597\*DFR(1,1) =E= 0 ; (LHS = 0)

CF03(2).. CF\_MFF(2) - 1.00671140939597\*DFR(2,1) =E= 0 ; (LHS = 0)

CF03(3).. CF\_MFF(3) - 1.00671140939597\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF04 =E=

CF04(1).. CF\_BackwashFlow(1) - CF\_MFF(1) + DFR(1,1) =E= 0 ; (LHS = 0)

CF04(2).. CF\_BackwashFlow(2) - CF\_MFF(2) + DFR(2,1) =E= 0 ; (LHS = 0)

CF04(3).. CF\_BackwashFlow(3) - CF\_MFF(3) + DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF05 =E=

CF05(1).. CF\_FeedPumpHP(1) - 0.346809353943718\*CF\_MFF(1) =E= 0 ; (LHS = 0)

CF05(2).. CF\_FeedPumpHP(2) - 0.346809353943718\*CF\_MFF(2) =E= 0 ; (LHS = 0)

CF05(3).. CF\_FeedPumpHP(3) - 0.346809353943718\*CF\_MFF(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF06 =E=

CF06(1).. - 6534.96\*CF\_FeedPumpHP(1) + CF\_FeedPumpPower(1) =E= 0 ; (LHS = 0)

CF06(2).. - 6534.96\*CF\_FeedPumpHP(2) + CF\_FeedPumpPower(2) =E= 0 ; (LHS = 0)

CF06(3).. - 6534.96\*CF\_FeedPumpHP(3) + CF\_FeedPumpPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF07 =E=

CF07(1).. - 43.508\*CF\_FeedPumpHP(1) + CF\_BackflushPower(1) =E= 0 ; (LHS = 0)

CF07(2).. - 43.508\*CF\_FeedPumpHP(2) + CF\_BackflushPower(2) =E= 0 ; (LHS = 0)

CF07(3).. - 43.508\*CF\_FeedPumpHP(3) + CF\_BackflushPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF08 =E=

CF08(1).. - 90\*CF\_NoOfModules(1) + CF\_NoOfMembranes(1) =E= 0 ; (LHS = 0)

CF08(2).. - 90\*CF\_NoOfModules(2) + CF\_NoOfMembranes(2) =E= 0 ; (LHS = 0)

CF08(3).. - 90\*CF\_NoOfModules(3) + CF\_NoOfMembranes(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF09 =E=

CF09(1).. CF\_BuildingArea(1) - 1.060338816\*DFR(1,1) =E= 0 ; (LHS = 0)

CF09(2).. CF\_BuildingArea(2) - 1.060338816\*DFR(2,1) =E= 0 ; (LHS = 0)

CF09(3).. CF\_BuildingArea(3) - 1.060338816\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF10 =E=

CF10(1).. - 370000\*CF\_NoOfModules(1) + CF\_MembraneModuleCost(1) =E= 0 ;

(LHS = 0)

CF10(2).. - 370000\*CF\_NoOfModules(2) + CF\_MembraneModuleCost(2) =E= 0 ;

(LHS = 0)

CF10(3).. - 370000\*CF\_NoOfModules(3) + CF\_MembraneModuleCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF11 =E=

CF11(1).. - 1076\*CF\_BuildingArea(1) + CF\_BuildingCost(1) =E= 0 ; (LHS = 0)

CF11(2).. - 1076\*CF\_BuildingArea(2) + CF\_BuildingCost(2) =E= 0 ; (LHS = 0)

CF11(3).. - 1076\*CF\_BuildingArea(3) + CF\_BuildingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF12 =E=

CF12(1).. - 70000\*CF\_NoOfModules(1) + CF\_InstallationCost(1) =E= 0 ; (LHS = 0)

CF12(2).. - 70000\*CF\_NoOfModules(2) + CF\_InstallationCost(2) =E= 0 ; (LHS = 0)

CF12(3).. - 70000\*CF\_NoOfModules(3) + CF\_InstallationCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF13 =E=

CF13(1).. - 0.05\*CF\_MembraneModuleCost(1) + CF\_MiscCost(1) =E= 0 ; (LHS = 0)

CF13(2).. - 0.05\*CF\_MembraneModuleCost(2) + CF\_MiscCost(2) =E= 0 ; (LHS = 0)

CF13(3).. - 0.05\*CF\_MembraneModuleCost(3) + CF\_MiscCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF14 =E=

CF14(1).. - 0.05\*CF\_MembraneModuleCost(1) - 0.05\*CF\_MiscCost(1)

+ CF\_PlantPipingCost(1) =E= 0 ; (LHS = 0)

CF14(2).. - 0.05\*CF\_MembraneModuleCost(2) - 0.05\*CF\_MiscCost(2)

+ CF\_PlantPipingCost(2) =E= 0 ; (LHS = 0)

CF14(3).. - 0.05\*CF\_MembraneModuleCost(3) - 0.05\*CF\_MiscCost(3)

+ CF\_PlantPipingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF15 =E=

CF15(1).. - 0.1\*CF\_MembraneModuleCost(1) - 0.1\*CF\_MiscCost(1)

+ CF\_EngineeringCost(1) =E= 0 ; (LHS = 0)

CF15(2).. - 0.1\*CF\_MembraneModuleCost(2) - 0.1\*CF\_MiscCost(2)

+ CF\_EngineeringCost(2) =E= 0 ; (LHS = 0)

CF15(3).. - 0.1\*CF\_MembraneModuleCost(3) - 0.1\*CF\_MiscCost(3)

+ CF\_EngineeringCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF16 =E=

CF16(1).. - CF\_MembraneModuleCost(1) - CF\_BuildingCost(1)

- CF\_InstallationCost(1) - CF\_MiscCost(1) - CF\_PlantPipingCost(1)

- CF\_EngineeringCost(1) + CF\_DirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF16(2).. - CF\_MembraneModuleCost(2) - CF\_BuildingCost(2)

- CF\_InstallationCost(2) - CF\_MiscCost(2) - CF\_PlantPipingCost(2)

- CF\_EngineeringCost(2) + CF\_DirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF16(3).. - CF\_MembraneModuleCost(3) - CF\_BuildingCost(3)

- CF\_InstallationCost(3) - CF\_MiscCost(3) - CF\_PlantPipingCost(3)

- CF\_EngineeringCost(3) + CF\_DirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF17 =E=

CF17(1).. - 0.06\*CF\_DirectCapitalCost(1) + CF\_ConstructionInterest(1) =E= 0 ;

(LHS = 0)

CF17(2).. - 0.06\*CF\_DirectCapitalCost(2) + CF\_ConstructionInterest(2) =E= 0 ;

(LHS = 0)

CF17(3).. - 0.06\*CF\_DirectCapitalCost(3) + CF\_ConstructionInterest(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF18 =E=

CF18(1).. - 0.2\*CF\_DirectCapitalCost(1) + CF\_Contingencies(1) =E= 0 ; (LHS = 0)

CF18(2).. - 0.2\*CF\_DirectCapitalCost(2) + CF\_Contingencies(2) =E= 0 ; (LHS = 0)

CF18(3).. - 0.2\*CF\_DirectCapitalCost(3) + CF\_Contingencies(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF19 =E=

CF19(1).. - 0.1\*CF\_DirectCapitalCost(1) + CF\_ProjectManagement(1) =E= 0 ;

(LHS = 0)

CF19(2).. - 0.1\*CF\_DirectCapitalCost(2) + CF\_ProjectManagement(2) =E= 0 ;

(LHS = 0)

CF19(3).. - 0.1\*CF\_DirectCapitalCost(3) + CF\_ProjectManagement(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF20 =E=

CF20(1).. - 0.04\*CF\_DirectCapitalCost(1) + CF\_WorkingCapital(1) =E= 0 ;

(LHS = 0)

CF20(2).. - 0.04\*CF\_DirectCapitalCost(2) + CF\_WorkingCapital(2) =E= 0 ;

(LHS = 0)

CF20(3).. - 0.04\*CF\_DirectCapitalCost(3) + CF\_WorkingCapital(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF21 =E=

CF21(1).. - CF\_ConstructionInterest(1) - CF\_Contingencies(1)

- CF\_ProjectManagement(1) - CF\_WorkingCapital(1)

+ CF\_IndirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF21(2).. - CF\_ConstructionInterest(2) - CF\_Contingencies(2)

- CF\_ProjectManagement(2) - CF\_WorkingCapital(2)

+ CF\_IndirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF21(3).. - CF\_ConstructionInterest(3) - CF\_Contingencies(3)

- CF\_ProjectManagement(3) - CF\_WorkingCapital(3)

+ CF\_IndirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF22 =E=

CF22(1).. - CF\_DirectCapitalCost(1) - CF\_IndirectCapitalCost(1)

+ CF\_TotalConstructionCost(1) =E= 0 ; (LHS = 0)

CF22(2).. - CF\_DirectCapitalCost(2) - CF\_IndirectCapitalCost(2)

+ CF\_TotalConstructionCost(2) =E= 0 ; (LHS = 0)

CF22(3).. - CF\_DirectCapitalCost(3) - CF\_IndirectCapitalCost(3)

+ CF\_TotalConstructionCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF23 =E=

CF23(1).. - 0.113928469826\*CF\_FeedPumpPower(1)

- 0.113928469826\*CF\_BackflushPower(1) + CF\_ElectricityCost(1) =E= 0 ;

(LHS = 0)

CF23(2).. - 0.113928469826\*CF\_FeedPumpPower(2)

- 0.113928469826\*CF\_BackflushPower(2) + CF\_ElectricityCost(2) =E= 0 ;

(LHS = 0)

CF23(3).. - 0.113928469826\*CF\_FeedPumpPower(3)

- 0.113928469826\*CF\_BackflushPower(3) + CF\_ElectricityCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF24 =E=

CF24(1).. CF\_LaborCost(1) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(2).. CF\_LaborCost(2) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(3).. CF\_LaborCost(3) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF25 =E=

CF25(1).. CF\_ChemicalCost(1) - 46.3298106922616\*DFR(1,1) =E= -270.578693255703

; (LHS = 0, INFES = 270.578693255703 \*\*\*\*)

CF25(2).. CF\_ChemicalCost(2) - 46.3298106922616\*DFR(2,1) =E= -270.578693255703

; (LHS = 0, INFES = 270.578693255703 \*\*\*\*)

CF25(3).. CF\_ChemicalCost(3) - 46.3298106922616\*DFR(3,1) =E= -270.578693255703

; (LHS = 0, INFES = 270.578693255703 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF26 =E=

CF26(1).. - 133.773114625416\*CF\_NoOfMembranes(1)

+ CF\_MembraneReplacementCost(1) =E= 0 ; (LHS = 0)

CF26(2).. - 133.773114625416\*CF\_NoOfMembranes(2)

+ CF\_MembraneReplacementCost(2) =E= 0 ; (LHS = 0)

CF26(3).. - 133.773114625416\*CF\_NoOfMembranes(3)

+ CF\_MembraneReplacementCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF27 =E=

CF27(1).. CF\_CleaningChemicalCost(1) - 9.26596213845232\*DFR(1,1) =E=

54.1160633458972 ; (LHS = 0, INFES = 54.1160633458972 \*\*\*\*)

CF27(2).. CF\_CleaningChemicalCost(2) - 9.26596213845232\*DFR(2,1) =E=

54.1160633458972 ; (LHS = 0, INFES = 54.1160633458972 \*\*\*\*)

CF27(3).. CF\_CleaningChemicalCost(3) - 9.26596213845232\*DFR(3,1) =E=

54.1160633458972 ; (LHS = 0, INFES = 54.1160633458972 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF28 =E=

CF28(1).. - 0.02\*CF\_DirectCapitalCost(1) + CF\_Repairs(1) =E= 0 ; (LHS = 0)

CF28(2).. - 0.02\*CF\_DirectCapitalCost(2) + CF\_Repairs(2) =E= 0 ; (LHS = 0)

CF28(3).. - 0.02\*CF\_DirectCapitalCost(3) + CF\_Repairs(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF29 =E=

CF29(1).. - CF\_ElectricityCost(1) - CF\_LaborCost(1) - CF\_ChemicalCost(1)

- CF\_MembraneReplacementCost(1) - CF\_CleaningChemicalCost(1)

- CF\_Repairs(1) + CF\_TotalOMCost(1) =E= 0 ; (LHS = 0)

CF29(2).. - CF\_ElectricityCost(2) - CF\_LaborCost(2) - CF\_ChemicalCost(2)

- CF\_MembraneReplacementCost(2) - CF\_CleaningChemicalCost(2)

- CF\_Repairs(2) + CF\_TotalOMCost(2) =E= 0 ; (LHS = 0)

CF29(3).. - CF\_ElectricityCost(3) - CF\_LaborCost(3) - CF\_ChemicalCost(3)

- CF\_MembraneReplacementCost(3) - CF\_CleaningChemicalCost(3)

- CF\_Repairs(3) + CF\_TotalOMCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF30 =E=

CF30(1).. - 0.101852208823151\*CF\_TotalConstructionCost(1)

+ CF\_CapitalRecovery(1) =E= 0 ; (LHS = 0)

CF30(2).. - 0.101852208823151\*CF\_TotalConstructionCost(2)

+ CF\_CapitalRecovery(2) =E= 0 ; (LHS = 0)

CF30(3).. - 0.101852208823151\*CF\_TotalConstructionCost(3)

+ CF\_CapitalRecovery(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF31 =E=

CF31(1).. - 2\*CF\_TotalOMCost(1) - 2\*CF\_CapitalRecovery(1) + CF\_AnnualCost(1)

=E= 0 ; (LHS = 0)

CF31(2).. - 2\*CF\_TotalOMCost(2) - 2\*CF\_CapitalRecovery(2) + CF\_AnnualCost(2)

=E= 0 ; (LHS = 0)

CF31(3).. - 2\*CF\_TotalOMCost(3) - 2\*CF\_CapitalRecovery(3) + CF\_AnnualCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC01 =E=

GAC01(1).. GAC\_CapitalCost(1) - (7.37701051584E16)\*Volume(1,2) =E= 0 ;

(LHS = 0)

GAC01(2).. GAC\_CapitalCost(2) - (7.37701051584E16)\*Volume(2,2) =E= 0 ;

(LHS = 0)

GAC01(3).. GAC\_CapitalCost(3) - (7.37701051584E16)\*Volume(3,2) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC02 =E=

GAC02(1).. GAC\_OMCost(1) - (8.53307527956E15)\*Volume(1,2) =E= 0 ; (LHS = 0)

GAC02(2).. GAC\_OMCost(2) - (8.53307527956E15)\*Volume(2,2) =E= 0 ; (LHS = 0)

GAC02(3).. GAC\_OMCost(3) - (8.53307527956E15)\*Volume(3,2) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC03 =E=

GAC03(1).. - GAC\_CapitalCost(1) - GAC\_OMCost(1) + GAC\_TotalCost(1) =E= 0 ;

(LHS = 0)

GAC03(2).. - GAC\_CapitalCost(2) - GAC\_OMCost(2) + GAC\_TotalCost(2) =E= 0 ;

(LHS = 0)

GAC03(3).. - GAC\_CapitalCost(3) - GAC\_OMCost(3) + GAC\_TotalCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX01 =E=

IX01(1).. IX\_MinResinVolume(1) - 0.18\*DFR(1,3) =E= 0 ; (LHS = 0)

IX01(2).. IX\_MinResinVolume(2) - 0.18\*DFR(2,3) =E= 0 ; (LHS = 0)

IX01(3).. IX\_MinResinVolume(3) - 0.18\*DFR(3,3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX02 =E=

IX02(1).. IX\_MinVolExhaustionTime(1) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(2).. IX\_MinVolExhaustionTime(2) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(3).. IX\_MinVolExhaustionTime(3) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX04 =E=

IX04(1).. IX\_ExhaustionTimeResinVolume(1) - 0.0156384\*DFR(1,3) =E= 0 ;

(LHS = 0)

IX04(2).. IX\_ExhaustionTimeResinVolume(2) - 0.0156384\*DFR(2,3) =E= 0 ;

(LHS = 0)

IX04(3).. IX\_ExhaustionTimeResinVolume(3) - 0.0156384\*DFR(3,3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX05 =E=

IX05(1).. - 2\*IX\_ExhaustionTimeResinVolume(1) + IX\_VesselVolume(1) =E= 0 ;

(LHS = 0)

IX05(2).. - 2\*IX\_ExhaustionTimeResinVolume(2) + IX\_VesselVolume(2) =E= 0 ;

(LHS = 0)

IX05(3).. - 2\*IX\_ExhaustionTimeResinVolume(3) + IX\_VesselVolume(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX06 =E=

IX06(1).. - 1332.3746263144\*IX\_ExhaustionTimeResinVolume(1) + IX\_ResinCost(1)

=E= 0 ; (LHS = 0)

IX06(2).. - 1332.3746263144\*IX\_ExhaustionTimeResinVolume(2) + IX\_ResinCost(2)

=E= 0 ; (LHS = 0)

IX06(3).. - 1332.3746263144\*IX\_ExhaustionTimeResinVolume(3) + IX\_ResinCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX07 =E=

IX07(1).. - (329419.73460751)\*IX\_VesselVolume(1) + IX\_TankTotalCost(1) =E= 0 ;

(LHS = -6.53307027629864, INFES = 6.53307027629864 \*\*\*\*)

IX07(2).. - (329419.73460751)\*IX\_VesselVolume(2) + IX\_TankTotalCost(2) =E= 0 ;

(LHS = -6.53307027629864, INFES = 6.53307027629864 \*\*\*\*)

IX07(3).. - (329419.73460751)\*IX\_VesselVolume(3) + IX\_TankTotalCost(3) =E= 0 ;

(LHS = -6.53307027629864, INFES = 6.53307027629864 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX08 =E=

IX08(1).. - 150\*IX\_ExhaustionTimeResinVolume(1) + IX\_NaClReq(1) =E= 0 ;

(LHS = 0)

IX08(2).. - 150\*IX\_ExhaustionTimeResinVolume(2) + IX\_NaClReq(2) =E= 0 ;

(LHS = 0)

IX08(3).. - 150\*IX\_ExhaustionTimeResinVolume(3) + IX\_NaClReq(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX09 =E=

IX09(1).. - 0.01\*IX\_NaClReq(1) + IX\_RegFluidReq(1) =E= 0 ; (LHS = 0)

IX09(2).. - 0.01\*IX\_NaClReq(2) + IX\_RegFluidReq(2) =E= 0 ; (LHS = 0)

IX09(3).. - 0.01\*IX\_NaClReq(3) + IX\_RegFluidReq(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX10 =E=

IX10(1).. - 3.65\*IX\_NaClReq(1) + IX\_TotalChemCost(1) =E= 0 ; (LHS = 0)

IX10(2).. - 3.65\*IX\_NaClReq(2) + IX\_TotalChemCost(2) =E= 0 ; (LHS = 0)

IX10(3).. - 3.65\*IX\_NaClReq(3) + IX\_TotalChemCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX11 =E=

IX11(1).. - 250\*IX\_RegFluidReq(1) + IX\_StorageTankCost(1) =E= 0 ; (LHS = 0)

IX11(2).. - 250\*IX\_RegFluidReq(2) + IX\_StorageTankCost(2) =E= 0 ; (LHS = 0)

IX11(3).. - 250\*IX\_RegFluidReq(3) + IX\_StorageTankCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX12 =E=

IX12(1).. - (2500000000)\*IX\_VesselVolume(1) + IX\_BedArea(1) =E= 0 ; (LHS = 0)

IX12(2).. - (2500000000)\*IX\_VesselVolume(2) + IX\_BedArea(2) =E= 0 ; (LHS = 0)

IX12(3).. - (2500000000)\*IX\_VesselVolume(3) + IX\_BedArea(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX13 =E=

IX13(1).. - (1254.21)\*IX\_BedArea(1) + IX\_ConstructionCost(1) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(2).. - (1254.21)\*IX\_BedArea(2) + IX\_ConstructionCost(2) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(3).. - (1254.21)\*IX\_BedArea(3) + IX\_ConstructionCost(3) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX14 =E=

IX14(1).. - (733000000000)\*IX\_BedArea(1) + IX\_OMCost(1) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(2).. - (733000000000)\*IX\_BedArea(2) + IX\_OMCost(2) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(3).. - (733000000000)\*IX\_BedArea(3) + IX\_OMCost(3) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX15 =E=

IX15(1).. - 24\*IX\_ResinCost(1) - IX\_TankTotalCost(1) - IX\_TotalChemCost(1)

- IX\_StorageTankCost(1) - IX\_ConstructionCost(1) - IX\_OMCost(1)

+ IX\_TotalCost(1) =E= 0 ; (LHS = 0)

IX15(2).. - 24\*IX\_ResinCost(2) - IX\_TankTotalCost(2) - IX\_TotalChemCost(2)

- IX\_StorageTankCost(2) - IX\_ConstructionCost(2) - IX\_OMCost(2)

+ IX\_TotalCost(2) =E= 0 ; (LHS = 0)

IX15(3).. - 24\*IX\_ResinCost(3) - IX\_TankTotalCost(3) - IX\_TotalChemCost(3)

- IX\_StorageTankCost(3) - IX\_ConstructionCost(3) - IX\_OMCost(3)

+ IX\_TotalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost01 =E=

NonlinearTechCost01(1).. - 1E-5\*CF\_AnnualCost(1) + NonlinearTechCost(1,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(2).. - 1E-5\*CF\_AnnualCost(2) + NonlinearTechCost(2,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(3).. - 1E-5\*CF\_AnnualCost(3) + NonlinearTechCost(3,1) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost02 =E=

NonlinearTechCost02(1).. - 1E-5\*GAC\_TotalCost(1) + NonlinearTechCost(1,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(2).. - 1E-5\*GAC\_TotalCost(2) + NonlinearTechCost(2,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(3).. - 1E-5\*GAC\_TotalCost(3) + NonlinearTechCost(3,2) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost03 =E=

NonlinearTechCost03(1).. - 1E-5\*IX\_TotalCost(1) + NonlinearTechCost(1,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(2).. - 1E-5\*IX\_TotalCost(2) + NonlinearTechCost(2,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(3).. - 1E-5\*IX\_TotalCost(3) + NonlinearTechCost(3,3) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE TechProblem Using NLP From line 868

---- CF\_NoOfModules Number of modules

CF\_NoOfModules(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(1)

-90 CF08(1)

-370000 CF10(1)

-70000 CF12(1)

CF\_NoOfModules(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(2)

-90 CF08(2)

-370000 CF10(2)

-70000 CF12(2)

CF\_NoOfModules(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(3)

-90 CF08(3)

-370000 CF10(3)

-70000 CF12(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackwashFlow Backwash flow

CF\_BackwashFlow(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(1)

CF\_BackwashFlow(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(2)

CF\_BackwashFlow(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpHP Feed pump horsepower

CF\_FeedPumpHP(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(1)

-6534.96 CF06(1)

-43.508 CF07(1)

CF\_FeedPumpHP(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(2)

-6534.96 CF06(2)

-43.508 CF07(2)

CF\_FeedPumpHP(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(3)

-6534.96 CF06(3)

-43.508 CF07(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpPower Feed pump power requirement in kWh

CF\_FeedPumpPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(1)

-0.1139 CF23(1)

CF\_FeedPumpPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(2)

-0.1139 CF23(2)

CF\_FeedPumpPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(3)

-0.1139 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackflushPower Backflush power requirement in kWh

CF\_BackflushPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(1)

-0.1139 CF23(1)

CF\_BackflushPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(2)

-0.1139 CF23(2)

CF\_BackflushPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(3)

-0.1139 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MFF Microfiltration feed flow in liters per sec

CF\_MFF(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(1)

-1 CF04(1)

-0.3468 CF05(1)

CF\_MFF(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(2)

-1 CF04(2)

-0.3468 CF05(2)

CF\_MFF(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(3)

-1 CF04(3)

-0.3468 CF05(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_NoOfMembranes Number of membranes used

CF\_NoOfMembranes(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(1)

-133.7731 CF26(1)

CF\_NoOfMembranes(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(2)

-133.7731 CF26(2)

CF\_NoOfMembranes(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(3)

-133.7731 CF26(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingArea Building area for the process implementation

CF\_BuildingArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(1)

-1076 CF11(1)

CF\_BuildingArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(2)

-1076 CF11(2)

CF\_BuildingArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(3)

-1076 CF11(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneModuleCost Membrane module cost

CF\_MembraneModuleCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(1)

-0.05 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MembraneModuleCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(2)

-0.05 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MembraneModuleCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(3)

-0.05 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingCost Building cost - based on the building area

CF\_BuildingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(1)

-1 CF16(1)

CF\_BuildingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(2)

-1 CF16(2)

CF\_BuildingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_InstallationCost Installation cost for the process

CF\_InstallationCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(1)

-1 CF16(1)

CF\_InstallationCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(2)

-1 CF16(2)

CF\_InstallationCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MiscCost Miscellaneous cost (taken as 5% of the module cost)

CF\_MiscCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MiscCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MiscCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_PlantPipingCost Plant piping cost (taken as 5% of the module and misc c

ost)

CF\_PlantPipingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(1)

-1 CF16(1)

CF\_PlantPipingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(2)

-1 CF16(2)

CF\_PlantPipingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_EngineeringCost Engineering cost (taken as 10% of the module and misc c

ost)

CF\_EngineeringCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(1)

-1 CF16(1)

CF\_EngineeringCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(2)

-1 CF16(2)

CF\_EngineeringCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_DirectCapitalCost Total direct capital cost

CF\_DirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(1)

-0.06 CF17(1)

-0.2 CF18(1)

-0.1 CF19(1)

-0.04 CF20(1)

-1 CF22(1)

-0.02 CF28(1)

CF\_DirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(2)

-0.06 CF17(2)

-0.2 CF18(2)

-0.1 CF19(2)

-0.04 CF20(2)

-1 CF22(2)

-0.02 CF28(2)

CF\_DirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(3)

-0.06 CF17(3)

-0.2 CF18(3)

-0.1 CF19(3)

-0.04 CF20(3)

-1 CF22(3)

-0.02 CF28(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ConstructionInterest Expense on interest during construction (taken as

6% of total direct capital cost)

CF\_ConstructionInterest(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(1)

-1 CF21(1)

CF\_ConstructionInterest(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(2)

-1 CF21(2)

CF\_ConstructionInterest(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Contingencies Contingencies (taken as 20% of total direct capital cost)

CF\_Contingencies(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(1)

-1 CF21(1)

CF\_Contingencies(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(2)

-1 CF21(2)

CF\_Contingencies(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ProjectManagement Fees and project management (taken as 10% of total di

rect capital cost)

CF\_ProjectManagement(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(1)

-1 CF21(1)

CF\_ProjectManagement(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(2)

-1 CF21(2)

CF\_ProjectManagement(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_WorkingCapital Working capital (taken as 4% of total direct capital cos

t)

CF\_WorkingCapital(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(1)

-1 CF21(1)

CF\_WorkingCapital(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(2)

-1 CF21(2)

CF\_WorkingCapital(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_IndirectCapitalCost Total indirect capital cost

CF\_IndirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(1)

-1 CF22(1)

CF\_IndirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(2)

-1 CF22(2)

CF\_IndirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(3)

-1 CF22(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalConstructionCost Total (direct and indirect) construction cost

CF\_TotalConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(1)

-0.1019 CF30(1)

CF\_TotalConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(2)

-0.1019 CF30(2)

CF\_TotalConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(3)

-0.1019 CF30(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ElectricityCost Electricity cost for the implementation of the process

CF\_ElectricityCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(1)

-1 CF29(1)

CF\_ElectricityCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(2)

-1 CF29(2)

CF\_ElectricityCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_LaborCost Labor cost for the implementation of the process

CF\_LaborCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(1)

-1 CF29(1)

CF\_LaborCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(2)

-1 CF29(2)

CF\_LaborCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ChemicalCost Chemical cost for the process

CF\_ChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(1)

-1 CF29(1)

CF\_ChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(2)

-1 CF29(2)

CF\_ChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneReplacementCost Membrane replacement cost for the process

CF\_MembraneReplacementCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(1)

-1 CF29(1)

CF\_MembraneReplacementCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(2)

-1 CF29(2)

CF\_MembraneReplacementCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CleaningChemicalCost Cleaning chemical (NaOCl) cost

CF\_CleaningChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(1)

-1 CF29(1)

CF\_CleaningChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(2)

-1 CF29(2)

CF\_CleaningChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Repairs Repairs replacement and misc cost (taken as 2% of the direct ca

pital cost)

CF\_Repairs(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(1)

-1 CF29(1)

CF\_Repairs(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(2)

-1 CF29(2)

CF\_Repairs(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalOMCost Total operating and maintenance cost

CF\_TotalOMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(1)

-2 CF31(1)

CF\_TotalOMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(2)

-2 CF31(2)

CF\_TotalOMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CapitalRecovery Capital recovery - calculate from the total captical co

st

CF\_CapitalRecovery(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(1)

-2 CF31(1)

CF\_CapitalRecovery(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(2)

-2 CF31(2)

CF\_CapitalRecovery(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_AnnualCost Annual cost depending on the Capital recovery and OM cost

CF\_AnnualCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(1)

-1.000000E-5 NonlinearTechCost01(1)

CF\_AnnualCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(2)

-1.000000E-5 NonlinearTechCost01(2)

CF\_AnnualCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(3)

-1.000000E-5 NonlinearTechCost01(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_CapitalCost Capital cost for the activated carbon process

GAC\_CapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(1)

-1 GAC03(1)

GAC\_CapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(2)

-1 GAC03(2)

GAC\_CapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_OMCost Operational and maintenance cost for the activated carbon proce

ss

GAC\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(1)

-1 GAC03(1)

GAC\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(2)

-1 GAC03(2)

GAC\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_TotalCost Total cost for the activated carbon process implementation

GAC\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(1)

-1.000000E-5 NonlinearTechCost02(1)

GAC\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(2)

-1.000000E-5 NonlinearTechCost02(2)

GAC\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(3)

-1.000000E-5 NonlinearTechCost02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinResinVolume Minimum volume of the medium in m3

IX\_MinResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(1)

IX\_MinResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(2)

IX\_MinResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinVolExhaustionTime Minimum volume exhaustion time in days

IX\_MinVolExhaustionTime(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(1)

IX\_MinVolExhaustionTime(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(2)

IX\_MinVolExhaustionTime(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ExhaustionTimeResinVolume Resin volume in m3 for the minimum exhaustion

time

IX\_ExhaustionTimeResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(1)

-2 IX05(1)

-1332.3746 IX06(1)

-150 IX08(1)

IX\_ExhaustionTimeResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(2)

-2 IX05(2)

-1332.3746 IX06(2)

-150 IX08(2)

IX\_ExhaustionTimeResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(3)

-2 IX05(3)

-1332.3746 IX06(3)

-150 IX08(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_VesselVolume Total vessel volume in m3

IX\_VesselVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(1)

(-329419.7346) IX07(1)

(-2.500000E+9) IX12(1)

IX\_VesselVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(2)

(-329419.7346) IX07(2)

(-2.500000E+9) IX12(2)

IX\_VesselVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(3)

(-329419.7346) IX07(3)

(-2.500000E+9) IX12(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ResinCost Total resin cost (in $ per day -- need to check)

IX\_ResinCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(1)

-24 IX15(1)

IX\_ResinCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(2)

-24 IX15(2)

IX\_ResinCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(3)

-24 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_BedArea Bed area for the vessel in m2

IX\_BedArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(1)

(-1254.21) IX13(1)

(-7.33000E+11) IX14(1)

IX\_BedArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(2)

(-1254.21) IX13(2)

(-7.33000E+11) IX14(2)

IX\_BedArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(3)

(-1254.21) IX13(3)

(-7.33000E+11) IX14(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TankTotalCost Total Tank cost in $

IX\_TankTotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(1)

-1 IX15(1)

IX\_TankTotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(2)

-1 IX15(2)

IX\_TankTotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_NaClReq NaCl requirement in Kg per day

IX\_NaClReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(1)

-0.01 IX09(1)

-3.65 IX10(1)

IX\_NaClReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(2)

-0.01 IX09(2)

-3.65 IX10(2)

IX\_NaClReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(3)

-0.01 IX09(3)

-3.65 IX10(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalChemCost Total chemical cost per year

IX\_TotalChemCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(1)

-1 IX15(1)

IX\_TotalChemCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(2)

-1 IX15(2)

IX\_TotalChemCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_RegFluidReq Regeneration fluid requirement

IX\_RegFluidReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(1)

-250 IX11(1)

IX\_RegFluidReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(2)

-250 IX11(2)

IX\_RegFluidReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(3)

-250 IX11(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_StorageTankCost Storage tank cost

IX\_StorageTankCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(1)

-1 IX15(1)

IX\_StorageTankCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(2)

-1 IX15(2)

IX\_StorageTankCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ConstructionCost Construction cost

IX\_ConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(1)

-1 IX15(1)

IX\_ConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(2)

-1 IX15(2)

IX\_ConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_OMCost Operating and maintenance cost

IX\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(1)

-1 IX15(1)

IX\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(2)

-1 IX15(2)

IX\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalCost Total cost for the implementation of ion exchange process for

each industry

IX\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(1)

-1.000000E-5 NonlinearTechCost03(1)

IX\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(2)

-1.000000E-5 NonlinearTechCost03(2)

IX\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(3)

-1.000000E-5 NonlinearTechCost03(3)

REMAINING 26 ENTRIES SKIPPED

---- Tobj Objective function for the technoogy only problem

Tobj

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 Tobjective

---- Volume volume of waste treated by each industry using each technology (def

ined over i and j)

Volume(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0028 Tc2(1)

-43.8021 DFREq(1,1)

-1.1574 CF01(1)

Volume(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0041 Tc2(1)

-43.8021 DFREq(1,2)

(-7.37701E+16) GAC01(1)

(-8.53308E+15) GAC02(1)

Volume(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0014 Tc2(1)

-43.8021 DFREq(1,3)

REMAINING 84 ENTRIES SKIPPED

---- DFR Desired flow rate for the industry in liters per sec

DFR(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,1)

-1.0067 CF03(1)

1 CF04(1)

-1.0603 CF09(1)

-46.3298 CF25(1)

-9.266 CF27(1)

DFR(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,2)

DFR(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,3)

-0.18 IX01(1)

-0.0156 IX04(1)

REMAINING 84 ENTRIES SKIPPED

---- NonlinearTechCost

NonlinearTechCost(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost01(1)

NonlinearTechCost(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost02(1)

NonlinearTechCost(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost03(1)

REMAINING 84 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE TechProblem Using NLP From line 868

LOOPS FOR/WHILE 1

FOR/WHILE 1

MODEL STATISTICS

BLOCKS OF EQUATIONS 54 SINGLE EQUATIONS 1,596

BLOCKS OF VARIABLES 51 SINGLE VARIABLES 1,625

NON ZERO ELEMENTS 4,003 NON LINEAR N-Z 174

DERIVATIVE POOL 10 CONSTANT POOL 31

CODE LENGTH 1,508

GENERATION TIME = 0.047 SECONDS 4 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.047 SECONDS 4 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 1

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE TechProblem Using NLP From line 868

S O L V E S U M M A R Y

MODEL TechProblem OBJECTIVE Tobj

TYPE NLP DIRECTION MINIMIZE

SOLVER CONOPT FROM LINE 868

\*\*\*\* SOLVER STATUS 7 Licensing Problems

\*\*\*\* MODEL STATUS 11 Licensing Problem

\*\*\*\* OBJECTIVE VALUE NA

RESOURCE USAGE, LIMIT 0.000 1000.000

ITERATION COUNT, LIMIT 0 2000000000

EVALUATION ERRORS 0 0

CONOPT 3 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

\*\*\* No license found

\*\*\* To update your license, please contact your distributor.

\*\*\* Too many equations for demo mode

\*\*\* Number of equations : 1596

\*\*\* Maximum allowed : 300

\*\*\* Too many variables for demo mode

\*\*\* Number of variables : 1625

\*\*\* Maximum allowed : 300

\*\*\* Too many nonzero elements for demo mode

\*\*\* Number of nonzeros : 4003

\*\*\* Maximum allowed : 2000

No solution returned

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE TechProblem Using NLP From line 868

---- Tobjective =E=

Tobjective.. Tobj - NonlinearTechCost(1,1) - NonlinearTechCost(1,2)

- NonlinearTechCost(1,3) - NonlinearTechCost(2,1) - NonlinearTechCost(2,2)

- NonlinearTechCost(2,3) - NonlinearTechCost(3,1) - NonlinearTechCost(3,2)

- NonlinearTechCost(3,3) - NonlinearTechCost(4,1) - NonlinearTechCost(4,2)

- NonlinearTechCost(4,3) - NonlinearTechCost(5,1) - NonlinearTechCost(5,2)

- NonlinearTechCost(5,3) - NonlinearTechCost(6,1) - NonlinearTechCost(6,2)

- NonlinearTechCost(6,3) - NonlinearTechCost(7,1) - NonlinearTechCost(7,2)

- NonlinearTechCost(7,3) - NonlinearTechCost(8,1) - NonlinearTechCost(8,2)

- NonlinearTechCost(8,3) - NonlinearTechCost(9,1) - NonlinearTechCost(9,2)

- NonlinearTechCost(9,3) - NonlinearTechCost(10,1)

- NonlinearTechCost(10,2) - NonlinearTechCost(10,3)

- NonlinearTechCost(11,1) - NonlinearTechCost(11,2)

- NonlinearTechCost(11,3) - NonlinearTechCost(12,1)

- NonlinearTechCost(12,2) - NonlinearTechCost(12,3)

- NonlinearTechCost(13,1) - NonlinearTechCost(13,2)

- NonlinearTechCost(13,3) - NonlinearTechCost(14,1)

- NonlinearTechCost(14,2) - NonlinearTechCost(14,3)

- NonlinearTechCost(15,1) - NonlinearTechCost(15,2)

- NonlinearTechCost(15,3) - NonlinearTechCost(16,1)

- NonlinearTechCost(16,2) - NonlinearTechCost(16,3)

- NonlinearTechCost(17,1) - NonlinearTechCost(17,2)

- NonlinearTechCost(17,3) - NonlinearTechCost(18,1)

- NonlinearTechCost(18,2) - NonlinearTechCost(18,3)

- NonlinearTechCost(19,1) - NonlinearTechCost(19,2)

- NonlinearTechCost(19,3) - NonlinearTechCost(20,1)

- NonlinearTechCost(20,2) - NonlinearTechCost(20,3)

- NonlinearTechCost(21,1) - NonlinearTechCost(21,2)

- NonlinearTechCost(21,3) - NonlinearTechCost(22,1)

- NonlinearTechCost(22,2) - NonlinearTechCost(22,3)

- NonlinearTechCost(23,1) - NonlinearTechCost(23,2)

- NonlinearTechCost(23,3) - NonlinearTechCost(24,1)

- NonlinearTechCost(24,2) - NonlinearTechCost(24,3)

- NonlinearTechCost(25,1) - NonlinearTechCost(25,2)

- NonlinearTechCost(25,3) - NonlinearTechCost(26,1)

- NonlinearTechCost(26,2) - NonlinearTechCost(26,3)

- NonlinearTechCost(27,1) - NonlinearTechCost(27,2)

- NonlinearTechCost(27,3) - NonlinearTechCost(28,1)

- NonlinearTechCost(28,2) - NonlinearTechCost(28,3)

- NonlinearTechCost(29,1) - NonlinearTechCost(29,2)

- NonlinearTechCost(29,3) =E= 0 ; (LHS = 0)

---- Tc1 =L=

Tc1(1).. Volume(1,1) + Volume(1,2) + Volume(1,3) =L= 46.1 ; (LHS = 0)

Tc1(2).. Volume(2,1) + Volume(2,2) + Volume(2,3) =L= 1.5 ; (LHS = 0)

Tc1(3).. Volume(3,1) + Volume(3,2) + Volume(3,3) =L= 4.6 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- Tc2 =G=

Tc2(1).. 0.002762685\*Volume(1,1) + 0.00414402749999999\*Volume(1,2)

+ 0.0013813425\*Volume(1,3) =G= 0.122832874808418 ;

(LHS = 0, INFES = 0.122832874808418 \*\*\*\*)

Tc2(2).. 0.002762685\*Volume(2,1) + 0.00414402749999999\*Volume(2,2)

+ 0.0013813425\*Volume(2,3) =G= 0.00202831822193877 ;

(LHS = 0, INFES = 0.00202831822193877 \*\*\*\*)

Tc2(3).. 0.002762685\*Volume(3,1) + 0.00414402749999999\*Volume(3,2)

+ 0.0013813425\*Volume(3,3) =G= 0.0100326811806122 ;

(LHS = 0, INFES = 0.0100326811806122 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- DFREq =E=

DFREq(1,1).. - 43.8020833333334\*Volume(1,1) + DFR(1,1) =E= 0 ; (LHS = 0)

DFREq(1,2).. - 43.8020833333334\*Volume(1,2) + DFR(1,2) =E= 0 ; (LHS = 0)

DFREq(1,3).. - 43.8020833333334\*Volume(1,3) + DFR(1,3) =E= 0 ; (LHS = 0)

REMAINING 84 ENTRIES SKIPPED

---- CF01 =E=

CF01(1).. CF\_NoOfModules(1) - 1.15740740740741\*Volume(1,1) =E= 0 ; (LHS = 0)

CF01(2).. CF\_NoOfModules(2) - 1.15740740740741\*Volume(2,1) =E= 0 ; (LHS = 0)

CF01(3).. CF\_NoOfModules(3) - 1.15740740740741\*Volume(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF03 =E=

CF03(1).. CF\_MFF(1) - 1.00671140939597\*DFR(1,1) =E= 0 ; (LHS = 0)

CF03(2).. CF\_MFF(2) - 1.00671140939597\*DFR(2,1) =E= 0 ; (LHS = 0)

CF03(3).. CF\_MFF(3) - 1.00671140939597\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF04 =E=

CF04(1).. CF\_BackwashFlow(1) - CF\_MFF(1) + DFR(1,1) =E= 0 ; (LHS = 0)

CF04(2).. CF\_BackwashFlow(2) - CF\_MFF(2) + DFR(2,1) =E= 0 ; (LHS = 0)

CF04(3).. CF\_BackwashFlow(3) - CF\_MFF(3) + DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF05 =E=

CF05(1).. CF\_FeedPumpHP(1) - 0.346809353943718\*CF\_MFF(1) =E= 0 ; (LHS = 0)

CF05(2).. CF\_FeedPumpHP(2) - 0.346809353943718\*CF\_MFF(2) =E= 0 ; (LHS = 0)

CF05(3).. CF\_FeedPumpHP(3) - 0.346809353943718\*CF\_MFF(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF06 =E=

CF06(1).. - 6534.96\*CF\_FeedPumpHP(1) + CF\_FeedPumpPower(1) =E= 0 ; (LHS = 0)

CF06(2).. - 6534.96\*CF\_FeedPumpHP(2) + CF\_FeedPumpPower(2) =E= 0 ; (LHS = 0)

CF06(3).. - 6534.96\*CF\_FeedPumpHP(3) + CF\_FeedPumpPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF07 =E=

CF07(1).. - 43.508\*CF\_FeedPumpHP(1) + CF\_BackflushPower(1) =E= 0 ; (LHS = 0)

CF07(2).. - 43.508\*CF\_FeedPumpHP(2) + CF\_BackflushPower(2) =E= 0 ; (LHS = 0)

CF07(3).. - 43.508\*CF\_FeedPumpHP(3) + CF\_BackflushPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF08 =E=

CF08(1).. - 90\*CF\_NoOfModules(1) + CF\_NoOfMembranes(1) =E= 0 ; (LHS = 0)

CF08(2).. - 90\*CF\_NoOfModules(2) + CF\_NoOfMembranes(2) =E= 0 ; (LHS = 0)

CF08(3).. - 90\*CF\_NoOfModules(3) + CF\_NoOfMembranes(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF09 =E=

CF09(1).. CF\_BuildingArea(1) - 1.060338816\*DFR(1,1) =E= 0 ; (LHS = 0)

CF09(2).. CF\_BuildingArea(2) - 1.060338816\*DFR(2,1) =E= 0 ; (LHS = 0)

CF09(3).. CF\_BuildingArea(3) - 1.060338816\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF10 =E=

CF10(1).. - 370000\*CF\_NoOfModules(1) + CF\_MembraneModuleCost(1) =E= 0 ;

(LHS = 0)

CF10(2).. - 370000\*CF\_NoOfModules(2) + CF\_MembraneModuleCost(2) =E= 0 ;

(LHS = 0)

CF10(3).. - 370000\*CF\_NoOfModules(3) + CF\_MembraneModuleCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF11 =E=

CF11(1).. - 1076\*CF\_BuildingArea(1) + CF\_BuildingCost(1) =E= 0 ; (LHS = 0)

CF11(2).. - 1076\*CF\_BuildingArea(2) + CF\_BuildingCost(2) =E= 0 ; (LHS = 0)

CF11(3).. - 1076\*CF\_BuildingArea(3) + CF\_BuildingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF12 =E=

CF12(1).. - 70000\*CF\_NoOfModules(1) + CF\_InstallationCost(1) =E= 0 ; (LHS = 0)

CF12(2).. - 70000\*CF\_NoOfModules(2) + CF\_InstallationCost(2) =E= 0 ; (LHS = 0)

CF12(3).. - 70000\*CF\_NoOfModules(3) + CF\_InstallationCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF13 =E=

CF13(1).. - 0.05\*CF\_MembraneModuleCost(1) + CF\_MiscCost(1) =E= 0 ; (LHS = 0)

CF13(2).. - 0.05\*CF\_MembraneModuleCost(2) + CF\_MiscCost(2) =E= 0 ; (LHS = 0)

CF13(3).. - 0.05\*CF\_MembraneModuleCost(3) + CF\_MiscCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF14 =E=

CF14(1).. - 0.05\*CF\_MembraneModuleCost(1) - 0.05\*CF\_MiscCost(1)

+ CF\_PlantPipingCost(1) =E= 0 ; (LHS = 0)

CF14(2).. - 0.05\*CF\_MembraneModuleCost(2) - 0.05\*CF\_MiscCost(2)

+ CF\_PlantPipingCost(2) =E= 0 ; (LHS = 0)

CF14(3).. - 0.05\*CF\_MembraneModuleCost(3) - 0.05\*CF\_MiscCost(3)

+ CF\_PlantPipingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF15 =E=

CF15(1).. - 0.1\*CF\_MembraneModuleCost(1) - 0.1\*CF\_MiscCost(1)

+ CF\_EngineeringCost(1) =E= 0 ; (LHS = 0)

CF15(2).. - 0.1\*CF\_MembraneModuleCost(2) - 0.1\*CF\_MiscCost(2)

+ CF\_EngineeringCost(2) =E= 0 ; (LHS = 0)

CF15(3).. - 0.1\*CF\_MembraneModuleCost(3) - 0.1\*CF\_MiscCost(3)

+ CF\_EngineeringCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF16 =E=

CF16(1).. - CF\_MembraneModuleCost(1) - CF\_BuildingCost(1)

- CF\_InstallationCost(1) - CF\_MiscCost(1) - CF\_PlantPipingCost(1)

- CF\_EngineeringCost(1) + CF\_DirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF16(2).. - CF\_MembraneModuleCost(2) - CF\_BuildingCost(2)

- CF\_InstallationCost(2) - CF\_MiscCost(2) - CF\_PlantPipingCost(2)

- CF\_EngineeringCost(2) + CF\_DirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF16(3).. - CF\_MembraneModuleCost(3) - CF\_BuildingCost(3)

- CF\_InstallationCost(3) - CF\_MiscCost(3) - CF\_PlantPipingCost(3)

- CF\_EngineeringCost(3) + CF\_DirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF17 =E=

CF17(1).. - 0.06\*CF\_DirectCapitalCost(1) + CF\_ConstructionInterest(1) =E= 0 ;

(LHS = 0)

CF17(2).. - 0.06\*CF\_DirectCapitalCost(2) + CF\_ConstructionInterest(2) =E= 0 ;

(LHS = 0)

CF17(3).. - 0.06\*CF\_DirectCapitalCost(3) + CF\_ConstructionInterest(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF18 =E=

CF18(1).. - 0.2\*CF\_DirectCapitalCost(1) + CF\_Contingencies(1) =E= 0 ; (LHS = 0)

CF18(2).. - 0.2\*CF\_DirectCapitalCost(2) + CF\_Contingencies(2) =E= 0 ; (LHS = 0)

CF18(3).. - 0.2\*CF\_DirectCapitalCost(3) + CF\_Contingencies(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF19 =E=

CF19(1).. - 0.1\*CF\_DirectCapitalCost(1) + CF\_ProjectManagement(1) =E= 0 ;

(LHS = 0)

CF19(2).. - 0.1\*CF\_DirectCapitalCost(2) + CF\_ProjectManagement(2) =E= 0 ;

(LHS = 0)

CF19(3).. - 0.1\*CF\_DirectCapitalCost(3) + CF\_ProjectManagement(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF20 =E=

CF20(1).. - 0.04\*CF\_DirectCapitalCost(1) + CF\_WorkingCapital(1) =E= 0 ;

(LHS = 0)

CF20(2).. - 0.04\*CF\_DirectCapitalCost(2) + CF\_WorkingCapital(2) =E= 0 ;

(LHS = 0)

CF20(3).. - 0.04\*CF\_DirectCapitalCost(3) + CF\_WorkingCapital(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF21 =E=

CF21(1).. - CF\_ConstructionInterest(1) - CF\_Contingencies(1)

- CF\_ProjectManagement(1) - CF\_WorkingCapital(1)

+ CF\_IndirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF21(2).. - CF\_ConstructionInterest(2) - CF\_Contingencies(2)

- CF\_ProjectManagement(2) - CF\_WorkingCapital(2)

+ CF\_IndirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF21(3).. - CF\_ConstructionInterest(3) - CF\_Contingencies(3)

- CF\_ProjectManagement(3) - CF\_WorkingCapital(3)

+ CF\_IndirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF22 =E=

CF22(1).. - CF\_DirectCapitalCost(1) - CF\_IndirectCapitalCost(1)

+ CF\_TotalConstructionCost(1) =E= 0 ; (LHS = 0)

CF22(2).. - CF\_DirectCapitalCost(2) - CF\_IndirectCapitalCost(2)

+ CF\_TotalConstructionCost(2) =E= 0 ; (LHS = 0)

CF22(3).. - CF\_DirectCapitalCost(3) - CF\_IndirectCapitalCost(3)

+ CF\_TotalConstructionCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF23 =E=

CF23(1).. - 0.097991868364\*CF\_FeedPumpPower(1)

- 0.097991868364\*CF\_BackflushPower(1) + CF\_ElectricityCost(1) =E= 0 ;

(LHS = 0)

CF23(2).. - 0.097991868364\*CF\_FeedPumpPower(2)

- 0.097991868364\*CF\_BackflushPower(2) + CF\_ElectricityCost(2) =E= 0 ;

(LHS = 0)

CF23(3).. - 0.097991868364\*CF\_FeedPumpPower(3)

- 0.097991868364\*CF\_BackflushPower(3) + CF\_ElectricityCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF24 =E=

CF24(1).. CF\_LaborCost(1) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(2).. CF\_LaborCost(2) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(3).. CF\_LaborCost(3) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF25 =E=

CF25(1).. CF\_ChemicalCost(1) - 46.1676573940737\*DFR(1,1) =E= -269.631673898723

; (LHS = 0, INFES = 269.631673898723 \*\*\*\*)

CF25(2).. CF\_ChemicalCost(2) - 46.1676573940737\*DFR(2,1) =E= -269.631673898723

; (LHS = 0, INFES = 269.631673898723 \*\*\*\*)

CF25(3).. CF\_ChemicalCost(3) - 46.1676573940737\*DFR(3,1) =E= -269.631673898723

; (LHS = 0, INFES = 269.631673898723 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF26 =E=

CF26(1).. - 147.708962383087\*CF\_NoOfMembranes(1)

+ CF\_MembraneReplacementCost(1) =E= 0 ; (LHS = 0)

CF26(2).. - 147.708962383087\*CF\_NoOfMembranes(2)

+ CF\_MembraneReplacementCost(2) =E= 0 ; (LHS = 0)

CF26(3).. - 147.708962383087\*CF\_NoOfMembranes(3)

+ CF\_MembraneReplacementCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF27 =E=

CF27(1).. CF\_CleaningChemicalCost(1) - 9.23353147881475\*DFR(1,1) =E=

53.9266583380769 ; (LHS = 0, INFES = 53.9266583380769 \*\*\*\*)

CF27(2).. CF\_CleaningChemicalCost(2) - 9.23353147881475\*DFR(2,1) =E=

53.9266583380769 ; (LHS = 0, INFES = 53.9266583380769 \*\*\*\*)

CF27(3).. CF\_CleaningChemicalCost(3) - 9.23353147881475\*DFR(3,1) =E=

53.9266583380769 ; (LHS = 0, INFES = 53.9266583380769 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF28 =E=

CF28(1).. - 0.02\*CF\_DirectCapitalCost(1) + CF\_Repairs(1) =E= 0 ; (LHS = 0)

CF28(2).. - 0.02\*CF\_DirectCapitalCost(2) + CF\_Repairs(2) =E= 0 ; (LHS = 0)

CF28(3).. - 0.02\*CF\_DirectCapitalCost(3) + CF\_Repairs(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF29 =E=

CF29(1).. - CF\_ElectricityCost(1) - CF\_LaborCost(1) - CF\_ChemicalCost(1)

- CF\_MembraneReplacementCost(1) - CF\_CleaningChemicalCost(1)

- CF\_Repairs(1) + CF\_TotalOMCost(1) =E= 0 ; (LHS = 0)

CF29(2).. - CF\_ElectricityCost(2) - CF\_LaborCost(2) - CF\_ChemicalCost(2)

- CF\_MembraneReplacementCost(2) - CF\_CleaningChemicalCost(2)

- CF\_Repairs(2) + CF\_TotalOMCost(2) =E= 0 ; (LHS = 0)

CF29(3).. - CF\_ElectricityCost(3) - CF\_LaborCost(3) - CF\_ChemicalCost(3)

- CF\_MembraneReplacementCost(3) - CF\_CleaningChemicalCost(3)

- CF\_Repairs(3) + CF\_TotalOMCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF30 =E=

CF30(1).. - 0.101852208823151\*CF\_TotalConstructionCost(1)

+ CF\_CapitalRecovery(1) =E= 0 ; (LHS = 0)

CF30(2).. - 0.101852208823151\*CF\_TotalConstructionCost(2)

+ CF\_CapitalRecovery(2) =E= 0 ; (LHS = 0)

CF30(3).. - 0.101852208823151\*CF\_TotalConstructionCost(3)

+ CF\_CapitalRecovery(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF31 =E=

CF31(1).. - 2\*CF\_TotalOMCost(1) - 2\*CF\_CapitalRecovery(1) + CF\_AnnualCost(1)

=E= 0 ; (LHS = 0)

CF31(2).. - 2\*CF\_TotalOMCost(2) - 2\*CF\_CapitalRecovery(2) + CF\_AnnualCost(2)

=E= 0 ; (LHS = 0)

CF31(3).. - 2\*CF\_TotalOMCost(3) - 2\*CF\_CapitalRecovery(3) + CF\_AnnualCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC01 =E=

GAC01(1).. GAC\_CapitalCost(1) - (7.37701051584E16)\*Volume(1,2) =E= 0 ;

(LHS = 0)

GAC01(2).. GAC\_CapitalCost(2) - (7.37701051584E16)\*Volume(2,2) =E= 0 ;

(LHS = 0)

GAC01(3).. GAC\_CapitalCost(3) - (7.37701051584E16)\*Volume(3,2) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC02 =E=

GAC02(1).. GAC\_OMCost(1) - (8.53307527956E15)\*Volume(1,2) =E= 0 ; (LHS = 0)

GAC02(2).. GAC\_OMCost(2) - (8.53307527956E15)\*Volume(2,2) =E= 0 ; (LHS = 0)

GAC02(3).. GAC\_OMCost(3) - (8.53307527956E15)\*Volume(3,2) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC03 =E=

GAC03(1).. - GAC\_CapitalCost(1) - GAC\_OMCost(1) + GAC\_TotalCost(1) =E= 0 ;

(LHS = 0)

GAC03(2).. - GAC\_CapitalCost(2) - GAC\_OMCost(2) + GAC\_TotalCost(2) =E= 0 ;

(LHS = 0)

GAC03(3).. - GAC\_CapitalCost(3) - GAC\_OMCost(3) + GAC\_TotalCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX01 =E=

IX01(1).. IX\_MinResinVolume(1) - 0.18\*DFR(1,3) =E= 0 ; (LHS = 0)

IX01(2).. IX\_MinResinVolume(2) - 0.18\*DFR(2,3) =E= 0 ; (LHS = 0)

IX01(3).. IX\_MinResinVolume(3) - 0.18\*DFR(3,3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX02 =E=

IX02(1).. IX\_MinVolExhaustionTime(1) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(2).. IX\_MinVolExhaustionTime(2) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(3).. IX\_MinVolExhaustionTime(3) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX04 =E=

IX04(1).. IX\_ExhaustionTimeResinVolume(1) - 0.0156384\*DFR(1,3) =E= 0 ;

(LHS = 0)

IX04(2).. IX\_ExhaustionTimeResinVolume(2) - 0.0156384\*DFR(2,3) =E= 0 ;

(LHS = 0)

IX04(3).. IX\_ExhaustionTimeResinVolume(3) - 0.0156384\*DFR(3,3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX05 =E=

IX05(1).. - 2\*IX\_ExhaustionTimeResinVolume(1) + IX\_VesselVolume(1) =E= 0 ;

(LHS = 0)

IX05(2).. - 2\*IX\_ExhaustionTimeResinVolume(2) + IX\_VesselVolume(2) =E= 0 ;

(LHS = 0)

IX05(3).. - 2\*IX\_ExhaustionTimeResinVolume(3) + IX\_VesselVolume(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX06 =E=

IX06(1).. - 1398.5149222972\*IX\_ExhaustionTimeResinVolume(1) + IX\_ResinCost(1)

=E= 0 ; (LHS = 0)

IX06(2).. - 1398.5149222972\*IX\_ExhaustionTimeResinVolume(2) + IX\_ResinCost(2)

=E= 0 ; (LHS = 0)

IX06(3).. - 1398.5149222972\*IX\_ExhaustionTimeResinVolume(3) + IX\_ResinCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX07 =E=

IX07(1).. - (175034.043621232)\*IX\_VesselVolume(1) + IX\_TankTotalCost(1) =E= 0 ;

(LHS = -3.4660511260612, INFES = 3.4660511260612 \*\*\*\*)

IX07(2).. - (175034.043621232)\*IX\_VesselVolume(2) + IX\_TankTotalCost(2) =E= 0 ;

(LHS = -3.4660511260612, INFES = 3.4660511260612 \*\*\*\*)

IX07(3).. - (175034.043621232)\*IX\_VesselVolume(3) + IX\_TankTotalCost(3) =E= 0 ;

(LHS = -3.4660511260612, INFES = 3.4660511260612 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX08 =E=

IX08(1).. - 150\*IX\_ExhaustionTimeResinVolume(1) + IX\_NaClReq(1) =E= 0 ;

(LHS = 0)

IX08(2).. - 150\*IX\_ExhaustionTimeResinVolume(2) + IX\_NaClReq(2) =E= 0 ;

(LHS = 0)

IX08(3).. - 150\*IX\_ExhaustionTimeResinVolume(3) + IX\_NaClReq(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX09 =E=

IX09(1).. - 0.01\*IX\_NaClReq(1) + IX\_RegFluidReq(1) =E= 0 ; (LHS = 0)

IX09(2).. - 0.01\*IX\_NaClReq(2) + IX\_RegFluidReq(2) =E= 0 ; (LHS = 0)

IX09(3).. - 0.01\*IX\_NaClReq(3) + IX\_RegFluidReq(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX10 =E=

IX10(1).. - 3.65\*IX\_NaClReq(1) + IX\_TotalChemCost(1) =E= 0 ; (LHS = 0)

IX10(2).. - 3.65\*IX\_NaClReq(2) + IX\_TotalChemCost(2) =E= 0 ; (LHS = 0)

IX10(3).. - 3.65\*IX\_NaClReq(3) + IX\_TotalChemCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX11 =E=

IX11(1).. - 250\*IX\_RegFluidReq(1) + IX\_StorageTankCost(1) =E= 0 ; (LHS = 0)

IX11(2).. - 250\*IX\_RegFluidReq(2) + IX\_StorageTankCost(2) =E= 0 ; (LHS = 0)

IX11(3).. - 250\*IX\_RegFluidReq(3) + IX\_StorageTankCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX12 =E=

IX12(1).. - (2500000000)\*IX\_VesselVolume(1) + IX\_BedArea(1) =E= 0 ; (LHS = 0)

IX12(2).. - (2500000000)\*IX\_VesselVolume(2) + IX\_BedArea(2) =E= 0 ; (LHS = 0)

IX12(3).. - (2500000000)\*IX\_VesselVolume(3) + IX\_BedArea(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX13 =E=

IX13(1).. - (1254.21)\*IX\_BedArea(1) + IX\_ConstructionCost(1) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(2).. - (1254.21)\*IX\_BedArea(2) + IX\_ConstructionCost(2) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(3).. - (1254.21)\*IX\_BedArea(3) + IX\_ConstructionCost(3) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX14 =E=

IX14(1).. - (733000000000)\*IX\_BedArea(1) + IX\_OMCost(1) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(2).. - (733000000000)\*IX\_BedArea(2) + IX\_OMCost(2) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(3).. - (733000000000)\*IX\_BedArea(3) + IX\_OMCost(3) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX15 =E=

IX15(1).. - 24\*IX\_ResinCost(1) - IX\_TankTotalCost(1) - IX\_TotalChemCost(1)

- IX\_StorageTankCost(1) - IX\_ConstructionCost(1) - IX\_OMCost(1)

+ IX\_TotalCost(1) =E= 0 ; (LHS = 0)

IX15(2).. - 24\*IX\_ResinCost(2) - IX\_TankTotalCost(2) - IX\_TotalChemCost(2)

- IX\_StorageTankCost(2) - IX\_ConstructionCost(2) - IX\_OMCost(2)

+ IX\_TotalCost(2) =E= 0 ; (LHS = 0)

IX15(3).. - 24\*IX\_ResinCost(3) - IX\_TankTotalCost(3) - IX\_TotalChemCost(3)

- IX\_StorageTankCost(3) - IX\_ConstructionCost(3) - IX\_OMCost(3)

+ IX\_TotalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost01 =E=

NonlinearTechCost01(1).. - 1E-5\*CF\_AnnualCost(1) + NonlinearTechCost(1,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(2).. - 1E-5\*CF\_AnnualCost(2) + NonlinearTechCost(2,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(3).. - 1E-5\*CF\_AnnualCost(3) + NonlinearTechCost(3,1) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost02 =E=

NonlinearTechCost02(1).. - 1E-5\*GAC\_TotalCost(1) + NonlinearTechCost(1,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(2).. - 1E-5\*GAC\_TotalCost(2) + NonlinearTechCost(2,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(3).. - 1E-5\*GAC\_TotalCost(3) + NonlinearTechCost(3,2) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost03 =E=

NonlinearTechCost03(1).. - 1E-5\*IX\_TotalCost(1) + NonlinearTechCost(1,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(2).. - 1E-5\*IX\_TotalCost(2) + NonlinearTechCost(2,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(3).. - 1E-5\*IX\_TotalCost(3) + NonlinearTechCost(3,3) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE TechProblem Using NLP From line 868

---- CF\_NoOfModules Number of modules

CF\_NoOfModules(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(1)

-90 CF08(1)

-370000 CF10(1)

-70000 CF12(1)

CF\_NoOfModules(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(2)

-90 CF08(2)

-370000 CF10(2)

-70000 CF12(2)

CF\_NoOfModules(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(3)

-90 CF08(3)

-370000 CF10(3)

-70000 CF12(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackwashFlow Backwash flow

CF\_BackwashFlow(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(1)

CF\_BackwashFlow(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(2)

CF\_BackwashFlow(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpHP Feed pump horsepower

CF\_FeedPumpHP(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(1)

-6534.96 CF06(1)

-43.508 CF07(1)

CF\_FeedPumpHP(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(2)

-6534.96 CF06(2)

-43.508 CF07(2)

CF\_FeedPumpHP(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(3)

-6534.96 CF06(3)

-43.508 CF07(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpPower Feed pump power requirement in kWh

CF\_FeedPumpPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(1)

-0.098 CF23(1)

CF\_FeedPumpPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(2)

-0.098 CF23(2)

CF\_FeedPumpPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(3)

-0.098 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackflushPower Backflush power requirement in kWh

CF\_BackflushPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(1)

-0.098 CF23(1)

CF\_BackflushPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(2)

-0.098 CF23(2)

CF\_BackflushPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(3)

-0.098 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MFF Microfiltration feed flow in liters per sec

CF\_MFF(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(1)

-1 CF04(1)

-0.3468 CF05(1)

CF\_MFF(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(2)

-1 CF04(2)

-0.3468 CF05(2)

CF\_MFF(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(3)

-1 CF04(3)

-0.3468 CF05(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_NoOfMembranes Number of membranes used

CF\_NoOfMembranes(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(1)

-147.709 CF26(1)

CF\_NoOfMembranes(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(2)

-147.709 CF26(2)

CF\_NoOfMembranes(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(3)

-147.709 CF26(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingArea Building area for the process implementation

CF\_BuildingArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(1)

-1076 CF11(1)

CF\_BuildingArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(2)

-1076 CF11(2)

CF\_BuildingArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(3)

-1076 CF11(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneModuleCost Membrane module cost

CF\_MembraneModuleCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(1)

-0.05 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MembraneModuleCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(2)

-0.05 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MembraneModuleCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(3)

-0.05 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingCost Building cost - based on the building area

CF\_BuildingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(1)

-1 CF16(1)

CF\_BuildingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(2)

-1 CF16(2)

CF\_BuildingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_InstallationCost Installation cost for the process

CF\_InstallationCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(1)

-1 CF16(1)

CF\_InstallationCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(2)

-1 CF16(2)

CF\_InstallationCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MiscCost Miscellaneous cost (taken as 5% of the module cost)

CF\_MiscCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MiscCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MiscCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_PlantPipingCost Plant piping cost (taken as 5% of the module and misc c

ost)

CF\_PlantPipingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(1)

-1 CF16(1)

CF\_PlantPipingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(2)

-1 CF16(2)

CF\_PlantPipingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_EngineeringCost Engineering cost (taken as 10% of the module and misc c

ost)

CF\_EngineeringCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(1)

-1 CF16(1)

CF\_EngineeringCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(2)

-1 CF16(2)

CF\_EngineeringCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_DirectCapitalCost Total direct capital cost

CF\_DirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(1)

-0.06 CF17(1)

-0.2 CF18(1)

-0.1 CF19(1)

-0.04 CF20(1)

-1 CF22(1)

-0.02 CF28(1)

CF\_DirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(2)

-0.06 CF17(2)

-0.2 CF18(2)

-0.1 CF19(2)

-0.04 CF20(2)

-1 CF22(2)

-0.02 CF28(2)

CF\_DirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(3)

-0.06 CF17(3)

-0.2 CF18(3)

-0.1 CF19(3)

-0.04 CF20(3)

-1 CF22(3)

-0.02 CF28(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ConstructionInterest Expense on interest during construction (taken as

6% of total direct capital cost)

CF\_ConstructionInterest(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(1)

-1 CF21(1)

CF\_ConstructionInterest(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(2)

-1 CF21(2)

CF\_ConstructionInterest(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Contingencies Contingencies (taken as 20% of total direct capital cost)

CF\_Contingencies(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(1)

-1 CF21(1)

CF\_Contingencies(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(2)

-1 CF21(2)

CF\_Contingencies(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ProjectManagement Fees and project management (taken as 10% of total di

rect capital cost)

CF\_ProjectManagement(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(1)

-1 CF21(1)

CF\_ProjectManagement(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(2)

-1 CF21(2)

CF\_ProjectManagement(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_WorkingCapital Working capital (taken as 4% of total direct capital cos

t)

CF\_WorkingCapital(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(1)

-1 CF21(1)

CF\_WorkingCapital(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(2)

-1 CF21(2)

CF\_WorkingCapital(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_IndirectCapitalCost Total indirect capital cost

CF\_IndirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(1)

-1 CF22(1)

CF\_IndirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(2)

-1 CF22(2)

CF\_IndirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(3)

-1 CF22(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalConstructionCost Total (direct and indirect) construction cost

CF\_TotalConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(1)

-0.1019 CF30(1)

CF\_TotalConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(2)

-0.1019 CF30(2)

CF\_TotalConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(3)

-0.1019 CF30(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ElectricityCost Electricity cost for the implementation of the process

CF\_ElectricityCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(1)

-1 CF29(1)

CF\_ElectricityCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(2)

-1 CF29(2)

CF\_ElectricityCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_LaborCost Labor cost for the implementation of the process

CF\_LaborCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(1)

-1 CF29(1)

CF\_LaborCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(2)

-1 CF29(2)

CF\_LaborCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ChemicalCost Chemical cost for the process

CF\_ChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(1)

-1 CF29(1)

CF\_ChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(2)

-1 CF29(2)

CF\_ChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneReplacementCost Membrane replacement cost for the process

CF\_MembraneReplacementCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(1)

-1 CF29(1)

CF\_MembraneReplacementCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(2)

-1 CF29(2)

CF\_MembraneReplacementCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CleaningChemicalCost Cleaning chemical (NaOCl) cost

CF\_CleaningChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(1)

-1 CF29(1)

CF\_CleaningChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(2)

-1 CF29(2)

CF\_CleaningChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Repairs Repairs replacement and misc cost (taken as 2% of the direct ca

pital cost)

CF\_Repairs(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(1)

-1 CF29(1)

CF\_Repairs(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(2)

-1 CF29(2)

CF\_Repairs(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalOMCost Total operating and maintenance cost

CF\_TotalOMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(1)

-2 CF31(1)

CF\_TotalOMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(2)

-2 CF31(2)

CF\_TotalOMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CapitalRecovery Capital recovery - calculate from the total captical co

st

CF\_CapitalRecovery(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(1)

-2 CF31(1)

CF\_CapitalRecovery(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(2)

-2 CF31(2)

CF\_CapitalRecovery(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_AnnualCost Annual cost depending on the Capital recovery and OM cost

CF\_AnnualCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(1)

-1.000000E-5 NonlinearTechCost01(1)

CF\_AnnualCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(2)

-1.000000E-5 NonlinearTechCost01(2)

CF\_AnnualCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(3)

-1.000000E-5 NonlinearTechCost01(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_CapitalCost Capital cost for the activated carbon process

GAC\_CapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(1)

-1 GAC03(1)

GAC\_CapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(2)

-1 GAC03(2)

GAC\_CapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_OMCost Operational and maintenance cost for the activated carbon proce

ss

GAC\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(1)

-1 GAC03(1)

GAC\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(2)

-1 GAC03(2)

GAC\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_TotalCost Total cost for the activated carbon process implementation

GAC\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(1)

-1.000000E-5 NonlinearTechCost02(1)

GAC\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(2)

-1.000000E-5 NonlinearTechCost02(2)

GAC\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(3)

-1.000000E-5 NonlinearTechCost02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinResinVolume Minimum volume of the medium in m3

IX\_MinResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(1)

IX\_MinResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(2)

IX\_MinResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinVolExhaustionTime Minimum volume exhaustion time in days

IX\_MinVolExhaustionTime(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(1)

IX\_MinVolExhaustionTime(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(2)

IX\_MinVolExhaustionTime(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ExhaustionTimeResinVolume Resin volume in m3 for the minimum exhaustion

time

IX\_ExhaustionTimeResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(1)

-2 IX05(1)

-1398.5149 IX06(1)

-150 IX08(1)

IX\_ExhaustionTimeResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(2)

-2 IX05(2)

-1398.5149 IX06(2)

-150 IX08(2)

IX\_ExhaustionTimeResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(3)

-2 IX05(3)

-1398.5149 IX06(3)

-150 IX08(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_VesselVolume Total vessel volume in m3

IX\_VesselVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(1)

(-175034.0436) IX07(1)

(-2.500000E+9) IX12(1)

IX\_VesselVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(2)

(-175034.0436) IX07(2)

(-2.500000E+9) IX12(2)

IX\_VesselVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(3)

(-175034.0436) IX07(3)

(-2.500000E+9) IX12(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ResinCost Total resin cost (in $ per day -- need to check)

IX\_ResinCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(1)

-24 IX15(1)

IX\_ResinCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(2)

-24 IX15(2)

IX\_ResinCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(3)

-24 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_BedArea Bed area for the vessel in m2

IX\_BedArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(1)

(-1254.21) IX13(1)

(-7.33000E+11) IX14(1)

IX\_BedArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(2)

(-1254.21) IX13(2)

(-7.33000E+11) IX14(2)

IX\_BedArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(3)

(-1254.21) IX13(3)

(-7.33000E+11) IX14(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TankTotalCost Total Tank cost in $

IX\_TankTotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(1)

-1 IX15(1)

IX\_TankTotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(2)

-1 IX15(2)

IX\_TankTotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_NaClReq NaCl requirement in Kg per day

IX\_NaClReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(1)

-0.01 IX09(1)

-3.65 IX10(1)

IX\_NaClReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(2)

-0.01 IX09(2)

-3.65 IX10(2)

IX\_NaClReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(3)

-0.01 IX09(3)

-3.65 IX10(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalChemCost Total chemical cost per year

IX\_TotalChemCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(1)

-1 IX15(1)

IX\_TotalChemCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(2)

-1 IX15(2)

IX\_TotalChemCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_RegFluidReq Regeneration fluid requirement

IX\_RegFluidReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(1)

-250 IX11(1)

IX\_RegFluidReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(2)

-250 IX11(2)

IX\_RegFluidReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(3)

-250 IX11(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_StorageTankCost Storage tank cost

IX\_StorageTankCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(1)

-1 IX15(1)

IX\_StorageTankCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(2)

-1 IX15(2)

IX\_StorageTankCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ConstructionCost Construction cost

IX\_ConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(1)

-1 IX15(1)

IX\_ConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(2)

-1 IX15(2)

IX\_ConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_OMCost Operating and maintenance cost

IX\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(1)

-1 IX15(1)

IX\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(2)

-1 IX15(2)

IX\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalCost Total cost for the implementation of ion exchange process for

each industry

IX\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(1)

-1.000000E-5 NonlinearTechCost03(1)

IX\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(2)

-1.000000E-5 NonlinearTechCost03(2)

IX\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(3)

-1.000000E-5 NonlinearTechCost03(3)

REMAINING 26 ENTRIES SKIPPED

---- Tobj Objective function for the technoogy only problem

Tobj

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 Tobjective

---- Volume volume of waste treated by each industry using each technology (def

ined over i and j)

Volume(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0028 Tc2(1)

-43.8021 DFREq(1,1)

-1.1574 CF01(1)

Volume(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0041 Tc2(1)

-43.8021 DFREq(1,2)

(-7.37701E+16) GAC01(1)

(-8.53308E+15) GAC02(1)

Volume(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0014 Tc2(1)

-43.8021 DFREq(1,3)

REMAINING 84 ENTRIES SKIPPED

---- DFR Desired flow rate for the industry in liters per sec

DFR(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,1)

-1.0067 CF03(1)

1 CF04(1)

-1.0603 CF09(1)

-46.1677 CF25(1)

-9.2335 CF27(1)

DFR(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,2)

DFR(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,3)

-0.18 IX01(1)

-0.0156 IX04(1)

REMAINING 84 ENTRIES SKIPPED

---- NonlinearTechCost

NonlinearTechCost(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost01(1)

NonlinearTechCost(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost02(1)

NonlinearTechCost(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost03(1)

REMAINING 84 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE TechProblem Using NLP From line 868

LOOPS FOR/WHILE 1

FOR/WHILE 2

MODEL STATISTICS

BLOCKS OF EQUATIONS 54 SINGLE EQUATIONS 1,596

BLOCKS OF VARIABLES 51 SINGLE VARIABLES 1,625

NON ZERO ELEMENTS 4,003 NON LINEAR N-Z 174

DERIVATIVE POOL 10 CONSTANT POOL 31

CODE LENGTH 1,508

GENERATION TIME = 0.015 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.015 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 2

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE TechProblem Using NLP From line 868

S O L V E S U M M A R Y

MODEL TechProblem OBJECTIVE Tobj

TYPE NLP DIRECTION MINIMIZE

SOLVER CONOPT FROM LINE 868

\*\*\*\* SOLVER STATUS 7 Licensing Problems

\*\*\*\* MODEL STATUS 11 Licensing Problem

\*\*\*\* OBJECTIVE VALUE NA

RESOURCE USAGE, LIMIT 0.000 1000.000

ITERATION COUNT, LIMIT 0 2000000000

EVALUATION ERRORS 0 0

CONOPT 3 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

\*\*\* No license found

\*\*\* To update your license, please contact your distributor.

\*\*\* Too many equations for demo mode

\*\*\* Number of equations : 1596

\*\*\* Maximum allowed : 300

\*\*\* Too many variables for demo mode

\*\*\* Number of variables : 1625

\*\*\* Maximum allowed : 300

\*\*\* Too many nonzero elements for demo mode

\*\*\* Number of nonzeros : 4003

\*\*\* Maximum allowed : 2000

No solution returned

GAMS 24.1.3 r41464 Released Jul 26, 2013 WEX-WEI x86\_64/MS Windows 01/19/16 16:16:30 Page 10

G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE TechProblem Using NLP From line 868

---- Tobjective =E=

Tobjective.. Tobj - NonlinearTechCost(1,1) - NonlinearTechCost(1,2)

- NonlinearTechCost(1,3) - NonlinearTechCost(2,1) - NonlinearTechCost(2,2)

- NonlinearTechCost(2,3) - NonlinearTechCost(3,1) - NonlinearTechCost(3,2)

- NonlinearTechCost(3,3) - NonlinearTechCost(4,1) - NonlinearTechCost(4,2)

- NonlinearTechCost(4,3) - NonlinearTechCost(5,1) - NonlinearTechCost(5,2)

- NonlinearTechCost(5,3) - NonlinearTechCost(6,1) - NonlinearTechCost(6,2)

- NonlinearTechCost(6,3) - NonlinearTechCost(7,1) - NonlinearTechCost(7,2)

- NonlinearTechCost(7,3) - NonlinearTechCost(8,1) - NonlinearTechCost(8,2)

- NonlinearTechCost(8,3) - NonlinearTechCost(9,1) - NonlinearTechCost(9,2)

- NonlinearTechCost(9,3) - NonlinearTechCost(10,1)

- NonlinearTechCost(10,2) - NonlinearTechCost(10,3)

- NonlinearTechCost(11,1) - NonlinearTechCost(11,2)

- NonlinearTechCost(11,3) - NonlinearTechCost(12,1)

- NonlinearTechCost(12,2) - NonlinearTechCost(12,3)

- NonlinearTechCost(13,1) - NonlinearTechCost(13,2)

- NonlinearTechCost(13,3) - NonlinearTechCost(14,1)

- NonlinearTechCost(14,2) - NonlinearTechCost(14,3)

- NonlinearTechCost(15,1) - NonlinearTechCost(15,2)

- NonlinearTechCost(15,3) - NonlinearTechCost(16,1)

- NonlinearTechCost(16,2) - NonlinearTechCost(16,3)

- NonlinearTechCost(17,1) - NonlinearTechCost(17,2)

- NonlinearTechCost(17,3) - NonlinearTechCost(18,1)

- NonlinearTechCost(18,2) - NonlinearTechCost(18,3)

- NonlinearTechCost(19,1) - NonlinearTechCost(19,2)

- NonlinearTechCost(19,3) - NonlinearTechCost(20,1)

- NonlinearTechCost(20,2) - NonlinearTechCost(20,3)

- NonlinearTechCost(21,1) - NonlinearTechCost(21,2)

- NonlinearTechCost(21,3) - NonlinearTechCost(22,1)

- NonlinearTechCost(22,2) - NonlinearTechCost(22,3)

- NonlinearTechCost(23,1) - NonlinearTechCost(23,2)

- NonlinearTechCost(23,3) - NonlinearTechCost(24,1)

- NonlinearTechCost(24,2) - NonlinearTechCost(24,3)

- NonlinearTechCost(25,1) - NonlinearTechCost(25,2)

- NonlinearTechCost(25,3) - NonlinearTechCost(26,1)

- NonlinearTechCost(26,2) - NonlinearTechCost(26,3)

- NonlinearTechCost(27,1) - NonlinearTechCost(27,2)

- NonlinearTechCost(27,3) - NonlinearTechCost(28,1)

- NonlinearTechCost(28,2) - NonlinearTechCost(28,3)

- NonlinearTechCost(29,1) - NonlinearTechCost(29,2)

- NonlinearTechCost(29,3) =E= 0 ; (LHS = 0)

---- Tc1 =L=

Tc1(1).. Volume(1,1) + Volume(1,2) + Volume(1,3) =L= 46.1 ; (LHS = 0)

Tc1(2).. Volume(2,1) + Volume(2,2) + Volume(2,3) =L= 1.5 ; (LHS = 0)

Tc1(3).. Volume(3,1) + Volume(3,2) + Volume(3,3) =L= 4.6 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- Tc2 =G=

Tc2(1).. 0.002762685\*Volume(1,1) + 0.00414402749999999\*Volume(1,2)

+ 0.0013813425\*Volume(1,3) =G= 0.122832874808418 ;

(LHS = 0, INFES = 0.122832874808418 \*\*\*\*)

Tc2(2).. 0.002762685\*Volume(2,1) + 0.00414402749999999\*Volume(2,2)

+ 0.0013813425\*Volume(2,3) =G= 0.00202831822193877 ;

(LHS = 0, INFES = 0.00202831822193877 \*\*\*\*)

Tc2(3).. 0.002762685\*Volume(3,1) + 0.00414402749999999\*Volume(3,2)

+ 0.0013813425\*Volume(3,3) =G= 0.0100326811806122 ;

(LHS = 0, INFES = 0.0100326811806122 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- DFREq =E=

DFREq(1,1).. - 43.8020833333334\*Volume(1,1) + DFR(1,1) =E= 0 ; (LHS = 0)

DFREq(1,2).. - 43.8020833333334\*Volume(1,2) + DFR(1,2) =E= 0 ; (LHS = 0)

DFREq(1,3).. - 43.8020833333334\*Volume(1,3) + DFR(1,3) =E= 0 ; (LHS = 0)

REMAINING 84 ENTRIES SKIPPED

---- CF01 =E=

CF01(1).. CF\_NoOfModules(1) - 1.15740740740741\*Volume(1,1) =E= 0 ; (LHS = 0)

CF01(2).. CF\_NoOfModules(2) - 1.15740740740741\*Volume(2,1) =E= 0 ; (LHS = 0)

CF01(3).. CF\_NoOfModules(3) - 1.15740740740741\*Volume(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF03 =E=

CF03(1).. CF\_MFF(1) - 1.00671140939597\*DFR(1,1) =E= 0 ; (LHS = 0)

CF03(2).. CF\_MFF(2) - 1.00671140939597\*DFR(2,1) =E= 0 ; (LHS = 0)

CF03(3).. CF\_MFF(3) - 1.00671140939597\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF04 =E=

CF04(1).. CF\_BackwashFlow(1) - CF\_MFF(1) + DFR(1,1) =E= 0 ; (LHS = 0)

CF04(2).. CF\_BackwashFlow(2) - CF\_MFF(2) + DFR(2,1) =E= 0 ; (LHS = 0)

CF04(3).. CF\_BackwashFlow(3) - CF\_MFF(3) + DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF05 =E=

CF05(1).. CF\_FeedPumpHP(1) - 0.346809353943718\*CF\_MFF(1) =E= 0 ; (LHS = 0)

CF05(2).. CF\_FeedPumpHP(2) - 0.346809353943718\*CF\_MFF(2) =E= 0 ; (LHS = 0)

CF05(3).. CF\_FeedPumpHP(3) - 0.346809353943718\*CF\_MFF(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF06 =E=

CF06(1).. - 6534.96\*CF\_FeedPumpHP(1) + CF\_FeedPumpPower(1) =E= 0 ; (LHS = 0)

CF06(2).. - 6534.96\*CF\_FeedPumpHP(2) + CF\_FeedPumpPower(2) =E= 0 ; (LHS = 0)

CF06(3).. - 6534.96\*CF\_FeedPumpHP(3) + CF\_FeedPumpPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF07 =E=

CF07(1).. - 43.508\*CF\_FeedPumpHP(1) + CF\_BackflushPower(1) =E= 0 ; (LHS = 0)

CF07(2).. - 43.508\*CF\_FeedPumpHP(2) + CF\_BackflushPower(2) =E= 0 ; (LHS = 0)

CF07(3).. - 43.508\*CF\_FeedPumpHP(3) + CF\_BackflushPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF08 =E=

CF08(1).. - 90\*CF\_NoOfModules(1) + CF\_NoOfMembranes(1) =E= 0 ; (LHS = 0)

CF08(2).. - 90\*CF\_NoOfModules(2) + CF\_NoOfMembranes(2) =E= 0 ; (LHS = 0)

CF08(3).. - 90\*CF\_NoOfModules(3) + CF\_NoOfMembranes(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF09 =E=

CF09(1).. CF\_BuildingArea(1) - 1.060338816\*DFR(1,1) =E= 0 ; (LHS = 0)

CF09(2).. CF\_BuildingArea(2) - 1.060338816\*DFR(2,1) =E= 0 ; (LHS = 0)

CF09(3).. CF\_BuildingArea(3) - 1.060338816\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF10 =E=

CF10(1).. - 370000\*CF\_NoOfModules(1) + CF\_MembraneModuleCost(1) =E= 0 ;

(LHS = 0)

CF10(2).. - 370000\*CF\_NoOfModules(2) + CF\_MembraneModuleCost(2) =E= 0 ;

(LHS = 0)

CF10(3).. - 370000\*CF\_NoOfModules(3) + CF\_MembraneModuleCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF11 =E=

CF11(1).. - 1076\*CF\_BuildingArea(1) + CF\_BuildingCost(1) =E= 0 ; (LHS = 0)

CF11(2).. - 1076\*CF\_BuildingArea(2) + CF\_BuildingCost(2) =E= 0 ; (LHS = 0)

CF11(3).. - 1076\*CF\_BuildingArea(3) + CF\_BuildingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF12 =E=

CF12(1).. - 70000\*CF\_NoOfModules(1) + CF\_InstallationCost(1) =E= 0 ; (LHS = 0)

CF12(2).. - 70000\*CF\_NoOfModules(2) + CF\_InstallationCost(2) =E= 0 ; (LHS = 0)

CF12(3).. - 70000\*CF\_NoOfModules(3) + CF\_InstallationCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF13 =E=

CF13(1).. - 0.05\*CF\_MembraneModuleCost(1) + CF\_MiscCost(1) =E= 0 ; (LHS = 0)

CF13(2).. - 0.05\*CF\_MembraneModuleCost(2) + CF\_MiscCost(2) =E= 0 ; (LHS = 0)

CF13(3).. - 0.05\*CF\_MembraneModuleCost(3) + CF\_MiscCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF14 =E=

CF14(1).. - 0.05\*CF\_MembraneModuleCost(1) - 0.05\*CF\_MiscCost(1)

+ CF\_PlantPipingCost(1) =E= 0 ; (LHS = 0)

CF14(2).. - 0.05\*CF\_MembraneModuleCost(2) - 0.05\*CF\_MiscCost(2)

+ CF\_PlantPipingCost(2) =E= 0 ; (LHS = 0)

CF14(3).. - 0.05\*CF\_MembraneModuleCost(3) - 0.05\*CF\_MiscCost(3)

+ CF\_PlantPipingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF15 =E=

CF15(1).. - 0.1\*CF\_MembraneModuleCost(1) - 0.1\*CF\_MiscCost(1)

+ CF\_EngineeringCost(1) =E= 0 ; (LHS = 0)

CF15(2).. - 0.1\*CF\_MembraneModuleCost(2) - 0.1\*CF\_MiscCost(2)

+ CF\_EngineeringCost(2) =E= 0 ; (LHS = 0)

CF15(3).. - 0.1\*CF\_MembraneModuleCost(3) - 0.1\*CF\_MiscCost(3)

+ CF\_EngineeringCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF16 =E=

CF16(1).. - CF\_MembraneModuleCost(1) - CF\_BuildingCost(1)

- CF\_InstallationCost(1) - CF\_MiscCost(1) - CF\_PlantPipingCost(1)

- CF\_EngineeringCost(1) + CF\_DirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF16(2).. - CF\_MembraneModuleCost(2) - CF\_BuildingCost(2)

- CF\_InstallationCost(2) - CF\_MiscCost(2) - CF\_PlantPipingCost(2)

- CF\_EngineeringCost(2) + CF\_DirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF16(3).. - CF\_MembraneModuleCost(3) - CF\_BuildingCost(3)

- CF\_InstallationCost(3) - CF\_MiscCost(3) - CF\_PlantPipingCost(3)

- CF\_EngineeringCost(3) + CF\_DirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF17 =E=

CF17(1).. - 0.06\*CF\_DirectCapitalCost(1) + CF\_ConstructionInterest(1) =E= 0 ;

(LHS = 0)

CF17(2).. - 0.06\*CF\_DirectCapitalCost(2) + CF\_ConstructionInterest(2) =E= 0 ;

(LHS = 0)

CF17(3).. - 0.06\*CF\_DirectCapitalCost(3) + CF\_ConstructionInterest(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF18 =E=

CF18(1).. - 0.2\*CF\_DirectCapitalCost(1) + CF\_Contingencies(1) =E= 0 ; (LHS = 0)

CF18(2).. - 0.2\*CF\_DirectCapitalCost(2) + CF\_Contingencies(2) =E= 0 ; (LHS = 0)

CF18(3).. - 0.2\*CF\_DirectCapitalCost(3) + CF\_Contingencies(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF19 =E=

CF19(1).. - 0.1\*CF\_DirectCapitalCost(1) + CF\_ProjectManagement(1) =E= 0 ;

(LHS = 0)

CF19(2).. - 0.1\*CF\_DirectCapitalCost(2) + CF\_ProjectManagement(2) =E= 0 ;

(LHS = 0)

CF19(3).. - 0.1\*CF\_DirectCapitalCost(3) + CF\_ProjectManagement(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF20 =E=

CF20(1).. - 0.04\*CF\_DirectCapitalCost(1) + CF\_WorkingCapital(1) =E= 0 ;

(LHS = 0)

CF20(2).. - 0.04\*CF\_DirectCapitalCost(2) + CF\_WorkingCapital(2) =E= 0 ;

(LHS = 0)

CF20(3).. - 0.04\*CF\_DirectCapitalCost(3) + CF\_WorkingCapital(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF21 =E=

CF21(1).. - CF\_ConstructionInterest(1) - CF\_Contingencies(1)

- CF\_ProjectManagement(1) - CF\_WorkingCapital(1)

+ CF\_IndirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF21(2).. - CF\_ConstructionInterest(2) - CF\_Contingencies(2)

- CF\_ProjectManagement(2) - CF\_WorkingCapital(2)

+ CF\_IndirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF21(3).. - CF\_ConstructionInterest(3) - CF\_Contingencies(3)

- CF\_ProjectManagement(3) - CF\_WorkingCapital(3)

+ CF\_IndirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF22 =E=

CF22(1).. - CF\_DirectCapitalCost(1) - CF\_IndirectCapitalCost(1)

+ CF\_TotalConstructionCost(1) =E= 0 ; (LHS = 0)

CF22(2).. - CF\_DirectCapitalCost(2) - CF\_IndirectCapitalCost(2)

+ CF\_TotalConstructionCost(2) =E= 0 ; (LHS = 0)

CF22(3).. - CF\_DirectCapitalCost(3) - CF\_IndirectCapitalCost(3)

+ CF\_TotalConstructionCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF23 =E=

CF23(1).. - 0.113663055482\*CF\_FeedPumpPower(1)

- 0.113663055482\*CF\_BackflushPower(1) + CF\_ElectricityCost(1) =E= 0 ;

(LHS = 0)

CF23(2).. - 0.113663055482\*CF\_FeedPumpPower(2)

- 0.113663055482\*CF\_BackflushPower(2) + CF\_ElectricityCost(2) =E= 0 ;

(LHS = 0)

CF23(3).. - 0.113663055482\*CF\_FeedPumpPower(3)

- 0.113663055482\*CF\_BackflushPower(3) + CF\_ElectricityCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF24 =E=

CF24(1).. CF\_LaborCost(1) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(2).. CF\_LaborCost(2) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(3).. CF\_LaborCost(3) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF25 =E=

CF25(1).. CF\_ChemicalCost(1) - 41.8492141903448\*DFR(1,1) =E= -244.410791242298

; (LHS = 0, INFES = 244.410791242298 \*\*\*\*)

CF25(2).. CF\_ChemicalCost(2) - 41.8492141903448\*DFR(2,1) =E= -244.410791242298

; (LHS = 0, INFES = 244.410791242298 \*\*\*\*)

CF25(3).. CF\_ChemicalCost(3) - 41.8492141903448\*DFR(3,1) =E= -244.410791242298

; (LHS = 0, INFES = 244.410791242298 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF26 =E=

CF26(1).. - 153.482537189773\*CF\_NoOfMembranes(1)

+ CF\_MembraneReplacementCost(1) =E= 0 ; (LHS = 0)

CF26(2).. - 153.482537189773\*CF\_NoOfMembranes(2)

+ CF\_MembraneReplacementCost(2) =E= 0 ; (LHS = 0)

CF26(3).. - 153.482537189773\*CF\_NoOfMembranes(3)

+ CF\_MembraneReplacementCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF27 =E=

CF27(1).. CF\_CleaningChemicalCost(1) - 8.36984283806897\*DFR(1,1) =E=

48.8824515417023 ; (LHS = 0, INFES = 48.8824515417023 \*\*\*\*)

CF27(2).. CF\_CleaningChemicalCost(2) - 8.36984283806897\*DFR(2,1) =E=

48.8824515417023 ; (LHS = 0, INFES = 48.8824515417023 \*\*\*\*)

CF27(3).. CF\_CleaningChemicalCost(3) - 8.36984283806897\*DFR(3,1) =E=

48.8824515417023 ; (LHS = 0, INFES = 48.8824515417023 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF28 =E=

CF28(1).. - 0.02\*CF\_DirectCapitalCost(1) + CF\_Repairs(1) =E= 0 ; (LHS = 0)

CF28(2).. - 0.02\*CF\_DirectCapitalCost(2) + CF\_Repairs(2) =E= 0 ; (LHS = 0)

CF28(3).. - 0.02\*CF\_DirectCapitalCost(3) + CF\_Repairs(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF29 =E=

CF29(1).. - CF\_ElectricityCost(1) - CF\_LaborCost(1) - CF\_ChemicalCost(1)

- CF\_MembraneReplacementCost(1) - CF\_CleaningChemicalCost(1)

- CF\_Repairs(1) + CF\_TotalOMCost(1) =E= 0 ; (LHS = 0)

CF29(2).. - CF\_ElectricityCost(2) - CF\_LaborCost(2) - CF\_ChemicalCost(2)

- CF\_MembraneReplacementCost(2) - CF\_CleaningChemicalCost(2)

- CF\_Repairs(2) + CF\_TotalOMCost(2) =E= 0 ; (LHS = 0)

CF29(3).. - CF\_ElectricityCost(3) - CF\_LaborCost(3) - CF\_ChemicalCost(3)

- CF\_MembraneReplacementCost(3) - CF\_CleaningChemicalCost(3)

- CF\_Repairs(3) + CF\_TotalOMCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF30 =E=

CF30(1).. - 0.101852208823151\*CF\_TotalConstructionCost(1)

+ CF\_CapitalRecovery(1) =E= 0 ; (LHS = 0)

CF30(2).. - 0.101852208823151\*CF\_TotalConstructionCost(2)

+ CF\_CapitalRecovery(2) =E= 0 ; (LHS = 0)

CF30(3).. - 0.101852208823151\*CF\_TotalConstructionCost(3)

+ CF\_CapitalRecovery(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF31 =E=

CF31(1).. - 2\*CF\_TotalOMCost(1) - 2\*CF\_CapitalRecovery(1) + CF\_AnnualCost(1)

=E= 0 ; (LHS = 0)

CF31(2).. - 2\*CF\_TotalOMCost(2) - 2\*CF\_CapitalRecovery(2) + CF\_AnnualCost(2)

=E= 0 ; (LHS = 0)

CF31(3).. - 2\*CF\_TotalOMCost(3) - 2\*CF\_CapitalRecovery(3) + CF\_AnnualCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC01 =E=

GAC01(1).. GAC\_CapitalCost(1) - (7.37701051584E16)\*Volume(1,2) =E= 0 ;

(LHS = 0)

GAC01(2).. GAC\_CapitalCost(2) - (7.37701051584E16)\*Volume(2,2) =E= 0 ;

(LHS = 0)

GAC01(3).. GAC\_CapitalCost(3) - (7.37701051584E16)\*Volume(3,2) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC02 =E=

GAC02(1).. GAC\_OMCost(1) - (8.53307527956E15)\*Volume(1,2) =E= 0 ; (LHS = 0)

GAC02(2).. GAC\_OMCost(2) - (8.53307527956E15)\*Volume(2,2) =E= 0 ; (LHS = 0)

GAC02(3).. GAC\_OMCost(3) - (8.53307527956E15)\*Volume(3,2) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC03 =E=

GAC03(1).. - GAC\_CapitalCost(1) - GAC\_OMCost(1) + GAC\_TotalCost(1) =E= 0 ;

(LHS = 0)

GAC03(2).. - GAC\_CapitalCost(2) - GAC\_OMCost(2) + GAC\_TotalCost(2) =E= 0 ;

(LHS = 0)

GAC03(3).. - GAC\_CapitalCost(3) - GAC\_OMCost(3) + GAC\_TotalCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX01 =E=

IX01(1).. IX\_MinResinVolume(1) - 0.18\*DFR(1,3) =E= 0 ; (LHS = 0)

IX01(2).. IX\_MinResinVolume(2) - 0.18\*DFR(2,3) =E= 0 ; (LHS = 0)

IX01(3).. IX\_MinResinVolume(3) - 0.18\*DFR(3,3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX02 =E=

IX02(1).. IX\_MinVolExhaustionTime(1) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(2).. IX\_MinVolExhaustionTime(2) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(3).. IX\_MinVolExhaustionTime(3) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX04 =E=

IX04(1).. IX\_ExhaustionTimeResinVolume(1) - 0.0156384\*DFR(1,3) =E= 0 ;

(LHS = 0)

IX04(2).. IX\_ExhaustionTimeResinVolume(2) - 0.0156384\*DFR(2,3) =E= 0 ;

(LHS = 0)

IX04(3).. IX\_ExhaustionTimeResinVolume(3) - 0.0156384\*DFR(3,3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX05 =E=

IX05(1).. - 2\*IX\_ExhaustionTimeResinVolume(1) + IX\_VesselVolume(1) =E= 0 ;

(LHS = 0)

IX05(2).. - 2\*IX\_ExhaustionTimeResinVolume(2) + IX\_VesselVolume(2) =E= 0 ;

(LHS = 0)

IX05(3).. - 2\*IX\_ExhaustionTimeResinVolume(3) + IX\_VesselVolume(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX06 =E=

IX06(1).. - 1623.4766436364\*IX\_ExhaustionTimeResinVolume(1) + IX\_ResinCost(1)

=E= 0 ; (LHS = 0)

IX06(2).. - 1623.4766436364\*IX\_ExhaustionTimeResinVolume(2) + IX\_ResinCost(2)

=E= 0 ; (LHS = 0)

IX06(3).. - 1623.4766436364\*IX\_ExhaustionTimeResinVolume(3) + IX\_ResinCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX07 =E=

IX07(1).. - (518869.201170893)\*IX\_VesselVolume(1) + IX\_TankTotalCost(1) =E= 0 ;

(LHS = -10.8337666237032, INFES = 10.8337666237032 \*\*\*\*)

IX07(2).. - (518869.201170893)\*IX\_VesselVolume(2) + IX\_TankTotalCost(2) =E= 0 ;

(LHS = -10.8337666237032, INFES = 10.8337666237032 \*\*\*\*)

IX07(3).. - (518869.201170893)\*IX\_VesselVolume(3) + IX\_TankTotalCost(3) =E= 0 ;

(LHS = -10.8337666237032, INFES = 10.8337666237032 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX08 =E=

IX08(1).. - 150\*IX\_ExhaustionTimeResinVolume(1) + IX\_NaClReq(1) =E= 0 ;

(LHS = 0)

IX08(2).. - 150\*IX\_ExhaustionTimeResinVolume(2) + IX\_NaClReq(2) =E= 0 ;

(LHS = 0)

IX08(3).. - 150\*IX\_ExhaustionTimeResinVolume(3) + IX\_NaClReq(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX09 =E=

IX09(1).. - 0.01\*IX\_NaClReq(1) + IX\_RegFluidReq(1) =E= 0 ; (LHS = 0)

IX09(2).. - 0.01\*IX\_NaClReq(2) + IX\_RegFluidReq(2) =E= 0 ; (LHS = 0)

IX09(3).. - 0.01\*IX\_NaClReq(3) + IX\_RegFluidReq(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX10 =E=

IX10(1).. - 3.65\*IX\_NaClReq(1) + IX\_TotalChemCost(1) =E= 0 ; (LHS = 0)

IX10(2).. - 3.65\*IX\_NaClReq(2) + IX\_TotalChemCost(2) =E= 0 ; (LHS = 0)

IX10(3).. - 3.65\*IX\_NaClReq(3) + IX\_TotalChemCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX11 =E=

IX11(1).. - 250\*IX\_RegFluidReq(1) + IX\_StorageTankCost(1) =E= 0 ; (LHS = 0)

IX11(2).. - 250\*IX\_RegFluidReq(2) + IX\_StorageTankCost(2) =E= 0 ; (LHS = 0)

IX11(3).. - 250\*IX\_RegFluidReq(3) + IX\_StorageTankCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX12 =E=

IX12(1).. - (2500000000)\*IX\_VesselVolume(1) + IX\_BedArea(1) =E= 0 ; (LHS = 0)

IX12(2).. - (2500000000)\*IX\_VesselVolume(2) + IX\_BedArea(2) =E= 0 ; (LHS = 0)

IX12(3).. - (2500000000)\*IX\_VesselVolume(3) + IX\_BedArea(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX13 =E=

IX13(1).. - (1254.21)\*IX\_BedArea(1) + IX\_ConstructionCost(1) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(2).. - (1254.21)\*IX\_BedArea(2) + IX\_ConstructionCost(2) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(3).. - (1254.21)\*IX\_BedArea(3) + IX\_ConstructionCost(3) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX14 =E=

IX14(1).. - (733000000000)\*IX\_BedArea(1) + IX\_OMCost(1) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(2).. - (733000000000)\*IX\_BedArea(2) + IX\_OMCost(2) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(3).. - (733000000000)\*IX\_BedArea(3) + IX\_OMCost(3) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX15 =E=

IX15(1).. - 24\*IX\_ResinCost(1) - IX\_TankTotalCost(1) - IX\_TotalChemCost(1)

- IX\_StorageTankCost(1) - IX\_ConstructionCost(1) - IX\_OMCost(1)

+ IX\_TotalCost(1) =E= 0 ; (LHS = 0)

IX15(2).. - 24\*IX\_ResinCost(2) - IX\_TankTotalCost(2) - IX\_TotalChemCost(2)

- IX\_StorageTankCost(2) - IX\_ConstructionCost(2) - IX\_OMCost(2)

+ IX\_TotalCost(2) =E= 0 ; (LHS = 0)

IX15(3).. - 24\*IX\_ResinCost(3) - IX\_TankTotalCost(3) - IX\_TotalChemCost(3)

- IX\_StorageTankCost(3) - IX\_ConstructionCost(3) - IX\_OMCost(3)

+ IX\_TotalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost01 =E=

NonlinearTechCost01(1).. - 1E-5\*CF\_AnnualCost(1) + NonlinearTechCost(1,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(2).. - 1E-5\*CF\_AnnualCost(2) + NonlinearTechCost(2,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(3).. - 1E-5\*CF\_AnnualCost(3) + NonlinearTechCost(3,1) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost02 =E=

NonlinearTechCost02(1).. - 1E-5\*GAC\_TotalCost(1) + NonlinearTechCost(1,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(2).. - 1E-5\*GAC\_TotalCost(2) + NonlinearTechCost(2,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(3).. - 1E-5\*GAC\_TotalCost(3) + NonlinearTechCost(3,2) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost03 =E=

NonlinearTechCost03(1).. - 1E-5\*IX\_TotalCost(1) + NonlinearTechCost(1,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(2).. - 1E-5\*IX\_TotalCost(2) + NonlinearTechCost(2,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(3).. - 1E-5\*IX\_TotalCost(3) + NonlinearTechCost(3,3) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE TechProblem Using NLP From line 868

---- CF\_NoOfModules Number of modules

CF\_NoOfModules(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(1)

-90 CF08(1)

-370000 CF10(1)

-70000 CF12(1)

CF\_NoOfModules(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(2)

-90 CF08(2)

-370000 CF10(2)

-70000 CF12(2)

CF\_NoOfModules(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(3)

-90 CF08(3)

-370000 CF10(3)

-70000 CF12(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackwashFlow Backwash flow

CF\_BackwashFlow(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(1)

CF\_BackwashFlow(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(2)

CF\_BackwashFlow(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpHP Feed pump horsepower

CF\_FeedPumpHP(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(1)

-6534.96 CF06(1)

-43.508 CF07(1)

CF\_FeedPumpHP(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(2)

-6534.96 CF06(2)

-43.508 CF07(2)

CF\_FeedPumpHP(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(3)

-6534.96 CF06(3)

-43.508 CF07(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpPower Feed pump power requirement in kWh

CF\_FeedPumpPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(1)

-0.1137 CF23(1)

CF\_FeedPumpPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(2)

-0.1137 CF23(2)

CF\_FeedPumpPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(3)

-0.1137 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackflushPower Backflush power requirement in kWh

CF\_BackflushPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(1)

-0.1137 CF23(1)

CF\_BackflushPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(2)

-0.1137 CF23(2)

CF\_BackflushPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(3)

-0.1137 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MFF Microfiltration feed flow in liters per sec

CF\_MFF(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(1)

-1 CF04(1)

-0.3468 CF05(1)

CF\_MFF(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(2)

-1 CF04(2)

-0.3468 CF05(2)

CF\_MFF(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(3)

-1 CF04(3)

-0.3468 CF05(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_NoOfMembranes Number of membranes used

CF\_NoOfMembranes(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(1)

-153.4825 CF26(1)

CF\_NoOfMembranes(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(2)

-153.4825 CF26(2)

CF\_NoOfMembranes(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(3)

-153.4825 CF26(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingArea Building area for the process implementation

CF\_BuildingArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(1)

-1076 CF11(1)

CF\_BuildingArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(2)

-1076 CF11(2)

CF\_BuildingArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(3)

-1076 CF11(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneModuleCost Membrane module cost

CF\_MembraneModuleCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(1)

-0.05 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MembraneModuleCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(2)

-0.05 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MembraneModuleCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(3)

-0.05 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingCost Building cost - based on the building area

CF\_BuildingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(1)

-1 CF16(1)

CF\_BuildingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(2)

-1 CF16(2)

CF\_BuildingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_InstallationCost Installation cost for the process

CF\_InstallationCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(1)

-1 CF16(1)

CF\_InstallationCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(2)

-1 CF16(2)

CF\_InstallationCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MiscCost Miscellaneous cost (taken as 5% of the module cost)

CF\_MiscCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MiscCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MiscCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_PlantPipingCost Plant piping cost (taken as 5% of the module and misc c

ost)

CF\_PlantPipingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(1)

-1 CF16(1)

CF\_PlantPipingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(2)

-1 CF16(2)

CF\_PlantPipingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_EngineeringCost Engineering cost (taken as 10% of the module and misc c

ost)

CF\_EngineeringCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(1)

-1 CF16(1)

CF\_EngineeringCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(2)

-1 CF16(2)

CF\_EngineeringCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_DirectCapitalCost Total direct capital cost

CF\_DirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(1)

-0.06 CF17(1)

-0.2 CF18(1)

-0.1 CF19(1)

-0.04 CF20(1)

-1 CF22(1)

-0.02 CF28(1)

CF\_DirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(2)

-0.06 CF17(2)

-0.2 CF18(2)

-0.1 CF19(2)

-0.04 CF20(2)

-1 CF22(2)

-0.02 CF28(2)

CF\_DirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(3)

-0.06 CF17(3)

-0.2 CF18(3)

-0.1 CF19(3)

-0.04 CF20(3)

-1 CF22(3)

-0.02 CF28(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ConstructionInterest Expense on interest during construction (taken as

6% of total direct capital cost)

CF\_ConstructionInterest(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(1)

-1 CF21(1)

CF\_ConstructionInterest(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(2)

-1 CF21(2)

CF\_ConstructionInterest(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Contingencies Contingencies (taken as 20% of total direct capital cost)

CF\_Contingencies(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(1)

-1 CF21(1)

CF\_Contingencies(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(2)

-1 CF21(2)

CF\_Contingencies(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ProjectManagement Fees and project management (taken as 10% of total di

rect capital cost)

CF\_ProjectManagement(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(1)

-1 CF21(1)

CF\_ProjectManagement(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(2)

-1 CF21(2)

CF\_ProjectManagement(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_WorkingCapital Working capital (taken as 4% of total direct capital cos

t)

CF\_WorkingCapital(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(1)

-1 CF21(1)

CF\_WorkingCapital(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(2)

-1 CF21(2)

CF\_WorkingCapital(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_IndirectCapitalCost Total indirect capital cost

CF\_IndirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(1)

-1 CF22(1)

CF\_IndirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(2)

-1 CF22(2)

CF\_IndirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(3)

-1 CF22(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalConstructionCost Total (direct and indirect) construction cost

CF\_TotalConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(1)

-0.1019 CF30(1)

CF\_TotalConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(2)

-0.1019 CF30(2)

CF\_TotalConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(3)

-0.1019 CF30(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ElectricityCost Electricity cost for the implementation of the process

CF\_ElectricityCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(1)

-1 CF29(1)

CF\_ElectricityCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(2)

-1 CF29(2)

CF\_ElectricityCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_LaborCost Labor cost for the implementation of the process

CF\_LaborCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(1)

-1 CF29(1)

CF\_LaborCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(2)

-1 CF29(2)

CF\_LaborCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ChemicalCost Chemical cost for the process

CF\_ChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(1)

-1 CF29(1)

CF\_ChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(2)

-1 CF29(2)

CF\_ChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneReplacementCost Membrane replacement cost for the process

CF\_MembraneReplacementCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(1)

-1 CF29(1)

CF\_MembraneReplacementCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(2)

-1 CF29(2)

CF\_MembraneReplacementCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CleaningChemicalCost Cleaning chemical (NaOCl) cost

CF\_CleaningChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(1)

-1 CF29(1)

CF\_CleaningChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(2)

-1 CF29(2)

CF\_CleaningChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Repairs Repairs replacement and misc cost (taken as 2% of the direct ca

pital cost)

CF\_Repairs(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(1)

-1 CF29(1)

CF\_Repairs(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(2)

-1 CF29(2)

CF\_Repairs(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalOMCost Total operating and maintenance cost

CF\_TotalOMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(1)

-2 CF31(1)

CF\_TotalOMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(2)

-2 CF31(2)

CF\_TotalOMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CapitalRecovery Capital recovery - calculate from the total captical co

st

CF\_CapitalRecovery(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(1)

-2 CF31(1)

CF\_CapitalRecovery(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(2)

-2 CF31(2)

CF\_CapitalRecovery(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_AnnualCost Annual cost depending on the Capital recovery and OM cost

CF\_AnnualCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(1)

-1.000000E-5 NonlinearTechCost01(1)

CF\_AnnualCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(2)

-1.000000E-5 NonlinearTechCost01(2)

CF\_AnnualCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(3)

-1.000000E-5 NonlinearTechCost01(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_CapitalCost Capital cost for the activated carbon process

GAC\_CapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(1)

-1 GAC03(1)

GAC\_CapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(2)

-1 GAC03(2)

GAC\_CapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_OMCost Operational and maintenance cost for the activated carbon proce

ss

GAC\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(1)

-1 GAC03(1)

GAC\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(2)

-1 GAC03(2)

GAC\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_TotalCost Total cost for the activated carbon process implementation

GAC\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(1)

-1.000000E-5 NonlinearTechCost02(1)

GAC\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(2)

-1.000000E-5 NonlinearTechCost02(2)

GAC\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(3)

-1.000000E-5 NonlinearTechCost02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinResinVolume Minimum volume of the medium in m3

IX\_MinResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(1)

IX\_MinResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(2)

IX\_MinResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinVolExhaustionTime Minimum volume exhaustion time in days

IX\_MinVolExhaustionTime(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(1)

IX\_MinVolExhaustionTime(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(2)

IX\_MinVolExhaustionTime(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ExhaustionTimeResinVolume Resin volume in m3 for the minimum exhaustion

time

IX\_ExhaustionTimeResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(1)

-2 IX05(1)

-1623.4766 IX06(1)

-150 IX08(1)

IX\_ExhaustionTimeResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(2)

-2 IX05(2)

-1623.4766 IX06(2)

-150 IX08(2)

IX\_ExhaustionTimeResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(3)

-2 IX05(3)

-1623.4766 IX06(3)

-150 IX08(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_VesselVolume Total vessel volume in m3

IX\_VesselVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(1)

(-518869.2012) IX07(1)

(-2.500000E+9) IX12(1)

IX\_VesselVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(2)

(-518869.2012) IX07(2)

(-2.500000E+9) IX12(2)

IX\_VesselVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(3)

(-518869.2012) IX07(3)

(-2.500000E+9) IX12(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ResinCost Total resin cost (in $ per day -- need to check)

IX\_ResinCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(1)

-24 IX15(1)

IX\_ResinCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(2)

-24 IX15(2)

IX\_ResinCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(3)

-24 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_BedArea Bed area for the vessel in m2

IX\_BedArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(1)

(-1254.21) IX13(1)

(-7.33000E+11) IX14(1)

IX\_BedArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(2)

(-1254.21) IX13(2)

(-7.33000E+11) IX14(2)

IX\_BedArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(3)

(-1254.21) IX13(3)

(-7.33000E+11) IX14(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TankTotalCost Total Tank cost in $

IX\_TankTotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(1)

-1 IX15(1)

IX\_TankTotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(2)

-1 IX15(2)

IX\_TankTotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_NaClReq NaCl requirement in Kg per day

IX\_NaClReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(1)

-0.01 IX09(1)

-3.65 IX10(1)

IX\_NaClReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(2)

-0.01 IX09(2)

-3.65 IX10(2)

IX\_NaClReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(3)

-0.01 IX09(3)

-3.65 IX10(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalChemCost Total chemical cost per year

IX\_TotalChemCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(1)

-1 IX15(1)

IX\_TotalChemCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(2)

-1 IX15(2)

IX\_TotalChemCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_RegFluidReq Regeneration fluid requirement

IX\_RegFluidReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(1)

-250 IX11(1)

IX\_RegFluidReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(2)

-250 IX11(2)

IX\_RegFluidReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(3)

-250 IX11(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_StorageTankCost Storage tank cost

IX\_StorageTankCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(1)

-1 IX15(1)

IX\_StorageTankCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(2)

-1 IX15(2)

IX\_StorageTankCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ConstructionCost Construction cost

IX\_ConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(1)

-1 IX15(1)

IX\_ConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(2)

-1 IX15(2)

IX\_ConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_OMCost Operating and maintenance cost

IX\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(1)

-1 IX15(1)

IX\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(2)

-1 IX15(2)

IX\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalCost Total cost for the implementation of ion exchange process for

each industry

IX\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(1)

-1.000000E-5 NonlinearTechCost03(1)

IX\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(2)

-1.000000E-5 NonlinearTechCost03(2)

IX\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(3)

-1.000000E-5 NonlinearTechCost03(3)

REMAINING 26 ENTRIES SKIPPED

---- Tobj Objective function for the technoogy only problem

Tobj

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 Tobjective

---- Volume volume of waste treated by each industry using each technology (def

ined over i and j)

Volume(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0028 Tc2(1)

-43.8021 DFREq(1,1)

-1.1574 CF01(1)

Volume(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0041 Tc2(1)

-43.8021 DFREq(1,2)

(-7.37701E+16) GAC01(1)

(-8.53308E+15) GAC02(1)

Volume(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0014 Tc2(1)

-43.8021 DFREq(1,3)

REMAINING 84 ENTRIES SKIPPED

---- DFR Desired flow rate for the industry in liters per sec

DFR(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,1)

-1.0067 CF03(1)

1 CF04(1)

-1.0603 CF09(1)

-41.8492 CF25(1)

-8.3698 CF27(1)

DFR(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,2)

DFR(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,3)

-0.18 IX01(1)

-0.0156 IX04(1)

REMAINING 84 ENTRIES SKIPPED

---- NonlinearTechCost

NonlinearTechCost(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost01(1)

NonlinearTechCost(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost02(1)

NonlinearTechCost(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost03(1)

REMAINING 84 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE TechProblem Using NLP From line 868

LOOPS FOR/WHILE 1

FOR/WHILE 3

MODEL STATISTICS

BLOCKS OF EQUATIONS 54 SINGLE EQUATIONS 1,596

BLOCKS OF VARIABLES 51 SINGLE VARIABLES 1,625

NON ZERO ELEMENTS 4,003 NON LINEAR N-Z 174

DERIVATIVE POOL 10 CONSTANT POOL 31

CODE LENGTH 1,508

GENERATION TIME = 0.000 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.000 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 3

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE TechProblem Using NLP From line 868

S O L V E S U M M A R Y

MODEL TechProblem OBJECTIVE Tobj

TYPE NLP DIRECTION MINIMIZE

SOLVER CONOPT FROM LINE 868

\*\*\*\* SOLVER STATUS 7 Licensing Problems

\*\*\*\* MODEL STATUS 11 Licensing Problem

\*\*\*\* OBJECTIVE VALUE NA

RESOURCE USAGE, LIMIT 0.000 1000.000

ITERATION COUNT, LIMIT 0 2000000000

EVALUATION ERRORS 0 0

CONOPT 3 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

\*\*\* No license found

\*\*\* To update your license, please contact your distributor.

\*\*\* Too many equations for demo mode

\*\*\* Number of equations : 1596

\*\*\* Maximum allowed : 300

\*\*\* Too many variables for demo mode

\*\*\* Number of variables : 1625

\*\*\* Maximum allowed : 300

\*\*\* Too many nonzero elements for demo mode

\*\*\* Number of nonzeros : 4003

\*\*\* Maximum allowed : 2000

No solution returned

GAMS 24.1.3 r41464 Released Jul 26, 2013 WEX-WEI x86\_64/MS Windows 01/19/16 16:16:30 Page 14

G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE TechProblem Using NLP From line 868

---- Tobjective =E=

Tobjective.. Tobj - NonlinearTechCost(1,1) - NonlinearTechCost(1,2)

- NonlinearTechCost(1,3) - NonlinearTechCost(2,1) - NonlinearTechCost(2,2)

- NonlinearTechCost(2,3) - NonlinearTechCost(3,1) - NonlinearTechCost(3,2)

- NonlinearTechCost(3,3) - NonlinearTechCost(4,1) - NonlinearTechCost(4,2)

- NonlinearTechCost(4,3) - NonlinearTechCost(5,1) - NonlinearTechCost(5,2)

- NonlinearTechCost(5,3) - NonlinearTechCost(6,1) - NonlinearTechCost(6,2)

- NonlinearTechCost(6,3) - NonlinearTechCost(7,1) - NonlinearTechCost(7,2)

- NonlinearTechCost(7,3) - NonlinearTechCost(8,1) - NonlinearTechCost(8,2)

- NonlinearTechCost(8,3) - NonlinearTechCost(9,1) - NonlinearTechCost(9,2)

- NonlinearTechCost(9,3) - NonlinearTechCost(10,1)

- NonlinearTechCost(10,2) - NonlinearTechCost(10,3)

- NonlinearTechCost(11,1) - NonlinearTechCost(11,2)

- NonlinearTechCost(11,3) - NonlinearTechCost(12,1)

- NonlinearTechCost(12,2) - NonlinearTechCost(12,3)

- NonlinearTechCost(13,1) - NonlinearTechCost(13,2)

- NonlinearTechCost(13,3) - NonlinearTechCost(14,1)

- NonlinearTechCost(14,2) - NonlinearTechCost(14,3)

- NonlinearTechCost(15,1) - NonlinearTechCost(15,2)

- NonlinearTechCost(15,3) - NonlinearTechCost(16,1)

- NonlinearTechCost(16,2) - NonlinearTechCost(16,3)

- NonlinearTechCost(17,1) - NonlinearTechCost(17,2)

- NonlinearTechCost(17,3) - NonlinearTechCost(18,1)

- NonlinearTechCost(18,2) - NonlinearTechCost(18,3)

- NonlinearTechCost(19,1) - NonlinearTechCost(19,2)

- NonlinearTechCost(19,3) - NonlinearTechCost(20,1)

- NonlinearTechCost(20,2) - NonlinearTechCost(20,3)

- NonlinearTechCost(21,1) - NonlinearTechCost(21,2)

- NonlinearTechCost(21,3) - NonlinearTechCost(22,1)

- NonlinearTechCost(22,2) - NonlinearTechCost(22,3)

- NonlinearTechCost(23,1) - NonlinearTechCost(23,2)

- NonlinearTechCost(23,3) - NonlinearTechCost(24,1)

- NonlinearTechCost(24,2) - NonlinearTechCost(24,3)

- NonlinearTechCost(25,1) - NonlinearTechCost(25,2)

- NonlinearTechCost(25,3) - NonlinearTechCost(26,1)

- NonlinearTechCost(26,2) - NonlinearTechCost(26,3)

- NonlinearTechCost(27,1) - NonlinearTechCost(27,2)

- NonlinearTechCost(27,3) - NonlinearTechCost(28,1)

- NonlinearTechCost(28,2) - NonlinearTechCost(28,3)

- NonlinearTechCost(29,1) - NonlinearTechCost(29,2)

- NonlinearTechCost(29,3) =E= 0 ; (LHS = 0)

---- Tc1 =L=

Tc1(1).. Volume(1,1) + Volume(1,2) + Volume(1,3) =L= 46.1 ; (LHS = 0)

Tc1(2).. Volume(2,1) + Volume(2,2) + Volume(2,3) =L= 1.5 ; (LHS = 0)

Tc1(3).. Volume(3,1) + Volume(3,2) + Volume(3,3) =L= 4.6 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- Tc2 =G=

Tc2(1).. 0.002762685\*Volume(1,1) + 0.00414402749999999\*Volume(1,2)

+ 0.0013813425\*Volume(1,3) =G= 0.122832874808418 ;

(LHS = 0, INFES = 0.122832874808418 \*\*\*\*)

Tc2(2).. 0.002762685\*Volume(2,1) + 0.00414402749999999\*Volume(2,2)

+ 0.0013813425\*Volume(2,3) =G= 0.00202831822193877 ;

(LHS = 0, INFES = 0.00202831822193877 \*\*\*\*)

Tc2(3).. 0.002762685\*Volume(3,1) + 0.00414402749999999\*Volume(3,2)

+ 0.0013813425\*Volume(3,3) =G= 0.0100326811806122 ;

(LHS = 0, INFES = 0.0100326811806122 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- DFREq =E=

DFREq(1,1).. - 43.8020833333334\*Volume(1,1) + DFR(1,1) =E= 0 ; (LHS = 0)

DFREq(1,2).. - 43.8020833333334\*Volume(1,2) + DFR(1,2) =E= 0 ; (LHS = 0)

DFREq(1,3).. - 43.8020833333334\*Volume(1,3) + DFR(1,3) =E= 0 ; (LHS = 0)

REMAINING 84 ENTRIES SKIPPED

---- CF01 =E=

CF01(1).. CF\_NoOfModules(1) - 1.15740740740741\*Volume(1,1) =E= 0 ; (LHS = 0)

CF01(2).. CF\_NoOfModules(2) - 1.15740740740741\*Volume(2,1) =E= 0 ; (LHS = 0)

CF01(3).. CF\_NoOfModules(3) - 1.15740740740741\*Volume(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF03 =E=

CF03(1).. CF\_MFF(1) - 1.00671140939597\*DFR(1,1) =E= 0 ; (LHS = 0)

CF03(2).. CF\_MFF(2) - 1.00671140939597\*DFR(2,1) =E= 0 ; (LHS = 0)

CF03(3).. CF\_MFF(3) - 1.00671140939597\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF04 =E=

CF04(1).. CF\_BackwashFlow(1) - CF\_MFF(1) + DFR(1,1) =E= 0 ; (LHS = 0)

CF04(2).. CF\_BackwashFlow(2) - CF\_MFF(2) + DFR(2,1) =E= 0 ; (LHS = 0)

CF04(3).. CF\_BackwashFlow(3) - CF\_MFF(3) + DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF05 =E=

CF05(1).. CF\_FeedPumpHP(1) - 0.346809353943718\*CF\_MFF(1) =E= 0 ; (LHS = 0)

CF05(2).. CF\_FeedPumpHP(2) - 0.346809353943718\*CF\_MFF(2) =E= 0 ; (LHS = 0)

CF05(3).. CF\_FeedPumpHP(3) - 0.346809353943718\*CF\_MFF(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF06 =E=

CF06(1).. - 6534.96\*CF\_FeedPumpHP(1) + CF\_FeedPumpPower(1) =E= 0 ; (LHS = 0)

CF06(2).. - 6534.96\*CF\_FeedPumpHP(2) + CF\_FeedPumpPower(2) =E= 0 ; (LHS = 0)

CF06(3).. - 6534.96\*CF\_FeedPumpHP(3) + CF\_FeedPumpPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF07 =E=

CF07(1).. - 43.508\*CF\_FeedPumpHP(1) + CF\_BackflushPower(1) =E= 0 ; (LHS = 0)

CF07(2).. - 43.508\*CF\_FeedPumpHP(2) + CF\_BackflushPower(2) =E= 0 ; (LHS = 0)

CF07(3).. - 43.508\*CF\_FeedPumpHP(3) + CF\_BackflushPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF08 =E=

CF08(1).. - 90\*CF\_NoOfModules(1) + CF\_NoOfMembranes(1) =E= 0 ; (LHS = 0)

CF08(2).. - 90\*CF\_NoOfModules(2) + CF\_NoOfMembranes(2) =E= 0 ; (LHS = 0)

CF08(3).. - 90\*CF\_NoOfModules(3) + CF\_NoOfMembranes(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF09 =E=

CF09(1).. CF\_BuildingArea(1) - 1.060338816\*DFR(1,1) =E= 0 ; (LHS = 0)

CF09(2).. CF\_BuildingArea(2) - 1.060338816\*DFR(2,1) =E= 0 ; (LHS = 0)

CF09(3).. CF\_BuildingArea(3) - 1.060338816\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF10 =E=

CF10(1).. - 370000\*CF\_NoOfModules(1) + CF\_MembraneModuleCost(1) =E= 0 ;

(LHS = 0)

CF10(2).. - 370000\*CF\_NoOfModules(2) + CF\_MembraneModuleCost(2) =E= 0 ;

(LHS = 0)

CF10(3).. - 370000\*CF\_NoOfModules(3) + CF\_MembraneModuleCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF11 =E=

CF11(1).. - 1076\*CF\_BuildingArea(1) + CF\_BuildingCost(1) =E= 0 ; (LHS = 0)

CF11(2).. - 1076\*CF\_BuildingArea(2) + CF\_BuildingCost(2) =E= 0 ; (LHS = 0)

CF11(3).. - 1076\*CF\_BuildingArea(3) + CF\_BuildingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF12 =E=

CF12(1).. - 70000\*CF\_NoOfModules(1) + CF\_InstallationCost(1) =E= 0 ; (LHS = 0)

CF12(2).. - 70000\*CF\_NoOfModules(2) + CF\_InstallationCost(2) =E= 0 ; (LHS = 0)

CF12(3).. - 70000\*CF\_NoOfModules(3) + CF\_InstallationCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF13 =E=

CF13(1).. - 0.05\*CF\_MembraneModuleCost(1) + CF\_MiscCost(1) =E= 0 ; (LHS = 0)

CF13(2).. - 0.05\*CF\_MembraneModuleCost(2) + CF\_MiscCost(2) =E= 0 ; (LHS = 0)

CF13(3).. - 0.05\*CF\_MembraneModuleCost(3) + CF\_MiscCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF14 =E=

CF14(1).. - 0.05\*CF\_MembraneModuleCost(1) - 0.05\*CF\_MiscCost(1)

+ CF\_PlantPipingCost(1) =E= 0 ; (LHS = 0)

CF14(2).. - 0.05\*CF\_MembraneModuleCost(2) - 0.05\*CF\_MiscCost(2)

+ CF\_PlantPipingCost(2) =E= 0 ; (LHS = 0)

CF14(3).. - 0.05\*CF\_MembraneModuleCost(3) - 0.05\*CF\_MiscCost(3)

+ CF\_PlantPipingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF15 =E=

CF15(1).. - 0.1\*CF\_MembraneModuleCost(1) - 0.1\*CF\_MiscCost(1)

+ CF\_EngineeringCost(1) =E= 0 ; (LHS = 0)

CF15(2).. - 0.1\*CF\_MembraneModuleCost(2) - 0.1\*CF\_MiscCost(2)

+ CF\_EngineeringCost(2) =E= 0 ; (LHS = 0)

CF15(3).. - 0.1\*CF\_MembraneModuleCost(3) - 0.1\*CF\_MiscCost(3)

+ CF\_EngineeringCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF16 =E=

CF16(1).. - CF\_MembraneModuleCost(1) - CF\_BuildingCost(1)

- CF\_InstallationCost(1) - CF\_MiscCost(1) - CF\_PlantPipingCost(1)

- CF\_EngineeringCost(1) + CF\_DirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF16(2).. - CF\_MembraneModuleCost(2) - CF\_BuildingCost(2)

- CF\_InstallationCost(2) - CF\_MiscCost(2) - CF\_PlantPipingCost(2)

- CF\_EngineeringCost(2) + CF\_DirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF16(3).. - CF\_MembraneModuleCost(3) - CF\_BuildingCost(3)

- CF\_InstallationCost(3) - CF\_MiscCost(3) - CF\_PlantPipingCost(3)

- CF\_EngineeringCost(3) + CF\_DirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF17 =E=

CF17(1).. - 0.06\*CF\_DirectCapitalCost(1) + CF\_ConstructionInterest(1) =E= 0 ;

(LHS = 0)

CF17(2).. - 0.06\*CF\_DirectCapitalCost(2) + CF\_ConstructionInterest(2) =E= 0 ;

(LHS = 0)

CF17(3).. - 0.06\*CF\_DirectCapitalCost(3) + CF\_ConstructionInterest(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF18 =E=

CF18(1).. - 0.2\*CF\_DirectCapitalCost(1) + CF\_Contingencies(1) =E= 0 ; (LHS = 0)

CF18(2).. - 0.2\*CF\_DirectCapitalCost(2) + CF\_Contingencies(2) =E= 0 ; (LHS = 0)

CF18(3).. - 0.2\*CF\_DirectCapitalCost(3) + CF\_Contingencies(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF19 =E=

CF19(1).. - 0.1\*CF\_DirectCapitalCost(1) + CF\_ProjectManagement(1) =E= 0 ;

(LHS = 0)

CF19(2).. - 0.1\*CF\_DirectCapitalCost(2) + CF\_ProjectManagement(2) =E= 0 ;

(LHS = 0)

CF19(3).. - 0.1\*CF\_DirectCapitalCost(3) + CF\_ProjectManagement(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF20 =E=

CF20(1).. - 0.04\*CF\_DirectCapitalCost(1) + CF\_WorkingCapital(1) =E= 0 ;

(LHS = 0)

CF20(2).. - 0.04\*CF\_DirectCapitalCost(2) + CF\_WorkingCapital(2) =E= 0 ;

(LHS = 0)

CF20(3).. - 0.04\*CF\_DirectCapitalCost(3) + CF\_WorkingCapital(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF21 =E=

CF21(1).. - CF\_ConstructionInterest(1) - CF\_Contingencies(1)

- CF\_ProjectManagement(1) - CF\_WorkingCapital(1)

+ CF\_IndirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF21(2).. - CF\_ConstructionInterest(2) - CF\_Contingencies(2)

- CF\_ProjectManagement(2) - CF\_WorkingCapital(2)

+ CF\_IndirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF21(3).. - CF\_ConstructionInterest(3) - CF\_Contingencies(3)

- CF\_ProjectManagement(3) - CF\_WorkingCapital(3)

+ CF\_IndirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF22 =E=

CF22(1).. - CF\_DirectCapitalCost(1) - CF\_IndirectCapitalCost(1)

+ CF\_TotalConstructionCost(1) =E= 0 ; (LHS = 0)

CF22(2).. - CF\_DirectCapitalCost(2) - CF\_IndirectCapitalCost(2)

+ CF\_TotalConstructionCost(2) =E= 0 ; (LHS = 0)

CF22(3).. - CF\_DirectCapitalCost(3) - CF\_IndirectCapitalCost(3)

+ CF\_TotalConstructionCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF23 =E=

CF23(1).. - 0.104965517746\*CF\_FeedPumpPower(1)

- 0.104965517746\*CF\_BackflushPower(1) + CF\_ElectricityCost(1) =E= 0 ;

(LHS = 0)

CF23(2).. - 0.104965517746\*CF\_FeedPumpPower(2)

- 0.104965517746\*CF\_BackflushPower(2) + CF\_ElectricityCost(2) =E= 0 ;

(LHS = 0)

CF23(3).. - 0.104965517746\*CF\_FeedPumpPower(3)

- 0.104965517746\*CF\_BackflushPower(3) + CF\_ElectricityCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF24 =E=

CF24(1).. CF\_LaborCost(1) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(2).. CF\_LaborCost(2) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(3).. CF\_LaborCost(3) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF25 =E=

CF25(1).. CF\_ChemicalCost(1) - 42.214602524918\*DFR(1,1) =E= -246.544758478995 ;

(LHS = 0, INFES = 246.544758478995 \*\*\*\*)

CF25(2).. CF\_ChemicalCost(2) - 42.214602524918\*DFR(2,1) =E= -246.544758478995 ;

(LHS = 0, INFES = 246.544758478995 \*\*\*\*)

CF25(3).. CF\_ChemicalCost(3) - 42.214602524918\*DFR(3,1) =E= -246.544758478995 ;

(LHS = 0, INFES = 246.544758478995 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF26 =E=

CF26(1).. - 104.143377747524\*CF\_NoOfMembranes(1)

+ CF\_MembraneReplacementCost(1) =E= 0 ; (LHS = 0)

CF26(2).. - 104.143377747524\*CF\_NoOfMembranes(2)

+ CF\_MembraneReplacementCost(2) =E= 0 ; (LHS = 0)

CF26(3).. - 104.143377747524\*CF\_NoOfMembranes(3)

+ CF\_MembraneReplacementCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF27 =E=

CF27(1).. CF\_CleaningChemicalCost(1) - 8.44292050498359\*DFR(1,1) =E=

49.309247549805 ; (LHS = 0, INFES = 49.309247549805 \*\*\*\*)

CF27(2).. CF\_CleaningChemicalCost(2) - 8.44292050498359\*DFR(2,1) =E=

49.309247549805 ; (LHS = 0, INFES = 49.309247549805 \*\*\*\*)

CF27(3).. CF\_CleaningChemicalCost(3) - 8.44292050498359\*DFR(3,1) =E=

49.309247549805 ; (LHS = 0, INFES = 49.309247549805 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF28 =E=

CF28(1).. - 0.02\*CF\_DirectCapitalCost(1) + CF\_Repairs(1) =E= 0 ; (LHS = 0)

CF28(2).. - 0.02\*CF\_DirectCapitalCost(2) + CF\_Repairs(2) =E= 0 ; (LHS = 0)

CF28(3).. - 0.02\*CF\_DirectCapitalCost(3) + CF\_Repairs(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF29 =E=

CF29(1).. - CF\_ElectricityCost(1) - CF\_LaborCost(1) - CF\_ChemicalCost(1)

- CF\_MembraneReplacementCost(1) - CF\_CleaningChemicalCost(1)

- CF\_Repairs(1) + CF\_TotalOMCost(1) =E= 0 ; (LHS = 0)

CF29(2).. - CF\_ElectricityCost(2) - CF\_LaborCost(2) - CF\_ChemicalCost(2)

- CF\_MembraneReplacementCost(2) - CF\_CleaningChemicalCost(2)

- CF\_Repairs(2) + CF\_TotalOMCost(2) =E= 0 ; (LHS = 0)

CF29(3).. - CF\_ElectricityCost(3) - CF\_LaborCost(3) - CF\_ChemicalCost(3)

- CF\_MembraneReplacementCost(3) - CF\_CleaningChemicalCost(3)

- CF\_Repairs(3) + CF\_TotalOMCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF30 =E=

CF30(1).. - 0.101852208823151\*CF\_TotalConstructionCost(1)

+ CF\_CapitalRecovery(1) =E= 0 ; (LHS = 0)

CF30(2).. - 0.101852208823151\*CF\_TotalConstructionCost(2)

+ CF\_CapitalRecovery(2) =E= 0 ; (LHS = 0)

CF30(3).. - 0.101852208823151\*CF\_TotalConstructionCost(3)

+ CF\_CapitalRecovery(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF31 =E=

CF31(1).. - 2\*CF\_TotalOMCost(1) - 2\*CF\_CapitalRecovery(1) + CF\_AnnualCost(1)

=E= 0 ; (LHS = 0)

CF31(2).. - 2\*CF\_TotalOMCost(2) - 2\*CF\_CapitalRecovery(2) + CF\_AnnualCost(2)

=E= 0 ; (LHS = 0)

CF31(3).. - 2\*CF\_TotalOMCost(3) - 2\*CF\_CapitalRecovery(3) + CF\_AnnualCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC01 =E=

GAC01(1).. GAC\_CapitalCost(1) - (7.37701051584E16)\*Volume(1,2) =E= 0 ;

(LHS = 0)

GAC01(2).. GAC\_CapitalCost(2) - (7.37701051584E16)\*Volume(2,2) =E= 0 ;

(LHS = 0)

GAC01(3).. GAC\_CapitalCost(3) - (7.37701051584E16)\*Volume(3,2) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC02 =E=

GAC02(1).. GAC\_OMCost(1) - (8.53307527956E15)\*Volume(1,2) =E= 0 ; (LHS = 0)

GAC02(2).. GAC\_OMCost(2) - (8.53307527956E15)\*Volume(2,2) =E= 0 ; (LHS = 0)

GAC02(3).. GAC\_OMCost(3) - (8.53307527956E15)\*Volume(3,2) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC03 =E=

GAC03(1).. - GAC\_CapitalCost(1) - GAC\_OMCost(1) + GAC\_TotalCost(1) =E= 0 ;

(LHS = 0)

GAC03(2).. - GAC\_CapitalCost(2) - GAC\_OMCost(2) + GAC\_TotalCost(2) =E= 0 ;

(LHS = 0)

GAC03(3).. - GAC\_CapitalCost(3) - GAC\_OMCost(3) + GAC\_TotalCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX01 =E=

IX01(1).. IX\_MinResinVolume(1) - 0.18\*DFR(1,3) =E= 0 ; (LHS = 0)

IX01(2).. IX\_MinResinVolume(2) - 0.18\*DFR(2,3) =E= 0 ; (LHS = 0)

IX01(3).. IX\_MinResinVolume(3) - 0.18\*DFR(3,3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX02 =E=

IX02(1).. IX\_MinVolExhaustionTime(1) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(2).. IX\_MinVolExhaustionTime(2) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(3).. IX\_MinVolExhaustionTime(3) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX04 =E=

IX04(1).. IX\_ExhaustionTimeResinVolume(1) - 0.0156384\*DFR(1,3) =E= 0 ;

(LHS = 0)

IX04(2).. IX\_ExhaustionTimeResinVolume(2) - 0.0156384\*DFR(2,3) =E= 0 ;

(LHS = 0)

IX04(3).. IX\_ExhaustionTimeResinVolume(3) - 0.0156384\*DFR(3,3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX05 =E=

IX05(1).. - 2\*IX\_ExhaustionTimeResinVolume(1) + IX\_VesselVolume(1) =E= 0 ;

(LHS = 0)

IX05(2).. - 2\*IX\_ExhaustionTimeResinVolume(2) + IX\_VesselVolume(2) =E= 0 ;

(LHS = 0)

IX05(3).. - 2\*IX\_ExhaustionTimeResinVolume(3) + IX\_VesselVolume(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX06 =E=

IX06(1).. - 1767.8334896332\*IX\_ExhaustionTimeResinVolume(1) + IX\_ResinCost(1)

=E= 0 ; (LHS = 0)

IX06(2).. - 1767.8334896332\*IX\_ExhaustionTimeResinVolume(2) + IX\_ResinCost(2)

=E= 0 ; (LHS = 0)

IX06(3).. - 1767.8334896332\*IX\_ExhaustionTimeResinVolume(3) + IX\_ResinCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX07 =E=

IX07(1).. - (185696.081345492)\*IX\_VesselVolume(1) + IX\_TankTotalCost(1) =E= 0 ;

(LHS = -2.81596844251084, INFES = 2.81596844251084 \*\*\*\*)

IX07(2).. - (185696.081345492)\*IX\_VesselVolume(2) + IX\_TankTotalCost(2) =E= 0 ;

(LHS = -2.81596844251084, INFES = 2.81596844251084 \*\*\*\*)

IX07(3).. - (185696.081345492)\*IX\_VesselVolume(3) + IX\_TankTotalCost(3) =E= 0 ;

(LHS = -2.81596844251084, INFES = 2.81596844251084 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX08 =E=

IX08(1).. - 150\*IX\_ExhaustionTimeResinVolume(1) + IX\_NaClReq(1) =E= 0 ;

(LHS = 0)

IX08(2).. - 150\*IX\_ExhaustionTimeResinVolume(2) + IX\_NaClReq(2) =E= 0 ;

(LHS = 0)

IX08(3).. - 150\*IX\_ExhaustionTimeResinVolume(3) + IX\_NaClReq(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX09 =E=

IX09(1).. - 0.01\*IX\_NaClReq(1) + IX\_RegFluidReq(1) =E= 0 ; (LHS = 0)

IX09(2).. - 0.01\*IX\_NaClReq(2) + IX\_RegFluidReq(2) =E= 0 ; (LHS = 0)

IX09(3).. - 0.01\*IX\_NaClReq(3) + IX\_RegFluidReq(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX10 =E=

IX10(1).. - 3.65\*IX\_NaClReq(1) + IX\_TotalChemCost(1) =E= 0 ; (LHS = 0)

IX10(2).. - 3.65\*IX\_NaClReq(2) + IX\_TotalChemCost(2) =E= 0 ; (LHS = 0)

IX10(3).. - 3.65\*IX\_NaClReq(3) + IX\_TotalChemCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX11 =E=

IX11(1).. - 250\*IX\_RegFluidReq(1) + IX\_StorageTankCost(1) =E= 0 ; (LHS = 0)

IX11(2).. - 250\*IX\_RegFluidReq(2) + IX\_StorageTankCost(2) =E= 0 ; (LHS = 0)

IX11(3).. - 250\*IX\_RegFluidReq(3) + IX\_StorageTankCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX12 =E=

IX12(1).. - (2500000000)\*IX\_VesselVolume(1) + IX\_BedArea(1) =E= 0 ; (LHS = 0)

IX12(2).. - (2500000000)\*IX\_VesselVolume(2) + IX\_BedArea(2) =E= 0 ; (LHS = 0)

IX12(3).. - (2500000000)\*IX\_VesselVolume(3) + IX\_BedArea(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX13 =E=

IX13(1).. - (1254.21)\*IX\_BedArea(1) + IX\_ConstructionCost(1) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(2).. - (1254.21)\*IX\_BedArea(2) + IX\_ConstructionCost(2) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(3).. - (1254.21)\*IX\_BedArea(3) + IX\_ConstructionCost(3) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX14 =E=

IX14(1).. - (733000000000)\*IX\_BedArea(1) + IX\_OMCost(1) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(2).. - (733000000000)\*IX\_BedArea(2) + IX\_OMCost(2) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(3).. - (733000000000)\*IX\_BedArea(3) + IX\_OMCost(3) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX15 =E=

IX15(1).. - 24\*IX\_ResinCost(1) - IX\_TankTotalCost(1) - IX\_TotalChemCost(1)

- IX\_StorageTankCost(1) - IX\_ConstructionCost(1) - IX\_OMCost(1)

+ IX\_TotalCost(1) =E= 0 ; (LHS = 0)

IX15(2).. - 24\*IX\_ResinCost(2) - IX\_TankTotalCost(2) - IX\_TotalChemCost(2)

- IX\_StorageTankCost(2) - IX\_ConstructionCost(2) - IX\_OMCost(2)

+ IX\_TotalCost(2) =E= 0 ; (LHS = 0)

IX15(3).. - 24\*IX\_ResinCost(3) - IX\_TankTotalCost(3) - IX\_TotalChemCost(3)

- IX\_StorageTankCost(3) - IX\_ConstructionCost(3) - IX\_OMCost(3)

+ IX\_TotalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost01 =E=

NonlinearTechCost01(1).. - 1E-5\*CF\_AnnualCost(1) + NonlinearTechCost(1,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(2).. - 1E-5\*CF\_AnnualCost(2) + NonlinearTechCost(2,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(3).. - 1E-5\*CF\_AnnualCost(3) + NonlinearTechCost(3,1) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost02 =E=

NonlinearTechCost02(1).. - 1E-5\*GAC\_TotalCost(1) + NonlinearTechCost(1,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(2).. - 1E-5\*GAC\_TotalCost(2) + NonlinearTechCost(2,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(3).. - 1E-5\*GAC\_TotalCost(3) + NonlinearTechCost(3,2) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost03 =E=

NonlinearTechCost03(1).. - 1E-5\*IX\_TotalCost(1) + NonlinearTechCost(1,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(2).. - 1E-5\*IX\_TotalCost(2) + NonlinearTechCost(2,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(3).. - 1E-5\*IX\_TotalCost(3) + NonlinearTechCost(3,3) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE TechProblem Using NLP From line 868

---- CF\_NoOfModules Number of modules

CF\_NoOfModules(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(1)

-90 CF08(1)

-370000 CF10(1)

-70000 CF12(1)

CF\_NoOfModules(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(2)

-90 CF08(2)

-370000 CF10(2)

-70000 CF12(2)

CF\_NoOfModules(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(3)

-90 CF08(3)

-370000 CF10(3)

-70000 CF12(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackwashFlow Backwash flow

CF\_BackwashFlow(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(1)

CF\_BackwashFlow(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(2)

CF\_BackwashFlow(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpHP Feed pump horsepower

CF\_FeedPumpHP(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(1)

-6534.96 CF06(1)

-43.508 CF07(1)

CF\_FeedPumpHP(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(2)

-6534.96 CF06(2)

-43.508 CF07(2)

CF\_FeedPumpHP(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(3)

-6534.96 CF06(3)

-43.508 CF07(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpPower Feed pump power requirement in kWh

CF\_FeedPumpPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(1)

-0.105 CF23(1)

CF\_FeedPumpPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(2)

-0.105 CF23(2)

CF\_FeedPumpPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(3)

-0.105 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackflushPower Backflush power requirement in kWh

CF\_BackflushPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(1)

-0.105 CF23(1)

CF\_BackflushPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(2)

-0.105 CF23(2)

CF\_BackflushPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(3)

-0.105 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MFF Microfiltration feed flow in liters per sec

CF\_MFF(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(1)

-1 CF04(1)

-0.3468 CF05(1)

CF\_MFF(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(2)

-1 CF04(2)

-0.3468 CF05(2)

CF\_MFF(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(3)

-1 CF04(3)

-0.3468 CF05(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_NoOfMembranes Number of membranes used

CF\_NoOfMembranes(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(1)

-104.1434 CF26(1)

CF\_NoOfMembranes(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(2)

-104.1434 CF26(2)

CF\_NoOfMembranes(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(3)

-104.1434 CF26(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingArea Building area for the process implementation

CF\_BuildingArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(1)

-1076 CF11(1)

CF\_BuildingArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(2)

-1076 CF11(2)

CF\_BuildingArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(3)

-1076 CF11(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneModuleCost Membrane module cost

CF\_MembraneModuleCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(1)

-0.05 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MembraneModuleCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(2)

-0.05 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MembraneModuleCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(3)

-0.05 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingCost Building cost - based on the building area

CF\_BuildingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(1)

-1 CF16(1)

CF\_BuildingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(2)

-1 CF16(2)

CF\_BuildingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_InstallationCost Installation cost for the process

CF\_InstallationCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(1)

-1 CF16(1)

CF\_InstallationCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(2)

-1 CF16(2)

CF\_InstallationCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MiscCost Miscellaneous cost (taken as 5% of the module cost)

CF\_MiscCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MiscCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MiscCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_PlantPipingCost Plant piping cost (taken as 5% of the module and misc c

ost)

CF\_PlantPipingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(1)

-1 CF16(1)

CF\_PlantPipingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(2)

-1 CF16(2)

CF\_PlantPipingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_EngineeringCost Engineering cost (taken as 10% of the module and misc c

ost)

CF\_EngineeringCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(1)

-1 CF16(1)

CF\_EngineeringCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(2)

-1 CF16(2)

CF\_EngineeringCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_DirectCapitalCost Total direct capital cost

CF\_DirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(1)

-0.06 CF17(1)

-0.2 CF18(1)

-0.1 CF19(1)

-0.04 CF20(1)

-1 CF22(1)

-0.02 CF28(1)

CF\_DirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(2)

-0.06 CF17(2)

-0.2 CF18(2)

-0.1 CF19(2)

-0.04 CF20(2)

-1 CF22(2)

-0.02 CF28(2)

CF\_DirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(3)

-0.06 CF17(3)

-0.2 CF18(3)

-0.1 CF19(3)

-0.04 CF20(3)

-1 CF22(3)

-0.02 CF28(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ConstructionInterest Expense on interest during construction (taken as

6% of total direct capital cost)

CF\_ConstructionInterest(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(1)

-1 CF21(1)

CF\_ConstructionInterest(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(2)

-1 CF21(2)

CF\_ConstructionInterest(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Contingencies Contingencies (taken as 20% of total direct capital cost)

CF\_Contingencies(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(1)

-1 CF21(1)

CF\_Contingencies(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(2)

-1 CF21(2)

CF\_Contingencies(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ProjectManagement Fees and project management (taken as 10% of total di

rect capital cost)

CF\_ProjectManagement(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(1)

-1 CF21(1)

CF\_ProjectManagement(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(2)

-1 CF21(2)

CF\_ProjectManagement(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_WorkingCapital Working capital (taken as 4% of total direct capital cos

t)

CF\_WorkingCapital(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(1)

-1 CF21(1)

CF\_WorkingCapital(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(2)

-1 CF21(2)

CF\_WorkingCapital(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_IndirectCapitalCost Total indirect capital cost

CF\_IndirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(1)

-1 CF22(1)

CF\_IndirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(2)

-1 CF22(2)

CF\_IndirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(3)

-1 CF22(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalConstructionCost Total (direct and indirect) construction cost

CF\_TotalConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(1)

-0.1019 CF30(1)

CF\_TotalConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(2)

-0.1019 CF30(2)

CF\_TotalConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(3)

-0.1019 CF30(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ElectricityCost Electricity cost for the implementation of the process

CF\_ElectricityCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(1)

-1 CF29(1)

CF\_ElectricityCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(2)

-1 CF29(2)

CF\_ElectricityCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_LaborCost Labor cost for the implementation of the process

CF\_LaborCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(1)

-1 CF29(1)

CF\_LaborCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(2)

-1 CF29(2)

CF\_LaborCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ChemicalCost Chemical cost for the process

CF\_ChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(1)

-1 CF29(1)

CF\_ChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(2)

-1 CF29(2)

CF\_ChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneReplacementCost Membrane replacement cost for the process

CF\_MembraneReplacementCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(1)

-1 CF29(1)

CF\_MembraneReplacementCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(2)

-1 CF29(2)

CF\_MembraneReplacementCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CleaningChemicalCost Cleaning chemical (NaOCl) cost

CF\_CleaningChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(1)

-1 CF29(1)

CF\_CleaningChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(2)

-1 CF29(2)

CF\_CleaningChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Repairs Repairs replacement and misc cost (taken as 2% of the direct ca

pital cost)

CF\_Repairs(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(1)

-1 CF29(1)

CF\_Repairs(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(2)

-1 CF29(2)

CF\_Repairs(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalOMCost Total operating and maintenance cost

CF\_TotalOMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(1)

-2 CF31(1)

CF\_TotalOMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(2)

-2 CF31(2)

CF\_TotalOMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CapitalRecovery Capital recovery - calculate from the total captical co

st

CF\_CapitalRecovery(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(1)

-2 CF31(1)

CF\_CapitalRecovery(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(2)

-2 CF31(2)

CF\_CapitalRecovery(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_AnnualCost Annual cost depending on the Capital recovery and OM cost

CF\_AnnualCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(1)

-1.000000E-5 NonlinearTechCost01(1)

CF\_AnnualCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(2)

-1.000000E-5 NonlinearTechCost01(2)

CF\_AnnualCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(3)

-1.000000E-5 NonlinearTechCost01(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_CapitalCost Capital cost for the activated carbon process

GAC\_CapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(1)

-1 GAC03(1)

GAC\_CapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(2)

-1 GAC03(2)

GAC\_CapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_OMCost Operational and maintenance cost for the activated carbon proce

ss

GAC\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(1)

-1 GAC03(1)

GAC\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(2)

-1 GAC03(2)

GAC\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_TotalCost Total cost for the activated carbon process implementation

GAC\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(1)

-1.000000E-5 NonlinearTechCost02(1)

GAC\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(2)

-1.000000E-5 NonlinearTechCost02(2)

GAC\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(3)

-1.000000E-5 NonlinearTechCost02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinResinVolume Minimum volume of the medium in m3

IX\_MinResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(1)

IX\_MinResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(2)

IX\_MinResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinVolExhaustionTime Minimum volume exhaustion time in days

IX\_MinVolExhaustionTime(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(1)

IX\_MinVolExhaustionTime(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(2)

IX\_MinVolExhaustionTime(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ExhaustionTimeResinVolume Resin volume in m3 for the minimum exhaustion

time

IX\_ExhaustionTimeResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(1)

-2 IX05(1)

-1767.8335 IX06(1)

-150 IX08(1)

IX\_ExhaustionTimeResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(2)

-2 IX05(2)

-1767.8335 IX06(2)

-150 IX08(2)

IX\_ExhaustionTimeResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(3)

-2 IX05(3)

-1767.8335 IX06(3)

-150 IX08(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_VesselVolume Total vessel volume in m3

IX\_VesselVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(1)

(-185696.0813) IX07(1)

(-2.500000E+9) IX12(1)

IX\_VesselVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(2)

(-185696.0813) IX07(2)

(-2.500000E+9) IX12(2)

IX\_VesselVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(3)

(-185696.0813) IX07(3)

(-2.500000E+9) IX12(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ResinCost Total resin cost (in $ per day -- need to check)

IX\_ResinCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(1)

-24 IX15(1)

IX\_ResinCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(2)

-24 IX15(2)

IX\_ResinCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(3)

-24 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_BedArea Bed area for the vessel in m2

IX\_BedArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(1)

(-1254.21) IX13(1)

(-7.33000E+11) IX14(1)

IX\_BedArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(2)

(-1254.21) IX13(2)

(-7.33000E+11) IX14(2)

IX\_BedArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(3)

(-1254.21) IX13(3)

(-7.33000E+11) IX14(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TankTotalCost Total Tank cost in $

IX\_TankTotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(1)

-1 IX15(1)

IX\_TankTotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(2)

-1 IX15(2)

IX\_TankTotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_NaClReq NaCl requirement in Kg per day

IX\_NaClReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(1)

-0.01 IX09(1)

-3.65 IX10(1)

IX\_NaClReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(2)

-0.01 IX09(2)

-3.65 IX10(2)

IX\_NaClReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(3)

-0.01 IX09(3)

-3.65 IX10(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalChemCost Total chemical cost per year

IX\_TotalChemCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(1)

-1 IX15(1)

IX\_TotalChemCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(2)

-1 IX15(2)

IX\_TotalChemCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_RegFluidReq Regeneration fluid requirement

IX\_RegFluidReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(1)

-250 IX11(1)

IX\_RegFluidReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(2)

-250 IX11(2)

IX\_RegFluidReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(3)

-250 IX11(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_StorageTankCost Storage tank cost

IX\_StorageTankCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(1)

-1 IX15(1)

IX\_StorageTankCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(2)

-1 IX15(2)

IX\_StorageTankCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ConstructionCost Construction cost

IX\_ConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(1)

-1 IX15(1)

IX\_ConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(2)

-1 IX15(2)

IX\_ConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_OMCost Operating and maintenance cost

IX\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(1)

-1 IX15(1)

IX\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(2)

-1 IX15(2)

IX\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalCost Total cost for the implementation of ion exchange process for

each industry

IX\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(1)

-1.000000E-5 NonlinearTechCost03(1)

IX\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(2)

-1.000000E-5 NonlinearTechCost03(2)

IX\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(3)

-1.000000E-5 NonlinearTechCost03(3)

REMAINING 26 ENTRIES SKIPPED

---- Tobj Objective function for the technoogy only problem

Tobj

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 Tobjective

---- Volume volume of waste treated by each industry using each technology (def

ined over i and j)

Volume(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0028 Tc2(1)

-43.8021 DFREq(1,1)

-1.1574 CF01(1)

Volume(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0041 Tc2(1)

-43.8021 DFREq(1,2)

(-7.37701E+16) GAC01(1)

(-8.53308E+15) GAC02(1)

Volume(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0014 Tc2(1)

-43.8021 DFREq(1,3)

REMAINING 84 ENTRIES SKIPPED

---- DFR Desired flow rate for the industry in liters per sec

DFR(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,1)

-1.0067 CF03(1)

1 CF04(1)

-1.0603 CF09(1)

-42.2146 CF25(1)

-8.4429 CF27(1)

DFR(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,2)

DFR(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,3)

-0.18 IX01(1)

-0.0156 IX04(1)

REMAINING 84 ENTRIES SKIPPED

---- NonlinearTechCost

NonlinearTechCost(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost01(1)

NonlinearTechCost(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost02(1)

NonlinearTechCost(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost03(1)

REMAINING 84 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE TechProblem Using NLP From line 868

LOOPS FOR/WHILE 1

FOR/WHILE 4

MODEL STATISTICS

BLOCKS OF EQUATIONS 54 SINGLE EQUATIONS 1,596

BLOCKS OF VARIABLES 51 SINGLE VARIABLES 1,625

NON ZERO ELEMENTS 4,003 NON LINEAR N-Z 174

DERIVATIVE POOL 10 CONSTANT POOL 31

CODE LENGTH 1,508

GENERATION TIME = 0.016 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.016 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 4

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE TechProblem Using NLP From line 868

S O L V E S U M M A R Y

MODEL TechProblem OBJECTIVE Tobj

TYPE NLP DIRECTION MINIMIZE

SOLVER CONOPT FROM LINE 868

\*\*\*\* SOLVER STATUS 7 Licensing Problems

\*\*\*\* MODEL STATUS 11 Licensing Problem

\*\*\*\* OBJECTIVE VALUE NA

RESOURCE USAGE, LIMIT 0.000 1000.000

ITERATION COUNT, LIMIT 0 2000000000

EVALUATION ERRORS 0 0

CONOPT 3 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

\*\*\* No license found

\*\*\* To update your license, please contact your distributor.

\*\*\* Too many equations for demo mode

\*\*\* Number of equations : 1596

\*\*\* Maximum allowed : 300

\*\*\* Too many variables for demo mode

\*\*\* Number of variables : 1625

\*\*\* Maximum allowed : 300

\*\*\* Too many nonzero elements for demo mode

\*\*\* Number of nonzeros : 4003

\*\*\* Maximum allowed : 2000

No solution returned

GAMS 24.1.3 r41464 Released Jul 26, 2013 WEX-WEI x86\_64/MS Windows 01/19/16 16:16:30 Page 18

G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE TechProblem Using NLP From line 868

---- Tobjective =E=

Tobjective.. Tobj - NonlinearTechCost(1,1) - NonlinearTechCost(1,2)

- NonlinearTechCost(1,3) - NonlinearTechCost(2,1) - NonlinearTechCost(2,2)

- NonlinearTechCost(2,3) - NonlinearTechCost(3,1) - NonlinearTechCost(3,2)

- NonlinearTechCost(3,3) - NonlinearTechCost(4,1) - NonlinearTechCost(4,2)

- NonlinearTechCost(4,3) - NonlinearTechCost(5,1) - NonlinearTechCost(5,2)

- NonlinearTechCost(5,3) - NonlinearTechCost(6,1) - NonlinearTechCost(6,2)

- NonlinearTechCost(6,3) - NonlinearTechCost(7,1) - NonlinearTechCost(7,2)

- NonlinearTechCost(7,3) - NonlinearTechCost(8,1) - NonlinearTechCost(8,2)

- NonlinearTechCost(8,3) - NonlinearTechCost(9,1) - NonlinearTechCost(9,2)

- NonlinearTechCost(9,3) - NonlinearTechCost(10,1)

- NonlinearTechCost(10,2) - NonlinearTechCost(10,3)

- NonlinearTechCost(11,1) - NonlinearTechCost(11,2)

- NonlinearTechCost(11,3) - NonlinearTechCost(12,1)

- NonlinearTechCost(12,2) - NonlinearTechCost(12,3)

- NonlinearTechCost(13,1) - NonlinearTechCost(13,2)

- NonlinearTechCost(13,3) - NonlinearTechCost(14,1)

- NonlinearTechCost(14,2) - NonlinearTechCost(14,3)

- NonlinearTechCost(15,1) - NonlinearTechCost(15,2)

- NonlinearTechCost(15,3) - NonlinearTechCost(16,1)

- NonlinearTechCost(16,2) - NonlinearTechCost(16,3)

- NonlinearTechCost(17,1) - NonlinearTechCost(17,2)

- NonlinearTechCost(17,3) - NonlinearTechCost(18,1)

- NonlinearTechCost(18,2) - NonlinearTechCost(18,3)

- NonlinearTechCost(19,1) - NonlinearTechCost(19,2)

- NonlinearTechCost(19,3) - NonlinearTechCost(20,1)

- NonlinearTechCost(20,2) - NonlinearTechCost(20,3)

- NonlinearTechCost(21,1) - NonlinearTechCost(21,2)

- NonlinearTechCost(21,3) - NonlinearTechCost(22,1)

- NonlinearTechCost(22,2) - NonlinearTechCost(22,3)

- NonlinearTechCost(23,1) - NonlinearTechCost(23,2)

- NonlinearTechCost(23,3) - NonlinearTechCost(24,1)

- NonlinearTechCost(24,2) - NonlinearTechCost(24,3)

- NonlinearTechCost(25,1) - NonlinearTechCost(25,2)

- NonlinearTechCost(25,3) - NonlinearTechCost(26,1)

- NonlinearTechCost(26,2) - NonlinearTechCost(26,3)

- NonlinearTechCost(27,1) - NonlinearTechCost(27,2)

- NonlinearTechCost(27,3) - NonlinearTechCost(28,1)

- NonlinearTechCost(28,2) - NonlinearTechCost(28,3)

- NonlinearTechCost(29,1) - NonlinearTechCost(29,2)

- NonlinearTechCost(29,3) =E= 0 ; (LHS = 0)

---- Tc1 =L=

Tc1(1).. Volume(1,1) + Volume(1,2) + Volume(1,3) =L= 46.1 ; (LHS = 0)

Tc1(2).. Volume(2,1) + Volume(2,2) + Volume(2,3) =L= 1.5 ; (LHS = 0)

Tc1(3).. Volume(3,1) + Volume(3,2) + Volume(3,3) =L= 4.6 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- Tc2 =G=

Tc2(1).. 0.002762685\*Volume(1,1) + 0.00414402749999999\*Volume(1,2)

+ 0.0013813425\*Volume(1,3) =G= 0.122832874808418 ;

(LHS = 0, INFES = 0.122832874808418 \*\*\*\*)

Tc2(2).. 0.002762685\*Volume(2,1) + 0.00414402749999999\*Volume(2,2)

+ 0.0013813425\*Volume(2,3) =G= 0.00202831822193877 ;

(LHS = 0, INFES = 0.00202831822193877 \*\*\*\*)

Tc2(3).. 0.002762685\*Volume(3,1) + 0.00414402749999999\*Volume(3,2)

+ 0.0013813425\*Volume(3,3) =G= 0.0100326811806122 ;

(LHS = 0, INFES = 0.0100326811806122 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- DFREq =E=

DFREq(1,1).. - 43.8020833333334\*Volume(1,1) + DFR(1,1) =E= 0 ; (LHS = 0)

DFREq(1,2).. - 43.8020833333334\*Volume(1,2) + DFR(1,2) =E= 0 ; (LHS = 0)

DFREq(1,3).. - 43.8020833333334\*Volume(1,3) + DFR(1,3) =E= 0 ; (LHS = 0)

REMAINING 84 ENTRIES SKIPPED

---- CF01 =E=

CF01(1).. CF\_NoOfModules(1) - 1.15740740740741\*Volume(1,1) =E= 0 ; (LHS = 0)

CF01(2).. CF\_NoOfModules(2) - 1.15740740740741\*Volume(2,1) =E= 0 ; (LHS = 0)

CF01(3).. CF\_NoOfModules(3) - 1.15740740740741\*Volume(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF03 =E=

CF03(1).. CF\_MFF(1) - 1.00671140939597\*DFR(1,1) =E= 0 ; (LHS = 0)

CF03(2).. CF\_MFF(2) - 1.00671140939597\*DFR(2,1) =E= 0 ; (LHS = 0)

CF03(3).. CF\_MFF(3) - 1.00671140939597\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF04 =E=

CF04(1).. CF\_BackwashFlow(1) - CF\_MFF(1) + DFR(1,1) =E= 0 ; (LHS = 0)

CF04(2).. CF\_BackwashFlow(2) - CF\_MFF(2) + DFR(2,1) =E= 0 ; (LHS = 0)

CF04(3).. CF\_BackwashFlow(3) - CF\_MFF(3) + DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF05 =E=

CF05(1).. CF\_FeedPumpHP(1) - 0.346809353943718\*CF\_MFF(1) =E= 0 ; (LHS = 0)

CF05(2).. CF\_FeedPumpHP(2) - 0.346809353943718\*CF\_MFF(2) =E= 0 ; (LHS = 0)

CF05(3).. CF\_FeedPumpHP(3) - 0.346809353943718\*CF\_MFF(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF06 =E=

CF06(1).. - 6534.96\*CF\_FeedPumpHP(1) + CF\_FeedPumpPower(1) =E= 0 ; (LHS = 0)

CF06(2).. - 6534.96\*CF\_FeedPumpHP(2) + CF\_FeedPumpPower(2) =E= 0 ; (LHS = 0)

CF06(3).. - 6534.96\*CF\_FeedPumpHP(3) + CF\_FeedPumpPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF07 =E=

CF07(1).. - 43.508\*CF\_FeedPumpHP(1) + CF\_BackflushPower(1) =E= 0 ; (LHS = 0)

CF07(2).. - 43.508\*CF\_FeedPumpHP(2) + CF\_BackflushPower(2) =E= 0 ; (LHS = 0)

CF07(3).. - 43.508\*CF\_FeedPumpHP(3) + CF\_BackflushPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF08 =E=

CF08(1).. - 90\*CF\_NoOfModules(1) + CF\_NoOfMembranes(1) =E= 0 ; (LHS = 0)

CF08(2).. - 90\*CF\_NoOfModules(2) + CF\_NoOfMembranes(2) =E= 0 ; (LHS = 0)

CF08(3).. - 90\*CF\_NoOfModules(3) + CF\_NoOfMembranes(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF09 =E=

CF09(1).. CF\_BuildingArea(1) - 1.060338816\*DFR(1,1) =E= 0 ; (LHS = 0)

CF09(2).. CF\_BuildingArea(2) - 1.060338816\*DFR(2,1) =E= 0 ; (LHS = 0)

CF09(3).. CF\_BuildingArea(3) - 1.060338816\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF10 =E=

CF10(1).. - 370000\*CF\_NoOfModules(1) + CF\_MembraneModuleCost(1) =E= 0 ;

(LHS = 0)

CF10(2).. - 370000\*CF\_NoOfModules(2) + CF\_MembraneModuleCost(2) =E= 0 ;

(LHS = 0)

CF10(3).. - 370000\*CF\_NoOfModules(3) + CF\_MembraneModuleCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF11 =E=

CF11(1).. - 1076\*CF\_BuildingArea(1) + CF\_BuildingCost(1) =E= 0 ; (LHS = 0)

CF11(2).. - 1076\*CF\_BuildingArea(2) + CF\_BuildingCost(2) =E= 0 ; (LHS = 0)

CF11(3).. - 1076\*CF\_BuildingArea(3) + CF\_BuildingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF12 =E=

CF12(1).. - 70000\*CF\_NoOfModules(1) + CF\_InstallationCost(1) =E= 0 ; (LHS = 0)

CF12(2).. - 70000\*CF\_NoOfModules(2) + CF\_InstallationCost(2) =E= 0 ; (LHS = 0)

CF12(3).. - 70000\*CF\_NoOfModules(3) + CF\_InstallationCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF13 =E=

CF13(1).. - 0.05\*CF\_MembraneModuleCost(1) + CF\_MiscCost(1) =E= 0 ; (LHS = 0)

CF13(2).. - 0.05\*CF\_MembraneModuleCost(2) + CF\_MiscCost(2) =E= 0 ; (LHS = 0)

CF13(3).. - 0.05\*CF\_MembraneModuleCost(3) + CF\_MiscCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF14 =E=

CF14(1).. - 0.05\*CF\_MembraneModuleCost(1) - 0.05\*CF\_MiscCost(1)

+ CF\_PlantPipingCost(1) =E= 0 ; (LHS = 0)

CF14(2).. - 0.05\*CF\_MembraneModuleCost(2) - 0.05\*CF\_MiscCost(2)

+ CF\_PlantPipingCost(2) =E= 0 ; (LHS = 0)

CF14(3).. - 0.05\*CF\_MembraneModuleCost(3) - 0.05\*CF\_MiscCost(3)

+ CF\_PlantPipingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF15 =E=

CF15(1).. - 0.1\*CF\_MembraneModuleCost(1) - 0.1\*CF\_MiscCost(1)

+ CF\_EngineeringCost(1) =E= 0 ; (LHS = 0)

CF15(2).. - 0.1\*CF\_MembraneModuleCost(2) - 0.1\*CF\_MiscCost(2)

+ CF\_EngineeringCost(2) =E= 0 ; (LHS = 0)

CF15(3).. - 0.1\*CF\_MembraneModuleCost(3) - 0.1\*CF\_MiscCost(3)

+ CF\_EngineeringCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF16 =E=

CF16(1).. - CF\_MembraneModuleCost(1) - CF\_BuildingCost(1)

- CF\_InstallationCost(1) - CF\_MiscCost(1) - CF\_PlantPipingCost(1)

- CF\_EngineeringCost(1) + CF\_DirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF16(2).. - CF\_MembraneModuleCost(2) - CF\_BuildingCost(2)

- CF\_InstallationCost(2) - CF\_MiscCost(2) - CF\_PlantPipingCost(2)

- CF\_EngineeringCost(2) + CF\_DirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF16(3).. - CF\_MembraneModuleCost(3) - CF\_BuildingCost(3)

- CF\_InstallationCost(3) - CF\_MiscCost(3) - CF\_PlantPipingCost(3)

- CF\_EngineeringCost(3) + CF\_DirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF17 =E=

CF17(1).. - 0.06\*CF\_DirectCapitalCost(1) + CF\_ConstructionInterest(1) =E= 0 ;

(LHS = 0)

CF17(2).. - 0.06\*CF\_DirectCapitalCost(2) + CF\_ConstructionInterest(2) =E= 0 ;

(LHS = 0)

CF17(3).. - 0.06\*CF\_DirectCapitalCost(3) + CF\_ConstructionInterest(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF18 =E=

CF18(1).. - 0.2\*CF\_DirectCapitalCost(1) + CF\_Contingencies(1) =E= 0 ; (LHS = 0)

CF18(2).. - 0.2\*CF\_DirectCapitalCost(2) + CF\_Contingencies(2) =E= 0 ; (LHS = 0)

CF18(3).. - 0.2\*CF\_DirectCapitalCost(3) + CF\_Contingencies(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF19 =E=

CF19(1).. - 0.1\*CF\_DirectCapitalCost(1) + CF\_ProjectManagement(1) =E= 0 ;

(LHS = 0)

CF19(2).. - 0.1\*CF\_DirectCapitalCost(2) + CF\_ProjectManagement(2) =E= 0 ;

(LHS = 0)

CF19(3).. - 0.1\*CF\_DirectCapitalCost(3) + CF\_ProjectManagement(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF20 =E=

CF20(1).. - 0.04\*CF\_DirectCapitalCost(1) + CF\_WorkingCapital(1) =E= 0 ;

(LHS = 0)

CF20(2).. - 0.04\*CF\_DirectCapitalCost(2) + CF\_WorkingCapital(2) =E= 0 ;

(LHS = 0)

CF20(3).. - 0.04\*CF\_DirectCapitalCost(3) + CF\_WorkingCapital(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF21 =E=

CF21(1).. - CF\_ConstructionInterest(1) - CF\_Contingencies(1)

- CF\_ProjectManagement(1) - CF\_WorkingCapital(1)

+ CF\_IndirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF21(2).. - CF\_ConstructionInterest(2) - CF\_Contingencies(2)

- CF\_ProjectManagement(2) - CF\_WorkingCapital(2)

+ CF\_IndirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF21(3).. - CF\_ConstructionInterest(3) - CF\_Contingencies(3)

- CF\_ProjectManagement(3) - CF\_WorkingCapital(3)

+ CF\_IndirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF22 =E=

CF22(1).. - CF\_DirectCapitalCost(1) - CF\_IndirectCapitalCost(1)

+ CF\_TotalConstructionCost(1) =E= 0 ; (LHS = 0)

CF22(2).. - CF\_DirectCapitalCost(2) - CF\_IndirectCapitalCost(2)

+ CF\_TotalConstructionCost(2) =E= 0 ; (LHS = 0)

CF22(3).. - CF\_DirectCapitalCost(3) - CF\_IndirectCapitalCost(3)

+ CF\_TotalConstructionCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF23 =E=

CF23(1).. - 0.080966314354\*CF\_FeedPumpPower(1)

- 0.080966314354\*CF\_BackflushPower(1) + CF\_ElectricityCost(1) =E= 0 ;

(LHS = 0)

CF23(2).. - 0.080966314354\*CF\_FeedPumpPower(2)

- 0.080966314354\*CF\_BackflushPower(2) + CF\_ElectricityCost(2) =E= 0 ;

(LHS = 0)

CF23(3).. - 0.080966314354\*CF\_FeedPumpPower(3)

- 0.080966314354\*CF\_BackflushPower(3) + CF\_ElectricityCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF24 =E=

CF24(1).. CF\_LaborCost(1) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(2).. CF\_LaborCost(2) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(3).. CF\_LaborCost(3) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF25 =E=

CF25(1).. CF\_ChemicalCost(1) - 50.834060153151\*DFR(1,1) =E= -296.884734981635 ;

(LHS = 0, INFES = 296.884734981635 \*\*\*\*)

CF25(2).. CF\_ChemicalCost(2) - 50.834060153151\*DFR(2,1) =E= -296.884734981635 ;

(LHS = 0, INFES = 296.884734981635 \*\*\*\*)

CF25(3).. CF\_ChemicalCost(3) - 50.834060153151\*DFR(3,1) =E= -296.884734981635 ;

(LHS = 0, INFES = 296.884734981635 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF26 =E=

CF26(1).. - 131.555190384423\*CF\_NoOfMembranes(1)

+ CF\_MembraneReplacementCost(1) =E= 0 ; (LHS = 0)

CF26(2).. - 131.555190384423\*CF\_NoOfMembranes(2)

+ CF\_MembraneReplacementCost(2) =E= 0 ; (LHS = 0)

CF26(3).. - 131.555190384423\*CF\_NoOfMembranes(3)

+ CF\_MembraneReplacementCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF27 =E=

CF27(1).. CF\_CleaningChemicalCost(1) - 10.1668120306302\*DFR(1,1) =E=

59.3773032583652 ; (LHS = 0, INFES = 59.3773032583652 \*\*\*\*)

CF27(2).. CF\_CleaningChemicalCost(2) - 10.1668120306302\*DFR(2,1) =E=

59.3773032583652 ; (LHS = 0, INFES = 59.3773032583652 \*\*\*\*)

CF27(3).. CF\_CleaningChemicalCost(3) - 10.1668120306302\*DFR(3,1) =E=

59.3773032583652 ; (LHS = 0, INFES = 59.3773032583652 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF28 =E=

CF28(1).. - 0.02\*CF\_DirectCapitalCost(1) + CF\_Repairs(1) =E= 0 ; (LHS = 0)

CF28(2).. - 0.02\*CF\_DirectCapitalCost(2) + CF\_Repairs(2) =E= 0 ; (LHS = 0)

CF28(3).. - 0.02\*CF\_DirectCapitalCost(3) + CF\_Repairs(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF29 =E=

CF29(1).. - CF\_ElectricityCost(1) - CF\_LaborCost(1) - CF\_ChemicalCost(1)

- CF\_MembraneReplacementCost(1) - CF\_CleaningChemicalCost(1)

- CF\_Repairs(1) + CF\_TotalOMCost(1) =E= 0 ; (LHS = 0)

CF29(2).. - CF\_ElectricityCost(2) - CF\_LaborCost(2) - CF\_ChemicalCost(2)

- CF\_MembraneReplacementCost(2) - CF\_CleaningChemicalCost(2)

- CF\_Repairs(2) + CF\_TotalOMCost(2) =E= 0 ; (LHS = 0)

CF29(3).. - CF\_ElectricityCost(3) - CF\_LaborCost(3) - CF\_ChemicalCost(3)

- CF\_MembraneReplacementCost(3) - CF\_CleaningChemicalCost(3)

- CF\_Repairs(3) + CF\_TotalOMCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF30 =E=

CF30(1).. - 0.101852208823151\*CF\_TotalConstructionCost(1)

+ CF\_CapitalRecovery(1) =E= 0 ; (LHS = 0)

CF30(2).. - 0.101852208823151\*CF\_TotalConstructionCost(2)

+ CF\_CapitalRecovery(2) =E= 0 ; (LHS = 0)

CF30(3).. - 0.101852208823151\*CF\_TotalConstructionCost(3)

+ CF\_CapitalRecovery(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF31 =E=

CF31(1).. - 2\*CF\_TotalOMCost(1) - 2\*CF\_CapitalRecovery(1) + CF\_AnnualCost(1)

=E= 0 ; (LHS = 0)

CF31(2).. - 2\*CF\_TotalOMCost(2) - 2\*CF\_CapitalRecovery(2) + CF\_AnnualCost(2)

=E= 0 ; (LHS = 0)

CF31(3).. - 2\*CF\_TotalOMCost(3) - 2\*CF\_CapitalRecovery(3) + CF\_AnnualCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC01 =E=

GAC01(1).. GAC\_CapitalCost(1) - (7.37701051584E16)\*Volume(1,2) =E= 0 ;

(LHS = 0)

GAC01(2).. GAC\_CapitalCost(2) - (7.37701051584E16)\*Volume(2,2) =E= 0 ;

(LHS = 0)

GAC01(3).. GAC\_CapitalCost(3) - (7.37701051584E16)\*Volume(3,2) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC02 =E=

GAC02(1).. GAC\_OMCost(1) - (8.53307527956E15)\*Volume(1,2) =E= 0 ; (LHS = 0)

GAC02(2).. GAC\_OMCost(2) - (8.53307527956E15)\*Volume(2,2) =E= 0 ; (LHS = 0)

GAC02(3).. GAC\_OMCost(3) - (8.53307527956E15)\*Volume(3,2) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC03 =E=

GAC03(1).. - GAC\_CapitalCost(1) - GAC\_OMCost(1) + GAC\_TotalCost(1) =E= 0 ;

(LHS = 0)

GAC03(2).. - GAC\_CapitalCost(2) - GAC\_OMCost(2) + GAC\_TotalCost(2) =E= 0 ;

(LHS = 0)

GAC03(3).. - GAC\_CapitalCost(3) - GAC\_OMCost(3) + GAC\_TotalCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX01 =E=

IX01(1).. IX\_MinResinVolume(1) - 0.18\*DFR(1,3) =E= 0 ; (LHS = 0)

IX01(2).. IX\_MinResinVolume(2) - 0.18\*DFR(2,3) =E= 0 ; (LHS = 0)

IX01(3).. IX\_MinResinVolume(3) - 0.18\*DFR(3,3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX02 =E=

IX02(1).. IX\_MinVolExhaustionTime(1) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(2).. IX\_MinVolExhaustionTime(2) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(3).. IX\_MinVolExhaustionTime(3) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX04 =E=

IX04(1).. IX\_ExhaustionTimeResinVolume(1) - 0.0156384\*DFR(1,3) =E= 0 ;

(LHS = 0)

IX04(2).. IX\_ExhaustionTimeResinVolume(2) - 0.0156384\*DFR(2,3) =E= 0 ;

(LHS = 0)

IX04(3).. IX\_ExhaustionTimeResinVolume(3) - 0.0156384\*DFR(3,3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX05 =E=

IX05(1).. - 2\*IX\_ExhaustionTimeResinVolume(1) + IX\_VesselVolume(1) =E= 0 ;

(LHS = 0)

IX05(2).. - 2\*IX\_ExhaustionTimeResinVolume(2) + IX\_VesselVolume(2) =E= 0 ;

(LHS = 0)

IX05(3).. - 2\*IX\_ExhaustionTimeResinVolume(3) + IX\_VesselVolume(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX06 =E=

IX06(1).. - 1400.0979233592\*IX\_ExhaustionTimeResinVolume(1) + IX\_ResinCost(1)

=E= 0 ; (LHS = 0)

IX06(2).. - 1400.0979233592\*IX\_ExhaustionTimeResinVolume(2) + IX\_ResinCost(2)

=E= 0 ; (LHS = 0)

IX06(3).. - 1400.0979233592\*IX\_ExhaustionTimeResinVolume(3) + IX\_ResinCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX07 =E=

IX07(1).. - (208772.919392819)\*IX\_VesselVolume(1) + IX\_TankTotalCost(1) =E= 0 ;

(LHS = -3.9022243189624, INFES = 3.9022243189624 \*\*\*\*)

IX07(2).. - (208772.919392819)\*IX\_VesselVolume(2) + IX\_TankTotalCost(2) =E= 0 ;

(LHS = -3.9022243189624, INFES = 3.9022243189624 \*\*\*\*)

IX07(3).. - (208772.919392819)\*IX\_VesselVolume(3) + IX\_TankTotalCost(3) =E= 0 ;

(LHS = -3.9022243189624, INFES = 3.9022243189624 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX08 =E=

IX08(1).. - 150\*IX\_ExhaustionTimeResinVolume(1) + IX\_NaClReq(1) =E= 0 ;

(LHS = 0)

IX08(2).. - 150\*IX\_ExhaustionTimeResinVolume(2) + IX\_NaClReq(2) =E= 0 ;

(LHS = 0)

IX08(3).. - 150\*IX\_ExhaustionTimeResinVolume(3) + IX\_NaClReq(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX09 =E=

IX09(1).. - 0.01\*IX\_NaClReq(1) + IX\_RegFluidReq(1) =E= 0 ; (LHS = 0)

IX09(2).. - 0.01\*IX\_NaClReq(2) + IX\_RegFluidReq(2) =E= 0 ; (LHS = 0)

IX09(3).. - 0.01\*IX\_NaClReq(3) + IX\_RegFluidReq(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX10 =E=

IX10(1).. - 3.65\*IX\_NaClReq(1) + IX\_TotalChemCost(1) =E= 0 ; (LHS = 0)

IX10(2).. - 3.65\*IX\_NaClReq(2) + IX\_TotalChemCost(2) =E= 0 ; (LHS = 0)

IX10(3).. - 3.65\*IX\_NaClReq(3) + IX\_TotalChemCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX11 =E=

IX11(1).. - 250\*IX\_RegFluidReq(1) + IX\_StorageTankCost(1) =E= 0 ; (LHS = 0)

IX11(2).. - 250\*IX\_RegFluidReq(2) + IX\_StorageTankCost(2) =E= 0 ; (LHS = 0)

IX11(3).. - 250\*IX\_RegFluidReq(3) + IX\_StorageTankCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX12 =E=

IX12(1).. - (2500000000)\*IX\_VesselVolume(1) + IX\_BedArea(1) =E= 0 ; (LHS = 0)

IX12(2).. - (2500000000)\*IX\_VesselVolume(2) + IX\_BedArea(2) =E= 0 ; (LHS = 0)

IX12(3).. - (2500000000)\*IX\_VesselVolume(3) + IX\_BedArea(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX13 =E=

IX13(1).. - (1254.21)\*IX\_BedArea(1) + IX\_ConstructionCost(1) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(2).. - (1254.21)\*IX\_BedArea(2) + IX\_ConstructionCost(2) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(3).. - (1254.21)\*IX\_BedArea(3) + IX\_ConstructionCost(3) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX14 =E=

IX14(1).. - (733000000000)\*IX\_BedArea(1) + IX\_OMCost(1) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(2).. - (733000000000)\*IX\_BedArea(2) + IX\_OMCost(2) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(3).. - (733000000000)\*IX\_BedArea(3) + IX\_OMCost(3) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX15 =E=

IX15(1).. - 24\*IX\_ResinCost(1) - IX\_TankTotalCost(1) - IX\_TotalChemCost(1)

- IX\_StorageTankCost(1) - IX\_ConstructionCost(1) - IX\_OMCost(1)

+ IX\_TotalCost(1) =E= 0 ; (LHS = 0)

IX15(2).. - 24\*IX\_ResinCost(2) - IX\_TankTotalCost(2) - IX\_TotalChemCost(2)

- IX\_StorageTankCost(2) - IX\_ConstructionCost(2) - IX\_OMCost(2)

+ IX\_TotalCost(2) =E= 0 ; (LHS = 0)

IX15(3).. - 24\*IX\_ResinCost(3) - IX\_TankTotalCost(3) - IX\_TotalChemCost(3)

- IX\_StorageTankCost(3) - IX\_ConstructionCost(3) - IX\_OMCost(3)

+ IX\_TotalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost01 =E=

NonlinearTechCost01(1).. - 1E-5\*CF\_AnnualCost(1) + NonlinearTechCost(1,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(2).. - 1E-5\*CF\_AnnualCost(2) + NonlinearTechCost(2,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(3).. - 1E-5\*CF\_AnnualCost(3) + NonlinearTechCost(3,1) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost02 =E=

NonlinearTechCost02(1).. - 1E-5\*GAC\_TotalCost(1) + NonlinearTechCost(1,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(2).. - 1E-5\*GAC\_TotalCost(2) + NonlinearTechCost(2,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(3).. - 1E-5\*GAC\_TotalCost(3) + NonlinearTechCost(3,2) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost03 =E=

NonlinearTechCost03(1).. - 1E-5\*IX\_TotalCost(1) + NonlinearTechCost(1,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(2).. - 1E-5\*IX\_TotalCost(2) + NonlinearTechCost(2,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(3).. - 1E-5\*IX\_TotalCost(3) + NonlinearTechCost(3,3) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE TechProblem Using NLP From line 868

---- CF\_NoOfModules Number of modules

CF\_NoOfModules(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(1)

-90 CF08(1)

-370000 CF10(1)

-70000 CF12(1)

CF\_NoOfModules(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(2)

-90 CF08(2)

-370000 CF10(2)

-70000 CF12(2)

CF\_NoOfModules(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(3)

-90 CF08(3)

-370000 CF10(3)

-70000 CF12(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackwashFlow Backwash flow

CF\_BackwashFlow(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(1)

CF\_BackwashFlow(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(2)

CF\_BackwashFlow(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpHP Feed pump horsepower

CF\_FeedPumpHP(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(1)

-6534.96 CF06(1)

-43.508 CF07(1)

CF\_FeedPumpHP(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(2)

-6534.96 CF06(2)

-43.508 CF07(2)

CF\_FeedPumpHP(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(3)

-6534.96 CF06(3)

-43.508 CF07(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpPower Feed pump power requirement in kWh

CF\_FeedPumpPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(1)

-0.081 CF23(1)

CF\_FeedPumpPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(2)

-0.081 CF23(2)

CF\_FeedPumpPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(3)

-0.081 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackflushPower Backflush power requirement in kWh

CF\_BackflushPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(1)

-0.081 CF23(1)

CF\_BackflushPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(2)

-0.081 CF23(2)

CF\_BackflushPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(3)

-0.081 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MFF Microfiltration feed flow in liters per sec

CF\_MFF(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(1)

-1 CF04(1)

-0.3468 CF05(1)

CF\_MFF(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(2)

-1 CF04(2)

-0.3468 CF05(2)

CF\_MFF(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(3)

-1 CF04(3)

-0.3468 CF05(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_NoOfMembranes Number of membranes used

CF\_NoOfMembranes(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(1)

-131.5552 CF26(1)

CF\_NoOfMembranes(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(2)

-131.5552 CF26(2)

CF\_NoOfMembranes(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(3)

-131.5552 CF26(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingArea Building area for the process implementation

CF\_BuildingArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(1)

-1076 CF11(1)

CF\_BuildingArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(2)

-1076 CF11(2)

CF\_BuildingArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(3)

-1076 CF11(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneModuleCost Membrane module cost

CF\_MembraneModuleCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(1)

-0.05 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MembraneModuleCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(2)

-0.05 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MembraneModuleCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(3)

-0.05 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingCost Building cost - based on the building area

CF\_BuildingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(1)

-1 CF16(1)

CF\_BuildingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(2)

-1 CF16(2)

CF\_BuildingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_InstallationCost Installation cost for the process

CF\_InstallationCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(1)

-1 CF16(1)

CF\_InstallationCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(2)

-1 CF16(2)

CF\_InstallationCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MiscCost Miscellaneous cost (taken as 5% of the module cost)

CF\_MiscCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MiscCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MiscCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_PlantPipingCost Plant piping cost (taken as 5% of the module and misc c

ost)

CF\_PlantPipingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(1)

-1 CF16(1)

CF\_PlantPipingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(2)

-1 CF16(2)

CF\_PlantPipingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_EngineeringCost Engineering cost (taken as 10% of the module and misc c

ost)

CF\_EngineeringCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(1)

-1 CF16(1)

CF\_EngineeringCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(2)

-1 CF16(2)

CF\_EngineeringCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_DirectCapitalCost Total direct capital cost

CF\_DirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(1)

-0.06 CF17(1)

-0.2 CF18(1)

-0.1 CF19(1)

-0.04 CF20(1)

-1 CF22(1)

-0.02 CF28(1)

CF\_DirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(2)

-0.06 CF17(2)

-0.2 CF18(2)

-0.1 CF19(2)

-0.04 CF20(2)

-1 CF22(2)

-0.02 CF28(2)

CF\_DirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(3)

-0.06 CF17(3)

-0.2 CF18(3)

-0.1 CF19(3)

-0.04 CF20(3)

-1 CF22(3)

-0.02 CF28(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ConstructionInterest Expense on interest during construction (taken as

6% of total direct capital cost)

CF\_ConstructionInterest(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(1)

-1 CF21(1)

CF\_ConstructionInterest(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(2)

-1 CF21(2)

CF\_ConstructionInterest(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Contingencies Contingencies (taken as 20% of total direct capital cost)

CF\_Contingencies(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(1)

-1 CF21(1)

CF\_Contingencies(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(2)

-1 CF21(2)

CF\_Contingencies(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ProjectManagement Fees and project management (taken as 10% of total di

rect capital cost)

CF\_ProjectManagement(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(1)

-1 CF21(1)

CF\_ProjectManagement(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(2)

-1 CF21(2)

CF\_ProjectManagement(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_WorkingCapital Working capital (taken as 4% of total direct capital cos

t)

CF\_WorkingCapital(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(1)

-1 CF21(1)

CF\_WorkingCapital(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(2)

-1 CF21(2)

CF\_WorkingCapital(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_IndirectCapitalCost Total indirect capital cost

CF\_IndirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(1)

-1 CF22(1)

CF\_IndirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(2)

-1 CF22(2)

CF\_IndirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(3)

-1 CF22(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalConstructionCost Total (direct and indirect) construction cost

CF\_TotalConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(1)

-0.1019 CF30(1)

CF\_TotalConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(2)

-0.1019 CF30(2)

CF\_TotalConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(3)

-0.1019 CF30(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ElectricityCost Electricity cost for the implementation of the process

CF\_ElectricityCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(1)

-1 CF29(1)

CF\_ElectricityCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(2)

-1 CF29(2)

CF\_ElectricityCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_LaborCost Labor cost for the implementation of the process

CF\_LaborCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(1)

-1 CF29(1)

CF\_LaborCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(2)

-1 CF29(2)

CF\_LaborCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ChemicalCost Chemical cost for the process

CF\_ChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(1)

-1 CF29(1)

CF\_ChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(2)

-1 CF29(2)

CF\_ChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneReplacementCost Membrane replacement cost for the process

CF\_MembraneReplacementCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(1)

-1 CF29(1)

CF\_MembraneReplacementCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(2)

-1 CF29(2)

CF\_MembraneReplacementCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CleaningChemicalCost Cleaning chemical (NaOCl) cost

CF\_CleaningChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(1)

-1 CF29(1)

CF\_CleaningChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(2)

-1 CF29(2)

CF\_CleaningChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Repairs Repairs replacement and misc cost (taken as 2% of the direct ca

pital cost)

CF\_Repairs(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(1)

-1 CF29(1)

CF\_Repairs(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(2)

-1 CF29(2)

CF\_Repairs(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalOMCost Total operating and maintenance cost

CF\_TotalOMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(1)

-2 CF31(1)

CF\_TotalOMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(2)

-2 CF31(2)

CF\_TotalOMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CapitalRecovery Capital recovery - calculate from the total captical co

st

CF\_CapitalRecovery(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(1)

-2 CF31(1)

CF\_CapitalRecovery(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(2)

-2 CF31(2)

CF\_CapitalRecovery(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_AnnualCost Annual cost depending on the Capital recovery and OM cost

CF\_AnnualCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(1)

-1.000000E-5 NonlinearTechCost01(1)

CF\_AnnualCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(2)

-1.000000E-5 NonlinearTechCost01(2)

CF\_AnnualCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(3)

-1.000000E-5 NonlinearTechCost01(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_CapitalCost Capital cost for the activated carbon process

GAC\_CapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(1)

-1 GAC03(1)

GAC\_CapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(2)

-1 GAC03(2)

GAC\_CapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_OMCost Operational and maintenance cost for the activated carbon proce

ss

GAC\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(1)

-1 GAC03(1)

GAC\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(2)

-1 GAC03(2)

GAC\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_TotalCost Total cost for the activated carbon process implementation

GAC\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(1)

-1.000000E-5 NonlinearTechCost02(1)

GAC\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(2)

-1.000000E-5 NonlinearTechCost02(2)

GAC\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(3)

-1.000000E-5 NonlinearTechCost02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinResinVolume Minimum volume of the medium in m3

IX\_MinResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(1)

IX\_MinResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(2)

IX\_MinResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinVolExhaustionTime Minimum volume exhaustion time in days

IX\_MinVolExhaustionTime(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(1)

IX\_MinVolExhaustionTime(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(2)

IX\_MinVolExhaustionTime(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ExhaustionTimeResinVolume Resin volume in m3 for the minimum exhaustion

time

IX\_ExhaustionTimeResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(1)

-2 IX05(1)

-1400.0979 IX06(1)

-150 IX08(1)

IX\_ExhaustionTimeResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(2)

-2 IX05(2)

-1400.0979 IX06(2)

-150 IX08(2)

IX\_ExhaustionTimeResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(3)

-2 IX05(3)

-1400.0979 IX06(3)

-150 IX08(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_VesselVolume Total vessel volume in m3

IX\_VesselVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(1)

(-208772.9194) IX07(1)

(-2.500000E+9) IX12(1)

IX\_VesselVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(2)

(-208772.9194) IX07(2)

(-2.500000E+9) IX12(2)

IX\_VesselVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(3)

(-208772.9194) IX07(3)

(-2.500000E+9) IX12(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ResinCost Total resin cost (in $ per day -- need to check)

IX\_ResinCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(1)

-24 IX15(1)

IX\_ResinCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(2)

-24 IX15(2)

IX\_ResinCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(3)

-24 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_BedArea Bed area for the vessel in m2

IX\_BedArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(1)

(-1254.21) IX13(1)

(-7.33000E+11) IX14(1)

IX\_BedArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(2)

(-1254.21) IX13(2)

(-7.33000E+11) IX14(2)

IX\_BedArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(3)

(-1254.21) IX13(3)

(-7.33000E+11) IX14(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TankTotalCost Total Tank cost in $

IX\_TankTotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(1)

-1 IX15(1)

IX\_TankTotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(2)

-1 IX15(2)

IX\_TankTotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_NaClReq NaCl requirement in Kg per day

IX\_NaClReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(1)

-0.01 IX09(1)

-3.65 IX10(1)

IX\_NaClReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(2)

-0.01 IX09(2)

-3.65 IX10(2)

IX\_NaClReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(3)

-0.01 IX09(3)

-3.65 IX10(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalChemCost Total chemical cost per year

IX\_TotalChemCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(1)

-1 IX15(1)

IX\_TotalChemCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(2)

-1 IX15(2)

IX\_TotalChemCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_RegFluidReq Regeneration fluid requirement

IX\_RegFluidReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(1)

-250 IX11(1)

IX\_RegFluidReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(2)

-250 IX11(2)

IX\_RegFluidReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(3)

-250 IX11(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_StorageTankCost Storage tank cost

IX\_StorageTankCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(1)

-1 IX15(1)

IX\_StorageTankCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(2)

-1 IX15(2)

IX\_StorageTankCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ConstructionCost Construction cost

IX\_ConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(1)

-1 IX15(1)

IX\_ConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(2)

-1 IX15(2)

IX\_ConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_OMCost Operating and maintenance cost

IX\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(1)

-1 IX15(1)

IX\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(2)

-1 IX15(2)

IX\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalCost Total cost for the implementation of ion exchange process for

each industry

IX\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(1)

-1.000000E-5 NonlinearTechCost03(1)

IX\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(2)

-1.000000E-5 NonlinearTechCost03(2)

IX\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(3)

-1.000000E-5 NonlinearTechCost03(3)

REMAINING 26 ENTRIES SKIPPED

---- Tobj Objective function for the technoogy only problem

Tobj

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 Tobjective

---- Volume volume of waste treated by each industry using each technology (def

ined over i and j)

Volume(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0028 Tc2(1)

-43.8021 DFREq(1,1)

-1.1574 CF01(1)

Volume(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0041 Tc2(1)

-43.8021 DFREq(1,2)

(-7.37701E+16) GAC01(1)

(-8.53308E+15) GAC02(1)

Volume(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0014 Tc2(1)

-43.8021 DFREq(1,3)

REMAINING 84 ENTRIES SKIPPED

---- DFR Desired flow rate for the industry in liters per sec

DFR(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,1)

-1.0067 CF03(1)

1 CF04(1)

-1.0603 CF09(1)

-50.8341 CF25(1)

-10.1668 CF27(1)

DFR(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,2)

DFR(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,3)

-0.18 IX01(1)

-0.0156 IX04(1)

REMAINING 84 ENTRIES SKIPPED

---- NonlinearTechCost

NonlinearTechCost(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost01(1)

NonlinearTechCost(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost02(1)

NonlinearTechCost(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost03(1)

REMAINING 84 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE TechProblem Using NLP From line 868

LOOPS FOR/WHILE 1

FOR/WHILE 5

MODEL STATISTICS

BLOCKS OF EQUATIONS 54 SINGLE EQUATIONS 1,596

BLOCKS OF VARIABLES 51 SINGLE VARIABLES 1,625

NON ZERO ELEMENTS 4,003 NON LINEAR N-Z 174

DERIVATIVE POOL 10 CONSTANT POOL 31

CODE LENGTH 1,508

GENERATION TIME = 0.016 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.016 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 5

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE TechProblem Using NLP From line 868

S O L V E S U M M A R Y

MODEL TechProblem OBJECTIVE Tobj

TYPE NLP DIRECTION MINIMIZE

SOLVER CONOPT FROM LINE 868

\*\*\*\* SOLVER STATUS 7 Licensing Problems

\*\*\*\* MODEL STATUS 11 Licensing Problem

\*\*\*\* OBJECTIVE VALUE NA

RESOURCE USAGE, LIMIT 0.000 1000.000

ITERATION COUNT, LIMIT 0 2000000000

EVALUATION ERRORS 0 0

CONOPT 3 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

\*\*\* No license found

\*\*\* To update your license, please contact your distributor.

\*\*\* Too many equations for demo mode

\*\*\* Number of equations : 1596

\*\*\* Maximum allowed : 300

\*\*\* Too many variables for demo mode

\*\*\* Number of variables : 1625

\*\*\* Maximum allowed : 300

\*\*\* Too many nonzero elements for demo mode

\*\*\* Number of nonzeros : 4003

\*\*\* Maximum allowed : 2000

No solution returned

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE TechProblem Using NLP From line 868

---- Tobjective =E=

Tobjective.. Tobj - NonlinearTechCost(1,1) - NonlinearTechCost(1,2)

- NonlinearTechCost(1,3) - NonlinearTechCost(2,1) - NonlinearTechCost(2,2)

- NonlinearTechCost(2,3) - NonlinearTechCost(3,1) - NonlinearTechCost(3,2)

- NonlinearTechCost(3,3) - NonlinearTechCost(4,1) - NonlinearTechCost(4,2)

- NonlinearTechCost(4,3) - NonlinearTechCost(5,1) - NonlinearTechCost(5,2)

- NonlinearTechCost(5,3) - NonlinearTechCost(6,1) - NonlinearTechCost(6,2)

- NonlinearTechCost(6,3) - NonlinearTechCost(7,1) - NonlinearTechCost(7,2)

- NonlinearTechCost(7,3) - NonlinearTechCost(8,1) - NonlinearTechCost(8,2)

- NonlinearTechCost(8,3) - NonlinearTechCost(9,1) - NonlinearTechCost(9,2)

- NonlinearTechCost(9,3) - NonlinearTechCost(10,1)

- NonlinearTechCost(10,2) - NonlinearTechCost(10,3)

- NonlinearTechCost(11,1) - NonlinearTechCost(11,2)

- NonlinearTechCost(11,3) - NonlinearTechCost(12,1)

- NonlinearTechCost(12,2) - NonlinearTechCost(12,3)

- NonlinearTechCost(13,1) - NonlinearTechCost(13,2)

- NonlinearTechCost(13,3) - NonlinearTechCost(14,1)

- NonlinearTechCost(14,2) - NonlinearTechCost(14,3)

- NonlinearTechCost(15,1) - NonlinearTechCost(15,2)

- NonlinearTechCost(15,3) - NonlinearTechCost(16,1)

- NonlinearTechCost(16,2) - NonlinearTechCost(16,3)

- NonlinearTechCost(17,1) - NonlinearTechCost(17,2)

- NonlinearTechCost(17,3) - NonlinearTechCost(18,1)

- NonlinearTechCost(18,2) - NonlinearTechCost(18,3)

- NonlinearTechCost(19,1) - NonlinearTechCost(19,2)

- NonlinearTechCost(19,3) - NonlinearTechCost(20,1)

- NonlinearTechCost(20,2) - NonlinearTechCost(20,3)

- NonlinearTechCost(21,1) - NonlinearTechCost(21,2)

- NonlinearTechCost(21,3) - NonlinearTechCost(22,1)

- NonlinearTechCost(22,2) - NonlinearTechCost(22,3)

- NonlinearTechCost(23,1) - NonlinearTechCost(23,2)

- NonlinearTechCost(23,3) - NonlinearTechCost(24,1)

- NonlinearTechCost(24,2) - NonlinearTechCost(24,3)

- NonlinearTechCost(25,1) - NonlinearTechCost(25,2)

- NonlinearTechCost(25,3) - NonlinearTechCost(26,1)

- NonlinearTechCost(26,2) - NonlinearTechCost(26,3)

- NonlinearTechCost(27,1) - NonlinearTechCost(27,2)

- NonlinearTechCost(27,3) - NonlinearTechCost(28,1)

- NonlinearTechCost(28,2) - NonlinearTechCost(28,3)

- NonlinearTechCost(29,1) - NonlinearTechCost(29,2)

- NonlinearTechCost(29,3) =E= 0 ; (LHS = 0)

---- Tc1 =L=

Tc1(1).. Volume(1,1) + Volume(1,2) + Volume(1,3) =L= 46.1 ; (LHS = 0)

Tc1(2).. Volume(2,1) + Volume(2,2) + Volume(2,3) =L= 1.5 ; (LHS = 0)

Tc1(3).. Volume(3,1) + Volume(3,2) + Volume(3,3) =L= 4.6 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- Tc2 =G=

Tc2(1).. 0.002762685\*Volume(1,1) + 0.00414402749999999\*Volume(1,2)

+ 0.0013813425\*Volume(1,3) =G= 0.122832874808418 ;

(LHS = 0, INFES = 0.122832874808418 \*\*\*\*)

Tc2(2).. 0.002762685\*Volume(2,1) + 0.00414402749999999\*Volume(2,2)

+ 0.0013813425\*Volume(2,3) =G= 0.00202831822193877 ;

(LHS = 0, INFES = 0.00202831822193877 \*\*\*\*)

Tc2(3).. 0.002762685\*Volume(3,1) + 0.00414402749999999\*Volume(3,2)

+ 0.0013813425\*Volume(3,3) =G= 0.0100326811806122 ;

(LHS = 0, INFES = 0.0100326811806122 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- DFREq =E=

DFREq(1,1).. - 43.8020833333334\*Volume(1,1) + DFR(1,1) =E= 0 ; (LHS = 0)

DFREq(1,2).. - 43.8020833333334\*Volume(1,2) + DFR(1,2) =E= 0 ; (LHS = 0)

DFREq(1,3).. - 43.8020833333334\*Volume(1,3) + DFR(1,3) =E= 0 ; (LHS = 0)

REMAINING 84 ENTRIES SKIPPED

---- CF01 =E=

CF01(1).. CF\_NoOfModules(1) - 1.15740740740741\*Volume(1,1) =E= 0 ; (LHS = 0)

CF01(2).. CF\_NoOfModules(2) - 1.15740740740741\*Volume(2,1) =E= 0 ; (LHS = 0)

CF01(3).. CF\_NoOfModules(3) - 1.15740740740741\*Volume(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF03 =E=

CF03(1).. CF\_MFF(1) - 1.00671140939597\*DFR(1,1) =E= 0 ; (LHS = 0)

CF03(2).. CF\_MFF(2) - 1.00671140939597\*DFR(2,1) =E= 0 ; (LHS = 0)

CF03(3).. CF\_MFF(3) - 1.00671140939597\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF04 =E=

CF04(1).. CF\_BackwashFlow(1) - CF\_MFF(1) + DFR(1,1) =E= 0 ; (LHS = 0)

CF04(2).. CF\_BackwashFlow(2) - CF\_MFF(2) + DFR(2,1) =E= 0 ; (LHS = 0)

CF04(3).. CF\_BackwashFlow(3) - CF\_MFF(3) + DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF05 =E=

CF05(1).. CF\_FeedPumpHP(1) - 0.346809353943718\*CF\_MFF(1) =E= 0 ; (LHS = 0)

CF05(2).. CF\_FeedPumpHP(2) - 0.346809353943718\*CF\_MFF(2) =E= 0 ; (LHS = 0)

CF05(3).. CF\_FeedPumpHP(3) - 0.346809353943718\*CF\_MFF(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF06 =E=

CF06(1).. - 6534.96\*CF\_FeedPumpHP(1) + CF\_FeedPumpPower(1) =E= 0 ; (LHS = 0)

CF06(2).. - 6534.96\*CF\_FeedPumpHP(2) + CF\_FeedPumpPower(2) =E= 0 ; (LHS = 0)

CF06(3).. - 6534.96\*CF\_FeedPumpHP(3) + CF\_FeedPumpPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF07 =E=

CF07(1).. - 43.508\*CF\_FeedPumpHP(1) + CF\_BackflushPower(1) =E= 0 ; (LHS = 0)

CF07(2).. - 43.508\*CF\_FeedPumpHP(2) + CF\_BackflushPower(2) =E= 0 ; (LHS = 0)

CF07(3).. - 43.508\*CF\_FeedPumpHP(3) + CF\_BackflushPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF08 =E=

CF08(1).. - 90\*CF\_NoOfModules(1) + CF\_NoOfMembranes(1) =E= 0 ; (LHS = 0)

CF08(2).. - 90\*CF\_NoOfModules(2) + CF\_NoOfMembranes(2) =E= 0 ; (LHS = 0)

CF08(3).. - 90\*CF\_NoOfModules(3) + CF\_NoOfMembranes(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF09 =E=

CF09(1).. CF\_BuildingArea(1) - 1.060338816\*DFR(1,1) =E= 0 ; (LHS = 0)

CF09(2).. CF\_BuildingArea(2) - 1.060338816\*DFR(2,1) =E= 0 ; (LHS = 0)

CF09(3).. CF\_BuildingArea(3) - 1.060338816\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF10 =E=

CF10(1).. - 370000\*CF\_NoOfModules(1) + CF\_MembraneModuleCost(1) =E= 0 ;

(LHS = 0)

CF10(2).. - 370000\*CF\_NoOfModules(2) + CF\_MembraneModuleCost(2) =E= 0 ;

(LHS = 0)

CF10(3).. - 370000\*CF\_NoOfModules(3) + CF\_MembraneModuleCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF11 =E=

CF11(1).. - 1076\*CF\_BuildingArea(1) + CF\_BuildingCost(1) =E= 0 ; (LHS = 0)

CF11(2).. - 1076\*CF\_BuildingArea(2) + CF\_BuildingCost(2) =E= 0 ; (LHS = 0)

CF11(3).. - 1076\*CF\_BuildingArea(3) + CF\_BuildingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF12 =E=

CF12(1).. - 70000\*CF\_NoOfModules(1) + CF\_InstallationCost(1) =E= 0 ; (LHS = 0)

CF12(2).. - 70000\*CF\_NoOfModules(2) + CF\_InstallationCost(2) =E= 0 ; (LHS = 0)

CF12(3).. - 70000\*CF\_NoOfModules(3) + CF\_InstallationCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF13 =E=

CF13(1).. - 0.05\*CF\_MembraneModuleCost(1) + CF\_MiscCost(1) =E= 0 ; (LHS = 0)

CF13(2).. - 0.05\*CF\_MembraneModuleCost(2) + CF\_MiscCost(2) =E= 0 ; (LHS = 0)

CF13(3).. - 0.05\*CF\_MembraneModuleCost(3) + CF\_MiscCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF14 =E=

CF14(1).. - 0.05\*CF\_MembraneModuleCost(1) - 0.05\*CF\_MiscCost(1)

+ CF\_PlantPipingCost(1) =E= 0 ; (LHS = 0)

CF14(2).. - 0.05\*CF\_MembraneModuleCost(2) - 0.05\*CF\_MiscCost(2)

+ CF\_PlantPipingCost(2) =E= 0 ; (LHS = 0)

CF14(3).. - 0.05\*CF\_MembraneModuleCost(3) - 0.05\*CF\_MiscCost(3)

+ CF\_PlantPipingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF15 =E=

CF15(1).. - 0.1\*CF\_MembraneModuleCost(1) - 0.1\*CF\_MiscCost(1)

+ CF\_EngineeringCost(1) =E= 0 ; (LHS = 0)

CF15(2).. - 0.1\*CF\_MembraneModuleCost(2) - 0.1\*CF\_MiscCost(2)

+ CF\_EngineeringCost(2) =E= 0 ; (LHS = 0)

CF15(3).. - 0.1\*CF\_MembraneModuleCost(3) - 0.1\*CF\_MiscCost(3)

+ CF\_EngineeringCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF16 =E=

CF16(1).. - CF\_MembraneModuleCost(1) - CF\_BuildingCost(1)

- CF\_InstallationCost(1) - CF\_MiscCost(1) - CF\_PlantPipingCost(1)

- CF\_EngineeringCost(1) + CF\_DirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF16(2).. - CF\_MembraneModuleCost(2) - CF\_BuildingCost(2)

- CF\_InstallationCost(2) - CF\_MiscCost(2) - CF\_PlantPipingCost(2)

- CF\_EngineeringCost(2) + CF\_DirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF16(3).. - CF\_MembraneModuleCost(3) - CF\_BuildingCost(3)

- CF\_InstallationCost(3) - CF\_MiscCost(3) - CF\_PlantPipingCost(3)

- CF\_EngineeringCost(3) + CF\_DirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF17 =E=

CF17(1).. - 0.06\*CF\_DirectCapitalCost(1) + CF\_ConstructionInterest(1) =E= 0 ;

(LHS = 0)

CF17(2).. - 0.06\*CF\_DirectCapitalCost(2) + CF\_ConstructionInterest(2) =E= 0 ;

(LHS = 0)

CF17(3).. - 0.06\*CF\_DirectCapitalCost(3) + CF\_ConstructionInterest(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF18 =E=

CF18(1).. - 0.2\*CF\_DirectCapitalCost(1) + CF\_Contingencies(1) =E= 0 ; (LHS = 0)

CF18(2).. - 0.2\*CF\_DirectCapitalCost(2) + CF\_Contingencies(2) =E= 0 ; (LHS = 0)

CF18(3).. - 0.2\*CF\_DirectCapitalCost(3) + CF\_Contingencies(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF19 =E=

CF19(1).. - 0.1\*CF\_DirectCapitalCost(1) + CF\_ProjectManagement(1) =E= 0 ;

(LHS = 0)

CF19(2).. - 0.1\*CF\_DirectCapitalCost(2) + CF\_ProjectManagement(2) =E= 0 ;

(LHS = 0)

CF19(3).. - 0.1\*CF\_DirectCapitalCost(3) + CF\_ProjectManagement(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF20 =E=

CF20(1).. - 0.04\*CF\_DirectCapitalCost(1) + CF\_WorkingCapital(1) =E= 0 ;

(LHS = 0)

CF20(2).. - 0.04\*CF\_DirectCapitalCost(2) + CF\_WorkingCapital(2) =E= 0 ;

(LHS = 0)

CF20(3).. - 0.04\*CF\_DirectCapitalCost(3) + CF\_WorkingCapital(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF21 =E=

CF21(1).. - CF\_ConstructionInterest(1) - CF\_Contingencies(1)

- CF\_ProjectManagement(1) - CF\_WorkingCapital(1)

+ CF\_IndirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF21(2).. - CF\_ConstructionInterest(2) - CF\_Contingencies(2)

- CF\_ProjectManagement(2) - CF\_WorkingCapital(2)

+ CF\_IndirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF21(3).. - CF\_ConstructionInterest(3) - CF\_Contingencies(3)

- CF\_ProjectManagement(3) - CF\_WorkingCapital(3)

+ CF\_IndirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF22 =E=

CF22(1).. - CF\_DirectCapitalCost(1) - CF\_IndirectCapitalCost(1)

+ CF\_TotalConstructionCost(1) =E= 0 ; (LHS = 0)

CF22(2).. - CF\_DirectCapitalCost(2) - CF\_IndirectCapitalCost(2)

+ CF\_TotalConstructionCost(2) =E= 0 ; (LHS = 0)

CF22(3).. - CF\_DirectCapitalCost(3) - CF\_IndirectCapitalCost(3)

+ CF\_TotalConstructionCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF23 =E=

CF23(1).. - 0.100309312842\*CF\_FeedPumpPower(1)

- 0.100309312842\*CF\_BackflushPower(1) + CF\_ElectricityCost(1) =E= 0 ;

(LHS = 0)

CF23(2).. - 0.100309312842\*CF\_FeedPumpPower(2)

- 0.100309312842\*CF\_BackflushPower(2) + CF\_ElectricityCost(2) =E= 0 ;

(LHS = 0)

CF23(3).. - 0.100309312842\*CF\_FeedPumpPower(3)

- 0.100309312842\*CF\_BackflushPower(3) + CF\_ElectricityCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF24 =E=

CF24(1).. CF\_LaborCost(1) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(2).. CF\_LaborCost(2) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(3).. CF\_LaborCost(3) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF25 =E=

CF25(1).. CF\_ChemicalCost(1) - 55.5810964467824\*DFR(1,1) =E= -324.608717833624

; (LHS = 0, INFES = 324.608717833624 \*\*\*\*)

CF25(2).. CF\_ChemicalCost(2) - 55.5810964467824\*DFR(2,1) =E= -324.608717833624

; (LHS = 0, INFES = 324.608717833624 \*\*\*\*)

CF25(3).. CF\_ChemicalCost(3) - 55.5810964467824\*DFR(3,1) =E= -324.608717833624

; (LHS = 0, INFES = 324.608717833624 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF26 =E=

CF26(1).. - 126.487470975781\*CF\_NoOfMembranes(1)

+ CF\_MembraneReplacementCost(1) =E= 0 ; (LHS = 0)

CF26(2).. - 126.487470975781\*CF\_NoOfMembranes(2)

+ CF\_MembraneReplacementCost(2) =E= 0 ; (LHS = 0)

CF26(3).. - 126.487470975781\*CF\_NoOfMembranes(3)

+ CF\_MembraneReplacementCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF27 =E=

CF27(1).. CF\_CleaningChemicalCost(1) - 11.1162192893565\*DFR(1,1) =E=

64.9221330975758 ; (LHS = 0, INFES = 64.9221330975758 \*\*\*\*)

CF27(2).. CF\_CleaningChemicalCost(2) - 11.1162192893565\*DFR(2,1) =E=

64.9221330975758 ; (LHS = 0, INFES = 64.9221330975758 \*\*\*\*)

CF27(3).. CF\_CleaningChemicalCost(3) - 11.1162192893565\*DFR(3,1) =E=

64.9221330975758 ; (LHS = 0, INFES = 64.9221330975758 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF28 =E=

CF28(1).. - 0.02\*CF\_DirectCapitalCost(1) + CF\_Repairs(1) =E= 0 ; (LHS = 0)

CF28(2).. - 0.02\*CF\_DirectCapitalCost(2) + CF\_Repairs(2) =E= 0 ; (LHS = 0)

CF28(3).. - 0.02\*CF\_DirectCapitalCost(3) + CF\_Repairs(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF29 =E=

CF29(1).. - CF\_ElectricityCost(1) - CF\_LaborCost(1) - CF\_ChemicalCost(1)

- CF\_MembraneReplacementCost(1) - CF\_CleaningChemicalCost(1)

- CF\_Repairs(1) + CF\_TotalOMCost(1) =E= 0 ; (LHS = 0)

CF29(2).. - CF\_ElectricityCost(2) - CF\_LaborCost(2) - CF\_ChemicalCost(2)

- CF\_MembraneReplacementCost(2) - CF\_CleaningChemicalCost(2)

- CF\_Repairs(2) + CF\_TotalOMCost(2) =E= 0 ; (LHS = 0)

CF29(3).. - CF\_ElectricityCost(3) - CF\_LaborCost(3) - CF\_ChemicalCost(3)

- CF\_MembraneReplacementCost(3) - CF\_CleaningChemicalCost(3)

- CF\_Repairs(3) + CF\_TotalOMCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF30 =E=

CF30(1).. - 0.101852208823151\*CF\_TotalConstructionCost(1)

+ CF\_CapitalRecovery(1) =E= 0 ; (LHS = 0)

CF30(2).. - 0.101852208823151\*CF\_TotalConstructionCost(2)

+ CF\_CapitalRecovery(2) =E= 0 ; (LHS = 0)

CF30(3).. - 0.101852208823151\*CF\_TotalConstructionCost(3)

+ CF\_CapitalRecovery(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF31 =E=

CF31(1).. - 2\*CF\_TotalOMCost(1) - 2\*CF\_CapitalRecovery(1) + CF\_AnnualCost(1)

=E= 0 ; (LHS = 0)

CF31(2).. - 2\*CF\_TotalOMCost(2) - 2\*CF\_CapitalRecovery(2) + CF\_AnnualCost(2)

=E= 0 ; (LHS = 0)

CF31(3).. - 2\*CF\_TotalOMCost(3) - 2\*CF\_CapitalRecovery(3) + CF\_AnnualCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC01 =E=

GAC01(1).. GAC\_CapitalCost(1) - (7.37701051584E16)\*Volume(1,2) =E= 0 ;

(LHS = 0)

GAC01(2).. GAC\_CapitalCost(2) - (7.37701051584E16)\*Volume(2,2) =E= 0 ;

(LHS = 0)

GAC01(3).. GAC\_CapitalCost(3) - (7.37701051584E16)\*Volume(3,2) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC02 =E=

GAC02(1).. GAC\_OMCost(1) - (8.53307527956E15)\*Volume(1,2) =E= 0 ; (LHS = 0)

GAC02(2).. GAC\_OMCost(2) - (8.53307527956E15)\*Volume(2,2) =E= 0 ; (LHS = 0)

GAC02(3).. GAC\_OMCost(3) - (8.53307527956E15)\*Volume(3,2) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC03 =E=

GAC03(1).. - GAC\_CapitalCost(1) - GAC\_OMCost(1) + GAC\_TotalCost(1) =E= 0 ;

(LHS = 0)

GAC03(2).. - GAC\_CapitalCost(2) - GAC\_OMCost(2) + GAC\_TotalCost(2) =E= 0 ;

(LHS = 0)

GAC03(3).. - GAC\_CapitalCost(3) - GAC\_OMCost(3) + GAC\_TotalCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX01 =E=

IX01(1).. IX\_MinResinVolume(1) - 0.18\*DFR(1,3) =E= 0 ; (LHS = 0)

IX01(2).. IX\_MinResinVolume(2) - 0.18\*DFR(2,3) =E= 0 ; (LHS = 0)

IX01(3).. IX\_MinResinVolume(3) - 0.18\*DFR(3,3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX02 =E=

IX02(1).. IX\_MinVolExhaustionTime(1) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(2).. IX\_MinVolExhaustionTime(2) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(3).. IX\_MinVolExhaustionTime(3) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX04 =E=

IX04(1).. IX\_ExhaustionTimeResinVolume(1) - 0.0156384\*DFR(1,3) =E= 0 ;

(LHS = 0)

IX04(2).. IX\_ExhaustionTimeResinVolume(2) - 0.0156384\*DFR(2,3) =E= 0 ;

(LHS = 0)

IX04(3).. IX\_ExhaustionTimeResinVolume(3) - 0.0156384\*DFR(3,3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX05 =E=

IX05(1).. - 2\*IX\_ExhaustionTimeResinVolume(1) + IX\_VesselVolume(1) =E= 0 ;

(LHS = 0)

IX05(2).. - 2\*IX\_ExhaustionTimeResinVolume(2) + IX\_VesselVolume(2) =E= 0 ;

(LHS = 0)

IX05(3).. - 2\*IX\_ExhaustionTimeResinVolume(3) + IX\_VesselVolume(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX06 =E=

IX06(1).. - 1307.5458258008\*IX\_ExhaustionTimeResinVolume(1) + IX\_ResinCost(1)

=E= 0 ; (LHS = 0)

IX06(2).. - 1307.5458258008\*IX\_ExhaustionTimeResinVolume(2) + IX\_ResinCost(2)

=E= 0 ; (LHS = 0)

IX06(3).. - 1307.5458258008\*IX\_ExhaustionTimeResinVolume(3) + IX\_ResinCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX07 =E=

IX07(1).. - (92413.4228211626)\*IX\_VesselVolume(1) + IX\_TankTotalCost(1) =E= 0 ;

(LHS = -1.47694068564108, INFES = 1.47694068564108 \*\*\*\*)

IX07(2).. - (92413.4228211626)\*IX\_VesselVolume(2) + IX\_TankTotalCost(2) =E= 0 ;

(LHS = -1.47694068564108, INFES = 1.47694068564108 \*\*\*\*)

IX07(3).. - (92413.4228211626)\*IX\_VesselVolume(3) + IX\_TankTotalCost(3) =E= 0 ;

(LHS = -1.47694068564108, INFES = 1.47694068564108 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX08 =E=

IX08(1).. - 150\*IX\_ExhaustionTimeResinVolume(1) + IX\_NaClReq(1) =E= 0 ;

(LHS = 0)

IX08(2).. - 150\*IX\_ExhaustionTimeResinVolume(2) + IX\_NaClReq(2) =E= 0 ;

(LHS = 0)

IX08(3).. - 150\*IX\_ExhaustionTimeResinVolume(3) + IX\_NaClReq(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX09 =E=

IX09(1).. - 0.01\*IX\_NaClReq(1) + IX\_RegFluidReq(1) =E= 0 ; (LHS = 0)

IX09(2).. - 0.01\*IX\_NaClReq(2) + IX\_RegFluidReq(2) =E= 0 ; (LHS = 0)

IX09(3).. - 0.01\*IX\_NaClReq(3) + IX\_RegFluidReq(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX10 =E=

IX10(1).. - 3.65\*IX\_NaClReq(1) + IX\_TotalChemCost(1) =E= 0 ; (LHS = 0)

IX10(2).. - 3.65\*IX\_NaClReq(2) + IX\_TotalChemCost(2) =E= 0 ; (LHS = 0)

IX10(3).. - 3.65\*IX\_NaClReq(3) + IX\_TotalChemCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX11 =E=

IX11(1).. - 250\*IX\_RegFluidReq(1) + IX\_StorageTankCost(1) =E= 0 ; (LHS = 0)

IX11(2).. - 250\*IX\_RegFluidReq(2) + IX\_StorageTankCost(2) =E= 0 ; (LHS = 0)

IX11(3).. - 250\*IX\_RegFluidReq(3) + IX\_StorageTankCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX12 =E=

IX12(1).. - (2500000000)\*IX\_VesselVolume(1) + IX\_BedArea(1) =E= 0 ; (LHS = 0)

IX12(2).. - (2500000000)\*IX\_VesselVolume(2) + IX\_BedArea(2) =E= 0 ; (LHS = 0)

IX12(3).. - (2500000000)\*IX\_VesselVolume(3) + IX\_BedArea(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX13 =E=

IX13(1).. - (1254.21)\*IX\_BedArea(1) + IX\_ConstructionCost(1) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(2).. - (1254.21)\*IX\_BedArea(2) + IX\_ConstructionCost(2) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(3).. - (1254.21)\*IX\_BedArea(3) + IX\_ConstructionCost(3) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX14 =E=

IX14(1).. - (733000000000)\*IX\_BedArea(1) + IX\_OMCost(1) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(2).. - (733000000000)\*IX\_BedArea(2) + IX\_OMCost(2) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(3).. - (733000000000)\*IX\_BedArea(3) + IX\_OMCost(3) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX15 =E=

IX15(1).. - 24\*IX\_ResinCost(1) - IX\_TankTotalCost(1) - IX\_TotalChemCost(1)

- IX\_StorageTankCost(1) - IX\_ConstructionCost(1) - IX\_OMCost(1)

+ IX\_TotalCost(1) =E= 0 ; (LHS = 0)

IX15(2).. - 24\*IX\_ResinCost(2) - IX\_TankTotalCost(2) - IX\_TotalChemCost(2)

- IX\_StorageTankCost(2) - IX\_ConstructionCost(2) - IX\_OMCost(2)

+ IX\_TotalCost(2) =E= 0 ; (LHS = 0)

IX15(3).. - 24\*IX\_ResinCost(3) - IX\_TankTotalCost(3) - IX\_TotalChemCost(3)

- IX\_StorageTankCost(3) - IX\_ConstructionCost(3) - IX\_OMCost(3)

+ IX\_TotalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost01 =E=

NonlinearTechCost01(1).. - 1E-5\*CF\_AnnualCost(1) + NonlinearTechCost(1,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(2).. - 1E-5\*CF\_AnnualCost(2) + NonlinearTechCost(2,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(3).. - 1E-5\*CF\_AnnualCost(3) + NonlinearTechCost(3,1) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost02 =E=

NonlinearTechCost02(1).. - 1E-5\*GAC\_TotalCost(1) + NonlinearTechCost(1,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(2).. - 1E-5\*GAC\_TotalCost(2) + NonlinearTechCost(2,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(3).. - 1E-5\*GAC\_TotalCost(3) + NonlinearTechCost(3,2) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost03 =E=

NonlinearTechCost03(1).. - 1E-5\*IX\_TotalCost(1) + NonlinearTechCost(1,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(2).. - 1E-5\*IX\_TotalCost(2) + NonlinearTechCost(2,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(3).. - 1E-5\*IX\_TotalCost(3) + NonlinearTechCost(3,3) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE TechProblem Using NLP From line 868

---- CF\_NoOfModules Number of modules

CF\_NoOfModules(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(1)

-90 CF08(1)

-370000 CF10(1)

-70000 CF12(1)

CF\_NoOfModules(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(2)

-90 CF08(2)

-370000 CF10(2)

-70000 CF12(2)

CF\_NoOfModules(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(3)

-90 CF08(3)

-370000 CF10(3)

-70000 CF12(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackwashFlow Backwash flow

CF\_BackwashFlow(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(1)

CF\_BackwashFlow(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(2)

CF\_BackwashFlow(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpHP Feed pump horsepower

CF\_FeedPumpHP(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(1)

-6534.96 CF06(1)

-43.508 CF07(1)

CF\_FeedPumpHP(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(2)

-6534.96 CF06(2)

-43.508 CF07(2)

CF\_FeedPumpHP(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(3)

-6534.96 CF06(3)

-43.508 CF07(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpPower Feed pump power requirement in kWh

CF\_FeedPumpPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(1)

-0.1003 CF23(1)

CF\_FeedPumpPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(2)

-0.1003 CF23(2)

CF\_FeedPumpPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(3)

-0.1003 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackflushPower Backflush power requirement in kWh

CF\_BackflushPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(1)

-0.1003 CF23(1)

CF\_BackflushPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(2)

-0.1003 CF23(2)

CF\_BackflushPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(3)

-0.1003 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MFF Microfiltration feed flow in liters per sec

CF\_MFF(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(1)

-1 CF04(1)

-0.3468 CF05(1)

CF\_MFF(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(2)

-1 CF04(2)

-0.3468 CF05(2)

CF\_MFF(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(3)

-1 CF04(3)

-0.3468 CF05(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_NoOfMembranes Number of membranes used

CF\_NoOfMembranes(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(1)

-126.4875 CF26(1)

CF\_NoOfMembranes(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(2)

-126.4875 CF26(2)

CF\_NoOfMembranes(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(3)

-126.4875 CF26(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingArea Building area for the process implementation

CF\_BuildingArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(1)

-1076 CF11(1)

CF\_BuildingArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(2)

-1076 CF11(2)

CF\_BuildingArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(3)

-1076 CF11(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneModuleCost Membrane module cost

CF\_MembraneModuleCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(1)

-0.05 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MembraneModuleCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(2)

-0.05 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MembraneModuleCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(3)

-0.05 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingCost Building cost - based on the building area

CF\_BuildingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(1)

-1 CF16(1)

CF\_BuildingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(2)

-1 CF16(2)

CF\_BuildingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_InstallationCost Installation cost for the process

CF\_InstallationCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(1)

-1 CF16(1)

CF\_InstallationCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(2)

-1 CF16(2)

CF\_InstallationCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MiscCost Miscellaneous cost (taken as 5% of the module cost)

CF\_MiscCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MiscCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MiscCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_PlantPipingCost Plant piping cost (taken as 5% of the module and misc c

ost)

CF\_PlantPipingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(1)

-1 CF16(1)

CF\_PlantPipingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(2)

-1 CF16(2)

CF\_PlantPipingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_EngineeringCost Engineering cost (taken as 10% of the module and misc c

ost)

CF\_EngineeringCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(1)

-1 CF16(1)

CF\_EngineeringCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(2)

-1 CF16(2)

CF\_EngineeringCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_DirectCapitalCost Total direct capital cost

CF\_DirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(1)

-0.06 CF17(1)

-0.2 CF18(1)

-0.1 CF19(1)

-0.04 CF20(1)

-1 CF22(1)

-0.02 CF28(1)

CF\_DirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(2)

-0.06 CF17(2)

-0.2 CF18(2)

-0.1 CF19(2)

-0.04 CF20(2)

-1 CF22(2)

-0.02 CF28(2)

CF\_DirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(3)

-0.06 CF17(3)

-0.2 CF18(3)

-0.1 CF19(3)

-0.04 CF20(3)

-1 CF22(3)

-0.02 CF28(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ConstructionInterest Expense on interest during construction (taken as

6% of total direct capital cost)

CF\_ConstructionInterest(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(1)

-1 CF21(1)

CF\_ConstructionInterest(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(2)

-1 CF21(2)

CF\_ConstructionInterest(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Contingencies Contingencies (taken as 20% of total direct capital cost)

CF\_Contingencies(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(1)

-1 CF21(1)

CF\_Contingencies(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(2)

-1 CF21(2)

CF\_Contingencies(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ProjectManagement Fees and project management (taken as 10% of total di

rect capital cost)

CF\_ProjectManagement(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(1)

-1 CF21(1)

CF\_ProjectManagement(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(2)

-1 CF21(2)

CF\_ProjectManagement(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_WorkingCapital Working capital (taken as 4% of total direct capital cos

t)

CF\_WorkingCapital(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(1)

-1 CF21(1)

CF\_WorkingCapital(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(2)

-1 CF21(2)

CF\_WorkingCapital(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_IndirectCapitalCost Total indirect capital cost

CF\_IndirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(1)

-1 CF22(1)

CF\_IndirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(2)

-1 CF22(2)

CF\_IndirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(3)

-1 CF22(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalConstructionCost Total (direct and indirect) construction cost

CF\_TotalConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(1)

-0.1019 CF30(1)

CF\_TotalConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(2)

-0.1019 CF30(2)

CF\_TotalConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(3)

-0.1019 CF30(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ElectricityCost Electricity cost for the implementation of the process

CF\_ElectricityCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(1)

-1 CF29(1)

CF\_ElectricityCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(2)

-1 CF29(2)

CF\_ElectricityCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_LaborCost Labor cost for the implementation of the process

CF\_LaborCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(1)

-1 CF29(1)

CF\_LaborCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(2)

-1 CF29(2)

CF\_LaborCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ChemicalCost Chemical cost for the process

CF\_ChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(1)

-1 CF29(1)

CF\_ChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(2)

-1 CF29(2)

CF\_ChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneReplacementCost Membrane replacement cost for the process

CF\_MembraneReplacementCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(1)

-1 CF29(1)

CF\_MembraneReplacementCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(2)

-1 CF29(2)

CF\_MembraneReplacementCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CleaningChemicalCost Cleaning chemical (NaOCl) cost

CF\_CleaningChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(1)

-1 CF29(1)

CF\_CleaningChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(2)

-1 CF29(2)

CF\_CleaningChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Repairs Repairs replacement and misc cost (taken as 2% of the direct ca

pital cost)

CF\_Repairs(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(1)

-1 CF29(1)

CF\_Repairs(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(2)

-1 CF29(2)

CF\_Repairs(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalOMCost Total operating and maintenance cost

CF\_TotalOMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(1)

-2 CF31(1)

CF\_TotalOMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(2)

-2 CF31(2)

CF\_TotalOMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CapitalRecovery Capital recovery - calculate from the total captical co

st

CF\_CapitalRecovery(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(1)

-2 CF31(1)

CF\_CapitalRecovery(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(2)

-2 CF31(2)

CF\_CapitalRecovery(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_AnnualCost Annual cost depending on the Capital recovery and OM cost

CF\_AnnualCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(1)

-1.000000E-5 NonlinearTechCost01(1)

CF\_AnnualCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(2)

-1.000000E-5 NonlinearTechCost01(2)

CF\_AnnualCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(3)

-1.000000E-5 NonlinearTechCost01(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_CapitalCost Capital cost for the activated carbon process

GAC\_CapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(1)

-1 GAC03(1)

GAC\_CapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(2)

-1 GAC03(2)

GAC\_CapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_OMCost Operational and maintenance cost for the activated carbon proce

ss

GAC\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(1)

-1 GAC03(1)

GAC\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(2)

-1 GAC03(2)

GAC\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_TotalCost Total cost for the activated carbon process implementation

GAC\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(1)

-1.000000E-5 NonlinearTechCost02(1)

GAC\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(2)

-1.000000E-5 NonlinearTechCost02(2)

GAC\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(3)

-1.000000E-5 NonlinearTechCost02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinResinVolume Minimum volume of the medium in m3

IX\_MinResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(1)

IX\_MinResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(2)

IX\_MinResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinVolExhaustionTime Minimum volume exhaustion time in days

IX\_MinVolExhaustionTime(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(1)

IX\_MinVolExhaustionTime(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(2)

IX\_MinVolExhaustionTime(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ExhaustionTimeResinVolume Resin volume in m3 for the minimum exhaustion

time

IX\_ExhaustionTimeResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(1)

-2 IX05(1)

-1307.5458 IX06(1)

-150 IX08(1)

IX\_ExhaustionTimeResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(2)

-2 IX05(2)

-1307.5458 IX06(2)

-150 IX08(2)

IX\_ExhaustionTimeResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(3)

-2 IX05(3)

-1307.5458 IX06(3)

-150 IX08(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_VesselVolume Total vessel volume in m3

IX\_VesselVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(1)

(-92413.4228) IX07(1)

(-2.500000E+9) IX12(1)

IX\_VesselVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(2)

(-92413.4228) IX07(2)

(-2.500000E+9) IX12(2)

IX\_VesselVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(3)

(-92413.4228) IX07(3)

(-2.500000E+9) IX12(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ResinCost Total resin cost (in $ per day -- need to check)

IX\_ResinCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(1)

-24 IX15(1)

IX\_ResinCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(2)

-24 IX15(2)

IX\_ResinCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(3)

-24 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_BedArea Bed area for the vessel in m2

IX\_BedArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(1)

(-1254.21) IX13(1)

(-7.33000E+11) IX14(1)

IX\_BedArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(2)

(-1254.21) IX13(2)

(-7.33000E+11) IX14(2)

IX\_BedArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(3)

(-1254.21) IX13(3)

(-7.33000E+11) IX14(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TankTotalCost Total Tank cost in $

IX\_TankTotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(1)

-1 IX15(1)

IX\_TankTotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(2)

-1 IX15(2)

IX\_TankTotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_NaClReq NaCl requirement in Kg per day

IX\_NaClReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(1)

-0.01 IX09(1)

-3.65 IX10(1)

IX\_NaClReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(2)

-0.01 IX09(2)

-3.65 IX10(2)

IX\_NaClReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(3)

-0.01 IX09(3)

-3.65 IX10(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalChemCost Total chemical cost per year

IX\_TotalChemCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(1)

-1 IX15(1)

IX\_TotalChemCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(2)

-1 IX15(2)

IX\_TotalChemCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_RegFluidReq Regeneration fluid requirement

IX\_RegFluidReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(1)

-250 IX11(1)

IX\_RegFluidReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(2)

-250 IX11(2)

IX\_RegFluidReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(3)

-250 IX11(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_StorageTankCost Storage tank cost

IX\_StorageTankCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(1)

-1 IX15(1)

IX\_StorageTankCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(2)

-1 IX15(2)

IX\_StorageTankCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ConstructionCost Construction cost

IX\_ConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(1)

-1 IX15(1)

IX\_ConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(2)

-1 IX15(2)

IX\_ConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_OMCost Operating and maintenance cost

IX\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(1)

-1 IX15(1)

IX\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(2)

-1 IX15(2)

IX\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalCost Total cost for the implementation of ion exchange process for

each industry

IX\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(1)

-1.000000E-5 NonlinearTechCost03(1)

IX\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(2)

-1.000000E-5 NonlinearTechCost03(2)

IX\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(3)

-1.000000E-5 NonlinearTechCost03(3)

REMAINING 26 ENTRIES SKIPPED

---- Tobj Objective function for the technoogy only problem

Tobj

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 Tobjective

---- Volume volume of waste treated by each industry using each technology (def

ined over i and j)

Volume(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0028 Tc2(1)

-43.8021 DFREq(1,1)

-1.1574 CF01(1)

Volume(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0041 Tc2(1)

-43.8021 DFREq(1,2)

(-7.37701E+16) GAC01(1)

(-8.53308E+15) GAC02(1)

Volume(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0014 Tc2(1)

-43.8021 DFREq(1,3)

REMAINING 84 ENTRIES SKIPPED

---- DFR Desired flow rate for the industry in liters per sec

DFR(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,1)

-1.0067 CF03(1)

1 CF04(1)

-1.0603 CF09(1)

-55.5811 CF25(1)

-11.1162 CF27(1)

DFR(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,2)

DFR(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,3)

-0.18 IX01(1)

-0.0156 IX04(1)

REMAINING 84 ENTRIES SKIPPED

---- NonlinearTechCost

NonlinearTechCost(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost01(1)

NonlinearTechCost(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost02(1)

NonlinearTechCost(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost03(1)

REMAINING 84 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE TechProblem Using NLP From line 868

LOOPS FOR/WHILE 1

FOR/WHILE 6

MODEL STATISTICS

BLOCKS OF EQUATIONS 54 SINGLE EQUATIONS 1,596

BLOCKS OF VARIABLES 51 SINGLE VARIABLES 1,625

NON ZERO ELEMENTS 4,003 NON LINEAR N-Z 174

DERIVATIVE POOL 10 CONSTANT POOL 31

CODE LENGTH 1,508

GENERATION TIME = 0.016 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.016 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 6

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE TechProblem Using NLP From line 868

S O L V E S U M M A R Y

MODEL TechProblem OBJECTIVE Tobj

TYPE NLP DIRECTION MINIMIZE

SOLVER CONOPT FROM LINE 868

\*\*\*\* SOLVER STATUS 7 Licensing Problems

\*\*\*\* MODEL STATUS 11 Licensing Problem

\*\*\*\* OBJECTIVE VALUE NA

RESOURCE USAGE, LIMIT 0.000 1000.000

ITERATION COUNT, LIMIT 0 2000000000

EVALUATION ERRORS 0 0

CONOPT 3 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

\*\*\* No license found

\*\*\* To update your license, please contact your distributor.

\*\*\* Too many equations for demo mode

\*\*\* Number of equations : 1596

\*\*\* Maximum allowed : 300

\*\*\* Too many variables for demo mode

\*\*\* Number of variables : 1625

\*\*\* Maximum allowed : 300

\*\*\* Too many nonzero elements for demo mode

\*\*\* Number of nonzeros : 4003

\*\*\* Maximum allowed : 2000

No solution returned

GAMS 24.1.3 r41464 Released Jul 26, 2013 WEX-WEI x86\_64/MS Windows 01/19/16 16:16:30 Page 26

G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE TechProblem Using NLP From line 868

---- Tobjective =E=

Tobjective.. Tobj - NonlinearTechCost(1,1) - NonlinearTechCost(1,2)

- NonlinearTechCost(1,3) - NonlinearTechCost(2,1) - NonlinearTechCost(2,2)

- NonlinearTechCost(2,3) - NonlinearTechCost(3,1) - NonlinearTechCost(3,2)

- NonlinearTechCost(3,3) - NonlinearTechCost(4,1) - NonlinearTechCost(4,2)

- NonlinearTechCost(4,3) - NonlinearTechCost(5,1) - NonlinearTechCost(5,2)

- NonlinearTechCost(5,3) - NonlinearTechCost(6,1) - NonlinearTechCost(6,2)

- NonlinearTechCost(6,3) - NonlinearTechCost(7,1) - NonlinearTechCost(7,2)

- NonlinearTechCost(7,3) - NonlinearTechCost(8,1) - NonlinearTechCost(8,2)

- NonlinearTechCost(8,3) - NonlinearTechCost(9,1) - NonlinearTechCost(9,2)

- NonlinearTechCost(9,3) - NonlinearTechCost(10,1)

- NonlinearTechCost(10,2) - NonlinearTechCost(10,3)

- NonlinearTechCost(11,1) - NonlinearTechCost(11,2)

- NonlinearTechCost(11,3) - NonlinearTechCost(12,1)

- NonlinearTechCost(12,2) - NonlinearTechCost(12,3)

- NonlinearTechCost(13,1) - NonlinearTechCost(13,2)

- NonlinearTechCost(13,3) - NonlinearTechCost(14,1)

- NonlinearTechCost(14,2) - NonlinearTechCost(14,3)

- NonlinearTechCost(15,1) - NonlinearTechCost(15,2)

- NonlinearTechCost(15,3) - NonlinearTechCost(16,1)

- NonlinearTechCost(16,2) - NonlinearTechCost(16,3)

- NonlinearTechCost(17,1) - NonlinearTechCost(17,2)

- NonlinearTechCost(17,3) - NonlinearTechCost(18,1)

- NonlinearTechCost(18,2) - NonlinearTechCost(18,3)

- NonlinearTechCost(19,1) - NonlinearTechCost(19,2)

- NonlinearTechCost(19,3) - NonlinearTechCost(20,1)

- NonlinearTechCost(20,2) - NonlinearTechCost(20,3)

- NonlinearTechCost(21,1) - NonlinearTechCost(21,2)

- NonlinearTechCost(21,3) - NonlinearTechCost(22,1)

- NonlinearTechCost(22,2) - NonlinearTechCost(22,3)

- NonlinearTechCost(23,1) - NonlinearTechCost(23,2)

- NonlinearTechCost(23,3) - NonlinearTechCost(24,1)

- NonlinearTechCost(24,2) - NonlinearTechCost(24,3)

- NonlinearTechCost(25,1) - NonlinearTechCost(25,2)

- NonlinearTechCost(25,3) - NonlinearTechCost(26,1)

- NonlinearTechCost(26,2) - NonlinearTechCost(26,3)

- NonlinearTechCost(27,1) - NonlinearTechCost(27,2)

- NonlinearTechCost(27,3) - NonlinearTechCost(28,1)

- NonlinearTechCost(28,2) - NonlinearTechCost(28,3)

- NonlinearTechCost(29,1) - NonlinearTechCost(29,2)

- NonlinearTechCost(29,3) =E= 0 ; (LHS = 0)

---- Tc1 =L=

Tc1(1).. Volume(1,1) + Volume(1,2) + Volume(1,3) =L= 46.1 ; (LHS = 0)

Tc1(2).. Volume(2,1) + Volume(2,2) + Volume(2,3) =L= 1.5 ; (LHS = 0)

Tc1(3).. Volume(3,1) + Volume(3,2) + Volume(3,3) =L= 4.6 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- Tc2 =G=

Tc2(1).. 0.002762685\*Volume(1,1) + 0.00414402749999999\*Volume(1,2)

+ 0.0013813425\*Volume(1,3) =G= 0.122832874808418 ;

(LHS = 0, INFES = 0.122832874808418 \*\*\*\*)

Tc2(2).. 0.002762685\*Volume(2,1) + 0.00414402749999999\*Volume(2,2)

+ 0.0013813425\*Volume(2,3) =G= 0.00202831822193877 ;

(LHS = 0, INFES = 0.00202831822193877 \*\*\*\*)

Tc2(3).. 0.002762685\*Volume(3,1) + 0.00414402749999999\*Volume(3,2)

+ 0.0013813425\*Volume(3,3) =G= 0.0100326811806122 ;

(LHS = 0, INFES = 0.0100326811806122 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- DFREq =E=

DFREq(1,1).. - 43.8020833333334\*Volume(1,1) + DFR(1,1) =E= 0 ; (LHS = 0)

DFREq(1,2).. - 43.8020833333334\*Volume(1,2) + DFR(1,2) =E= 0 ; (LHS = 0)

DFREq(1,3).. - 43.8020833333334\*Volume(1,3) + DFR(1,3) =E= 0 ; (LHS = 0)

REMAINING 84 ENTRIES SKIPPED

---- CF01 =E=

CF01(1).. CF\_NoOfModules(1) - 1.15740740740741\*Volume(1,1) =E= 0 ; (LHS = 0)

CF01(2).. CF\_NoOfModules(2) - 1.15740740740741\*Volume(2,1) =E= 0 ; (LHS = 0)

CF01(3).. CF\_NoOfModules(3) - 1.15740740740741\*Volume(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF03 =E=

CF03(1).. CF\_MFF(1) - 1.00671140939597\*DFR(1,1) =E= 0 ; (LHS = 0)

CF03(2).. CF\_MFF(2) - 1.00671140939597\*DFR(2,1) =E= 0 ; (LHS = 0)

CF03(3).. CF\_MFF(3) - 1.00671140939597\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF04 =E=

CF04(1).. CF\_BackwashFlow(1) - CF\_MFF(1) + DFR(1,1) =E= 0 ; (LHS = 0)

CF04(2).. CF\_BackwashFlow(2) - CF\_MFF(2) + DFR(2,1) =E= 0 ; (LHS = 0)

CF04(3).. CF\_BackwashFlow(3) - CF\_MFF(3) + DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF05 =E=

CF05(1).. CF\_FeedPumpHP(1) - 0.346809353943718\*CF\_MFF(1) =E= 0 ; (LHS = 0)

CF05(2).. CF\_FeedPumpHP(2) - 0.346809353943718\*CF\_MFF(2) =E= 0 ; (LHS = 0)

CF05(3).. CF\_FeedPumpHP(3) - 0.346809353943718\*CF\_MFF(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF06 =E=

CF06(1).. - 6534.96\*CF\_FeedPumpHP(1) + CF\_FeedPumpPower(1) =E= 0 ; (LHS = 0)

CF06(2).. - 6534.96\*CF\_FeedPumpHP(2) + CF\_FeedPumpPower(2) =E= 0 ; (LHS = 0)

CF06(3).. - 6534.96\*CF\_FeedPumpHP(3) + CF\_FeedPumpPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF07 =E=

CF07(1).. - 43.508\*CF\_FeedPumpHP(1) + CF\_BackflushPower(1) =E= 0 ; (LHS = 0)

CF07(2).. - 43.508\*CF\_FeedPumpHP(2) + CF\_BackflushPower(2) =E= 0 ; (LHS = 0)

CF07(3).. - 43.508\*CF\_FeedPumpHP(3) + CF\_BackflushPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF08 =E=

CF08(1).. - 90\*CF\_NoOfModules(1) + CF\_NoOfMembranes(1) =E= 0 ; (LHS = 0)

CF08(2).. - 90\*CF\_NoOfModules(2) + CF\_NoOfMembranes(2) =E= 0 ; (LHS = 0)

CF08(3).. - 90\*CF\_NoOfModules(3) + CF\_NoOfMembranes(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF09 =E=

CF09(1).. CF\_BuildingArea(1) - 1.060338816\*DFR(1,1) =E= 0 ; (LHS = 0)

CF09(2).. CF\_BuildingArea(2) - 1.060338816\*DFR(2,1) =E= 0 ; (LHS = 0)

CF09(3).. CF\_BuildingArea(3) - 1.060338816\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF10 =E=

CF10(1).. - 370000\*CF\_NoOfModules(1) + CF\_MembraneModuleCost(1) =E= 0 ;

(LHS = 0)

CF10(2).. - 370000\*CF\_NoOfModules(2) + CF\_MembraneModuleCost(2) =E= 0 ;

(LHS = 0)

CF10(3).. - 370000\*CF\_NoOfModules(3) + CF\_MembraneModuleCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF11 =E=

CF11(1).. - 1076\*CF\_BuildingArea(1) + CF\_BuildingCost(1) =E= 0 ; (LHS = 0)

CF11(2).. - 1076\*CF\_BuildingArea(2) + CF\_BuildingCost(2) =E= 0 ; (LHS = 0)

CF11(3).. - 1076\*CF\_BuildingArea(3) + CF\_BuildingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF12 =E=

CF12(1).. - 70000\*CF\_NoOfModules(1) + CF\_InstallationCost(1) =E= 0 ; (LHS = 0)

CF12(2).. - 70000\*CF\_NoOfModules(2) + CF\_InstallationCost(2) =E= 0 ; (LHS = 0)

CF12(3).. - 70000\*CF\_NoOfModules(3) + CF\_InstallationCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF13 =E=

CF13(1).. - 0.05\*CF\_MembraneModuleCost(1) + CF\_MiscCost(1) =E= 0 ; (LHS = 0)

CF13(2).. - 0.05\*CF\_MembraneModuleCost(2) + CF\_MiscCost(2) =E= 0 ; (LHS = 0)

CF13(3).. - 0.05\*CF\_MembraneModuleCost(3) + CF\_MiscCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF14 =E=

CF14(1).. - 0.05\*CF\_MembraneModuleCost(1) - 0.05\*CF\_MiscCost(1)

+ CF\_PlantPipingCost(1) =E= 0 ; (LHS = 0)

CF14(2).. - 0.05\*CF\_MembraneModuleCost(2) - 0.05\*CF\_MiscCost(2)

+ CF\_PlantPipingCost(2) =E= 0 ; (LHS = 0)

CF14(3).. - 0.05\*CF\_MembraneModuleCost(3) - 0.05\*CF\_MiscCost(3)

+ CF\_PlantPipingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF15 =E=

CF15(1).. - 0.1\*CF\_MembraneModuleCost(1) - 0.1\*CF\_MiscCost(1)

+ CF\_EngineeringCost(1) =E= 0 ; (LHS = 0)

CF15(2).. - 0.1\*CF\_MembraneModuleCost(2) - 0.1\*CF\_MiscCost(2)

+ CF\_EngineeringCost(2) =E= 0 ; (LHS = 0)

CF15(3).. - 0.1\*CF\_MembraneModuleCost(3) - 0.1\*CF\_MiscCost(3)

+ CF\_EngineeringCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF16 =E=

CF16(1).. - CF\_MembraneModuleCost(1) - CF\_BuildingCost(1)

- CF\_InstallationCost(1) - CF\_MiscCost(1) - CF\_PlantPipingCost(1)

- CF\_EngineeringCost(1) + CF\_DirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF16(2).. - CF\_MembraneModuleCost(2) - CF\_BuildingCost(2)

- CF\_InstallationCost(2) - CF\_MiscCost(2) - CF\_PlantPipingCost(2)

- CF\_EngineeringCost(2) + CF\_DirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF16(3).. - CF\_MembraneModuleCost(3) - CF\_BuildingCost(3)

- CF\_InstallationCost(3) - CF\_MiscCost(3) - CF\_PlantPipingCost(3)

- CF\_EngineeringCost(3) + CF\_DirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF17 =E=

CF17(1).. - 0.06\*CF\_DirectCapitalCost(1) + CF\_ConstructionInterest(1) =E= 0 ;

(LHS = 0)

CF17(2).. - 0.06\*CF\_DirectCapitalCost(2) + CF\_ConstructionInterest(2) =E= 0 ;

(LHS = 0)

CF17(3).. - 0.06\*CF\_DirectCapitalCost(3) + CF\_ConstructionInterest(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF18 =E=

CF18(1).. - 0.2\*CF\_DirectCapitalCost(1) + CF\_Contingencies(1) =E= 0 ; (LHS = 0)

CF18(2).. - 0.2\*CF\_DirectCapitalCost(2) + CF\_Contingencies(2) =E= 0 ; (LHS = 0)

CF18(3).. - 0.2\*CF\_DirectCapitalCost(3) + CF\_Contingencies(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF19 =E=

CF19(1).. - 0.1\*CF\_DirectCapitalCost(1) + CF\_ProjectManagement(1) =E= 0 ;

(LHS = 0)

CF19(2).. - 0.1\*CF\_DirectCapitalCost(2) + CF\_ProjectManagement(2) =E= 0 ;

(LHS = 0)

CF19(3).. - 0.1\*CF\_DirectCapitalCost(3) + CF\_ProjectManagement(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF20 =E=

CF20(1).. - 0.04\*CF\_DirectCapitalCost(1) + CF\_WorkingCapital(1) =E= 0 ;

(LHS = 0)

CF20(2).. - 0.04\*CF\_DirectCapitalCost(2) + CF\_WorkingCapital(2) =E= 0 ;

(LHS = 0)

CF20(3).. - 0.04\*CF\_DirectCapitalCost(3) + CF\_WorkingCapital(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF21 =E=

CF21(1).. - CF\_ConstructionInterest(1) - CF\_Contingencies(1)

- CF\_ProjectManagement(1) - CF\_WorkingCapital(1)

+ CF\_IndirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF21(2).. - CF\_ConstructionInterest(2) - CF\_Contingencies(2)

- CF\_ProjectManagement(2) - CF\_WorkingCapital(2)

+ CF\_IndirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF21(3).. - CF\_ConstructionInterest(3) - CF\_Contingencies(3)

- CF\_ProjectManagement(3) - CF\_WorkingCapital(3)

+ CF\_IndirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF22 =E=

CF22(1).. - CF\_DirectCapitalCost(1) - CF\_IndirectCapitalCost(1)

+ CF\_TotalConstructionCost(1) =E= 0 ; (LHS = 0)

CF22(2).. - CF\_DirectCapitalCost(2) - CF\_IndirectCapitalCost(2)

+ CF\_TotalConstructionCost(2) =E= 0 ; (LHS = 0)

CF22(3).. - CF\_DirectCapitalCost(3) - CF\_IndirectCapitalCost(3)

+ CF\_TotalConstructionCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF23 =E=

CF23(1).. - 0.082061678832\*CF\_FeedPumpPower(1)

- 0.082061678832\*CF\_BackflushPower(1) + CF\_ElectricityCost(1) =E= 0 ;

(LHS = 0)

CF23(2).. - 0.082061678832\*CF\_FeedPumpPower(2)

- 0.082061678832\*CF\_BackflushPower(2) + CF\_ElectricityCost(2) =E= 0 ;

(LHS = 0)

CF23(3).. - 0.082061678832\*CF\_FeedPumpPower(3)

- 0.082061678832\*CF\_BackflushPower(3) + CF\_ElectricityCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF24 =E=

CF24(1).. CF\_LaborCost(1) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(2).. CF\_LaborCost(2) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(3).. CF\_LaborCost(3) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF25 =E=

CF25(1).. CF\_ChemicalCost(1) - 43.7993216003044\*DFR(1,1) =E= -255.799948823795

; (LHS = 0, INFES = 255.799948823795 \*\*\*\*)

CF25(2).. CF\_ChemicalCost(2) - 43.7993216003044\*DFR(2,1) =E= -255.799948823795

; (LHS = 0, INFES = 255.799948823795 \*\*\*\*)

CF25(3).. CF\_ChemicalCost(3) - 43.7993216003044\*DFR(3,1) =E= -255.799948823795

; (LHS = 0, INFES = 255.799948823795 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF26 =E=

CF26(1).. - 117.765287732595\*CF\_NoOfMembranes(1)

+ CF\_MembraneReplacementCost(1) =E= 0 ; (LHS = 0)

CF26(2).. - 117.765287732595\*CF\_NoOfMembranes(2)

+ CF\_MembraneReplacementCost(2) =E= 0 ; (LHS = 0)

CF26(3).. - 117.765287732595\*CF\_NoOfMembranes(3)

+ CF\_MembraneReplacementCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF27 =E=

CF27(1).. CF\_CleaningChemicalCost(1) - 8.75986432006088\*DFR(1,1) =E=

51.1602967250046 ; (LHS = 0, INFES = 51.1602967250046 \*\*\*\*)

CF27(2).. CF\_CleaningChemicalCost(2) - 8.75986432006088\*DFR(2,1) =E=

51.1602967250046 ; (LHS = 0, INFES = 51.1602967250046 \*\*\*\*)

CF27(3).. CF\_CleaningChemicalCost(3) - 8.75986432006088\*DFR(3,1) =E=

51.1602967250046 ; (LHS = 0, INFES = 51.1602967250046 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF28 =E=

CF28(1).. - 0.02\*CF\_DirectCapitalCost(1) + CF\_Repairs(1) =E= 0 ; (LHS = 0)

CF28(2).. - 0.02\*CF\_DirectCapitalCost(2) + CF\_Repairs(2) =E= 0 ; (LHS = 0)

CF28(3).. - 0.02\*CF\_DirectCapitalCost(3) + CF\_Repairs(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF29 =E=

CF29(1).. - CF\_ElectricityCost(1) - CF\_LaborCost(1) - CF\_ChemicalCost(1)

- CF\_MembraneReplacementCost(1) - CF\_CleaningChemicalCost(1)

- CF\_Repairs(1) + CF\_TotalOMCost(1) =E= 0 ; (LHS = 0)

CF29(2).. - CF\_ElectricityCost(2) - CF\_LaborCost(2) - CF\_ChemicalCost(2)

- CF\_MembraneReplacementCost(2) - CF\_CleaningChemicalCost(2)

- CF\_Repairs(2) + CF\_TotalOMCost(2) =E= 0 ; (LHS = 0)

CF29(3).. - CF\_ElectricityCost(3) - CF\_LaborCost(3) - CF\_ChemicalCost(3)

- CF\_MembraneReplacementCost(3) - CF\_CleaningChemicalCost(3)

- CF\_Repairs(3) + CF\_TotalOMCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF30 =E=

CF30(1).. - 0.101852208823151\*CF\_TotalConstructionCost(1)

+ CF\_CapitalRecovery(1) =E= 0 ; (LHS = 0)

CF30(2).. - 0.101852208823151\*CF\_TotalConstructionCost(2)

+ CF\_CapitalRecovery(2) =E= 0 ; (LHS = 0)

CF30(3).. - 0.101852208823151\*CF\_TotalConstructionCost(3)

+ CF\_CapitalRecovery(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF31 =E=

CF31(1).. - 2\*CF\_TotalOMCost(1) - 2\*CF\_CapitalRecovery(1) + CF\_AnnualCost(1)

=E= 0 ; (LHS = 0)

CF31(2).. - 2\*CF\_TotalOMCost(2) - 2\*CF\_CapitalRecovery(2) + CF\_AnnualCost(2)

=E= 0 ; (LHS = 0)

CF31(3).. - 2\*CF\_TotalOMCost(3) - 2\*CF\_CapitalRecovery(3) + CF\_AnnualCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC01 =E=

GAC01(1).. GAC\_CapitalCost(1) - (7.37701051584E16)\*Volume(1,2) =E= 0 ;

(LHS = 0)

GAC01(2).. GAC\_CapitalCost(2) - (7.37701051584E16)\*Volume(2,2) =E= 0 ;

(LHS = 0)

GAC01(3).. GAC\_CapitalCost(3) - (7.37701051584E16)\*Volume(3,2) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC02 =E=

GAC02(1).. GAC\_OMCost(1) - (8.53307527956E15)\*Volume(1,2) =E= 0 ; (LHS = 0)

GAC02(2).. GAC\_OMCost(2) - (8.53307527956E15)\*Volume(2,2) =E= 0 ; (LHS = 0)

GAC02(3).. GAC\_OMCost(3) - (8.53307527956E15)\*Volume(3,2) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC03 =E=

GAC03(1).. - GAC\_CapitalCost(1) - GAC\_OMCost(1) + GAC\_TotalCost(1) =E= 0 ;

(LHS = 0)

GAC03(2).. - GAC\_CapitalCost(2) - GAC\_OMCost(2) + GAC\_TotalCost(2) =E= 0 ;

(LHS = 0)

GAC03(3).. - GAC\_CapitalCost(3) - GAC\_OMCost(3) + GAC\_TotalCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX01 =E=

IX01(1).. IX\_MinResinVolume(1) - 0.18\*DFR(1,3) =E= 0 ; (LHS = 0)

IX01(2).. IX\_MinResinVolume(2) - 0.18\*DFR(2,3) =E= 0 ; (LHS = 0)

IX01(3).. IX\_MinResinVolume(3) - 0.18\*DFR(3,3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX02 =E=

IX02(1).. IX\_MinVolExhaustionTime(1) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(2).. IX\_MinVolExhaustionTime(2) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(3).. IX\_MinVolExhaustionTime(3) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX04 =E=

IX04(1).. IX\_ExhaustionTimeResinVolume(1) - 0.0156384\*DFR(1,3) =E= 0 ;

(LHS = 0)

IX04(2).. IX\_ExhaustionTimeResinVolume(2) - 0.0156384\*DFR(2,3) =E= 0 ;

(LHS = 0)

IX04(3).. IX\_ExhaustionTimeResinVolume(3) - 0.0156384\*DFR(3,3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX05 =E=

IX05(1).. - 2\*IX\_ExhaustionTimeResinVolume(1) + IX\_VesselVolume(1) =E= 0 ;

(LHS = 0)

IX05(2).. - 2\*IX\_ExhaustionTimeResinVolume(2) + IX\_VesselVolume(2) =E= 0 ;

(LHS = 0)

IX05(3).. - 2\*IX\_ExhaustionTimeResinVolume(3) + IX\_VesselVolume(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX06 =E=

IX06(1).. - 1661.7223180044\*IX\_ExhaustionTimeResinVolume(1) + IX\_ResinCost(1)

=E= 0 ; (LHS = 0)

IX06(2).. - 1661.7223180044\*IX\_ExhaustionTimeResinVolume(2) + IX\_ResinCost(2)

=E= 0 ; (LHS = 0)

IX06(3).. - 1661.7223180044\*IX\_ExhaustionTimeResinVolume(3) + IX\_ResinCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX07 =E=

IX07(1).. - (438402.632994848)\*IX\_VesselVolume(1) + IX\_TankTotalCost(1) =E= 0 ;

(LHS = -8.4789591362408, INFES = 8.4789591362408 \*\*\*\*)

IX07(2).. - (438402.632994848)\*IX\_VesselVolume(2) + IX\_TankTotalCost(2) =E= 0 ;

(LHS = -8.4789591362408, INFES = 8.4789591362408 \*\*\*\*)

IX07(3).. - (438402.632994848)\*IX\_VesselVolume(3) + IX\_TankTotalCost(3) =E= 0 ;

(LHS = -8.4789591362408, INFES = 8.4789591362408 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX08 =E=

IX08(1).. - 150\*IX\_ExhaustionTimeResinVolume(1) + IX\_NaClReq(1) =E= 0 ;

(LHS = 0)

IX08(2).. - 150\*IX\_ExhaustionTimeResinVolume(2) + IX\_NaClReq(2) =E= 0 ;

(LHS = 0)

IX08(3).. - 150\*IX\_ExhaustionTimeResinVolume(3) + IX\_NaClReq(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX09 =E=

IX09(1).. - 0.01\*IX\_NaClReq(1) + IX\_RegFluidReq(1) =E= 0 ; (LHS = 0)

IX09(2).. - 0.01\*IX\_NaClReq(2) + IX\_RegFluidReq(2) =E= 0 ; (LHS = 0)

IX09(3).. - 0.01\*IX\_NaClReq(3) + IX\_RegFluidReq(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX10 =E=

IX10(1).. - 3.65\*IX\_NaClReq(1) + IX\_TotalChemCost(1) =E= 0 ; (LHS = 0)

IX10(2).. - 3.65\*IX\_NaClReq(2) + IX\_TotalChemCost(2) =E= 0 ; (LHS = 0)

IX10(3).. - 3.65\*IX\_NaClReq(3) + IX\_TotalChemCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX11 =E=

IX11(1).. - 250\*IX\_RegFluidReq(1) + IX\_StorageTankCost(1) =E= 0 ; (LHS = 0)

IX11(2).. - 250\*IX\_RegFluidReq(2) + IX\_StorageTankCost(2) =E= 0 ; (LHS = 0)

IX11(3).. - 250\*IX\_RegFluidReq(3) + IX\_StorageTankCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX12 =E=

IX12(1).. - (2500000000)\*IX\_VesselVolume(1) + IX\_BedArea(1) =E= 0 ; (LHS = 0)

IX12(2).. - (2500000000)\*IX\_VesselVolume(2) + IX\_BedArea(2) =E= 0 ; (LHS = 0)

IX12(3).. - (2500000000)\*IX\_VesselVolume(3) + IX\_BedArea(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX13 =E=

IX13(1).. - (1254.21)\*IX\_BedArea(1) + IX\_ConstructionCost(1) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(2).. - (1254.21)\*IX\_BedArea(2) + IX\_ConstructionCost(2) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(3).. - (1254.21)\*IX\_BedArea(3) + IX\_ConstructionCost(3) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX14 =E=

IX14(1).. - (733000000000)\*IX\_BedArea(1) + IX\_OMCost(1) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(2).. - (733000000000)\*IX\_BedArea(2) + IX\_OMCost(2) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(3).. - (733000000000)\*IX\_BedArea(3) + IX\_OMCost(3) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX15 =E=

IX15(1).. - 24\*IX\_ResinCost(1) - IX\_TankTotalCost(1) - IX\_TotalChemCost(1)

- IX\_StorageTankCost(1) - IX\_ConstructionCost(1) - IX\_OMCost(1)

+ IX\_TotalCost(1) =E= 0 ; (LHS = 0)

IX15(2).. - 24\*IX\_ResinCost(2) - IX\_TankTotalCost(2) - IX\_TotalChemCost(2)

- IX\_StorageTankCost(2) - IX\_ConstructionCost(2) - IX\_OMCost(2)

+ IX\_TotalCost(2) =E= 0 ; (LHS = 0)

IX15(3).. - 24\*IX\_ResinCost(3) - IX\_TankTotalCost(3) - IX\_TotalChemCost(3)

- IX\_StorageTankCost(3) - IX\_ConstructionCost(3) - IX\_OMCost(3)

+ IX\_TotalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost01 =E=

NonlinearTechCost01(1).. - 1E-5\*CF\_AnnualCost(1) + NonlinearTechCost(1,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(2).. - 1E-5\*CF\_AnnualCost(2) + NonlinearTechCost(2,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(3).. - 1E-5\*CF\_AnnualCost(3) + NonlinearTechCost(3,1) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost02 =E=

NonlinearTechCost02(1).. - 1E-5\*GAC\_TotalCost(1) + NonlinearTechCost(1,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(2).. - 1E-5\*GAC\_TotalCost(2) + NonlinearTechCost(2,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(3).. - 1E-5\*GAC\_TotalCost(3) + NonlinearTechCost(3,2) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost03 =E=

NonlinearTechCost03(1).. - 1E-5\*IX\_TotalCost(1) + NonlinearTechCost(1,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(2).. - 1E-5\*IX\_TotalCost(2) + NonlinearTechCost(2,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(3).. - 1E-5\*IX\_TotalCost(3) + NonlinearTechCost(3,3) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE TechProblem Using NLP From line 868

---- CF\_NoOfModules Number of modules

CF\_NoOfModules(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(1)

-90 CF08(1)

-370000 CF10(1)

-70000 CF12(1)

CF\_NoOfModules(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(2)

-90 CF08(2)

-370000 CF10(2)

-70000 CF12(2)

CF\_NoOfModules(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(3)

-90 CF08(3)

-370000 CF10(3)

-70000 CF12(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackwashFlow Backwash flow

CF\_BackwashFlow(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(1)

CF\_BackwashFlow(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(2)

CF\_BackwashFlow(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpHP Feed pump horsepower

CF\_FeedPumpHP(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(1)

-6534.96 CF06(1)

-43.508 CF07(1)

CF\_FeedPumpHP(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(2)

-6534.96 CF06(2)

-43.508 CF07(2)

CF\_FeedPumpHP(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(3)

-6534.96 CF06(3)

-43.508 CF07(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpPower Feed pump power requirement in kWh

CF\_FeedPumpPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(1)

-0.0821 CF23(1)

CF\_FeedPumpPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(2)

-0.0821 CF23(2)

CF\_FeedPumpPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(3)

-0.0821 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackflushPower Backflush power requirement in kWh

CF\_BackflushPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(1)

-0.0821 CF23(1)

CF\_BackflushPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(2)

-0.0821 CF23(2)

CF\_BackflushPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(3)

-0.0821 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MFF Microfiltration feed flow in liters per sec

CF\_MFF(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(1)

-1 CF04(1)

-0.3468 CF05(1)

CF\_MFF(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(2)

-1 CF04(2)

-0.3468 CF05(2)

CF\_MFF(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(3)

-1 CF04(3)

-0.3468 CF05(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_NoOfMembranes Number of membranes used

CF\_NoOfMembranes(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(1)

-117.7653 CF26(1)

CF\_NoOfMembranes(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(2)

-117.7653 CF26(2)

CF\_NoOfMembranes(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(3)

-117.7653 CF26(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingArea Building area for the process implementation

CF\_BuildingArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(1)

-1076 CF11(1)

CF\_BuildingArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(2)

-1076 CF11(2)

CF\_BuildingArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(3)

-1076 CF11(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneModuleCost Membrane module cost

CF\_MembraneModuleCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(1)

-0.05 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MembraneModuleCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(2)

-0.05 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MembraneModuleCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(3)

-0.05 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingCost Building cost - based on the building area

CF\_BuildingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(1)

-1 CF16(1)

CF\_BuildingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(2)

-1 CF16(2)

CF\_BuildingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_InstallationCost Installation cost for the process

CF\_InstallationCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(1)

-1 CF16(1)

CF\_InstallationCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(2)

-1 CF16(2)

CF\_InstallationCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MiscCost Miscellaneous cost (taken as 5% of the module cost)

CF\_MiscCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MiscCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MiscCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_PlantPipingCost Plant piping cost (taken as 5% of the module and misc c

ost)

CF\_PlantPipingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(1)

-1 CF16(1)

CF\_PlantPipingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(2)

-1 CF16(2)

CF\_PlantPipingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_EngineeringCost Engineering cost (taken as 10% of the module and misc c

ost)

CF\_EngineeringCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(1)

-1 CF16(1)

CF\_EngineeringCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(2)

-1 CF16(2)

CF\_EngineeringCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_DirectCapitalCost Total direct capital cost

CF\_DirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(1)

-0.06 CF17(1)

-0.2 CF18(1)

-0.1 CF19(1)

-0.04 CF20(1)

-1 CF22(1)

-0.02 CF28(1)

CF\_DirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(2)

-0.06 CF17(2)

-0.2 CF18(2)

-0.1 CF19(2)

-0.04 CF20(2)

-1 CF22(2)

-0.02 CF28(2)

CF\_DirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(3)

-0.06 CF17(3)

-0.2 CF18(3)

-0.1 CF19(3)

-0.04 CF20(3)

-1 CF22(3)

-0.02 CF28(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ConstructionInterest Expense on interest during construction (taken as

6% of total direct capital cost)

CF\_ConstructionInterest(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(1)

-1 CF21(1)

CF\_ConstructionInterest(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(2)

-1 CF21(2)

CF\_ConstructionInterest(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Contingencies Contingencies (taken as 20% of total direct capital cost)

CF\_Contingencies(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(1)

-1 CF21(1)

CF\_Contingencies(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(2)

-1 CF21(2)

CF\_Contingencies(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ProjectManagement Fees and project management (taken as 10% of total di

rect capital cost)

CF\_ProjectManagement(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(1)

-1 CF21(1)

CF\_ProjectManagement(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(2)

-1 CF21(2)

CF\_ProjectManagement(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_WorkingCapital Working capital (taken as 4% of total direct capital cos

t)

CF\_WorkingCapital(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(1)

-1 CF21(1)

CF\_WorkingCapital(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(2)

-1 CF21(2)

CF\_WorkingCapital(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_IndirectCapitalCost Total indirect capital cost

CF\_IndirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(1)

-1 CF22(1)

CF\_IndirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(2)

-1 CF22(2)

CF\_IndirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(3)

-1 CF22(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalConstructionCost Total (direct and indirect) construction cost

CF\_TotalConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(1)

-0.1019 CF30(1)

CF\_TotalConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(2)

-0.1019 CF30(2)

CF\_TotalConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(3)

-0.1019 CF30(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ElectricityCost Electricity cost for the implementation of the process

CF\_ElectricityCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(1)

-1 CF29(1)

CF\_ElectricityCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(2)

-1 CF29(2)

CF\_ElectricityCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_LaborCost Labor cost for the implementation of the process

CF\_LaborCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(1)

-1 CF29(1)

CF\_LaborCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(2)

-1 CF29(2)

CF\_LaborCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ChemicalCost Chemical cost for the process

CF\_ChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(1)

-1 CF29(1)

CF\_ChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(2)

-1 CF29(2)

CF\_ChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneReplacementCost Membrane replacement cost for the process

CF\_MembraneReplacementCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(1)

-1 CF29(1)

CF\_MembraneReplacementCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(2)

-1 CF29(2)

CF\_MembraneReplacementCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CleaningChemicalCost Cleaning chemical (NaOCl) cost

CF\_CleaningChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(1)

-1 CF29(1)

CF\_CleaningChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(2)

-1 CF29(2)

CF\_CleaningChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Repairs Repairs replacement and misc cost (taken as 2% of the direct ca

pital cost)

CF\_Repairs(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(1)

-1 CF29(1)

CF\_Repairs(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(2)

-1 CF29(2)

CF\_Repairs(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalOMCost Total operating and maintenance cost

CF\_TotalOMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(1)

-2 CF31(1)

CF\_TotalOMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(2)

-2 CF31(2)

CF\_TotalOMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CapitalRecovery Capital recovery - calculate from the total captical co

st

CF\_CapitalRecovery(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(1)

-2 CF31(1)

CF\_CapitalRecovery(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(2)

-2 CF31(2)

CF\_CapitalRecovery(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_AnnualCost Annual cost depending on the Capital recovery and OM cost

CF\_AnnualCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(1)

-1.000000E-5 NonlinearTechCost01(1)

CF\_AnnualCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(2)

-1.000000E-5 NonlinearTechCost01(2)

CF\_AnnualCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(3)

-1.000000E-5 NonlinearTechCost01(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_CapitalCost Capital cost for the activated carbon process

GAC\_CapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(1)

-1 GAC03(1)

GAC\_CapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(2)

-1 GAC03(2)

GAC\_CapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_OMCost Operational and maintenance cost for the activated carbon proce

ss

GAC\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(1)

-1 GAC03(1)

GAC\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(2)

-1 GAC03(2)

GAC\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_TotalCost Total cost for the activated carbon process implementation

GAC\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(1)

-1.000000E-5 NonlinearTechCost02(1)

GAC\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(2)

-1.000000E-5 NonlinearTechCost02(2)

GAC\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(3)

-1.000000E-5 NonlinearTechCost02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinResinVolume Minimum volume of the medium in m3

IX\_MinResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(1)

IX\_MinResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(2)

IX\_MinResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinVolExhaustionTime Minimum volume exhaustion time in days

IX\_MinVolExhaustionTime(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(1)

IX\_MinVolExhaustionTime(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(2)

IX\_MinVolExhaustionTime(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ExhaustionTimeResinVolume Resin volume in m3 for the minimum exhaustion

time

IX\_ExhaustionTimeResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(1)

-2 IX05(1)

-1661.7223 IX06(1)

-150 IX08(1)

IX\_ExhaustionTimeResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(2)

-2 IX05(2)

-1661.7223 IX06(2)

-150 IX08(2)

IX\_ExhaustionTimeResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(3)

-2 IX05(3)

-1661.7223 IX06(3)

-150 IX08(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_VesselVolume Total vessel volume in m3

IX\_VesselVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(1)

(-438402.633) IX07(1)

(-2.500000E+9) IX12(1)

IX\_VesselVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(2)

(-438402.633) IX07(2)

(-2.500000E+9) IX12(2)

IX\_VesselVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(3)

(-438402.633) IX07(3)

(-2.500000E+9) IX12(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ResinCost Total resin cost (in $ per day -- need to check)

IX\_ResinCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(1)

-24 IX15(1)

IX\_ResinCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(2)

-24 IX15(2)

IX\_ResinCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(3)

-24 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_BedArea Bed area for the vessel in m2

IX\_BedArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(1)

(-1254.21) IX13(1)

(-7.33000E+11) IX14(1)

IX\_BedArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(2)

(-1254.21) IX13(2)

(-7.33000E+11) IX14(2)

IX\_BedArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(3)

(-1254.21) IX13(3)

(-7.33000E+11) IX14(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TankTotalCost Total Tank cost in $

IX\_TankTotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(1)

-1 IX15(1)

IX\_TankTotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(2)

-1 IX15(2)

IX\_TankTotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_NaClReq NaCl requirement in Kg per day

IX\_NaClReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(1)

-0.01 IX09(1)

-3.65 IX10(1)

IX\_NaClReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(2)

-0.01 IX09(2)

-3.65 IX10(2)

IX\_NaClReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(3)

-0.01 IX09(3)

-3.65 IX10(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalChemCost Total chemical cost per year

IX\_TotalChemCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(1)

-1 IX15(1)

IX\_TotalChemCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(2)

-1 IX15(2)

IX\_TotalChemCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_RegFluidReq Regeneration fluid requirement

IX\_RegFluidReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(1)

-250 IX11(1)

IX\_RegFluidReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(2)

-250 IX11(2)

IX\_RegFluidReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(3)

-250 IX11(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_StorageTankCost Storage tank cost

IX\_StorageTankCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(1)

-1 IX15(1)

IX\_StorageTankCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(2)

-1 IX15(2)

IX\_StorageTankCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ConstructionCost Construction cost

IX\_ConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(1)

-1 IX15(1)

IX\_ConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(2)

-1 IX15(2)

IX\_ConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_OMCost Operating and maintenance cost

IX\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(1)

-1 IX15(1)

IX\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(2)

-1 IX15(2)

IX\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalCost Total cost for the implementation of ion exchange process for

each industry

IX\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(1)

-1.000000E-5 NonlinearTechCost03(1)

IX\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(2)

-1.000000E-5 NonlinearTechCost03(2)

IX\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(3)

-1.000000E-5 NonlinearTechCost03(3)

REMAINING 26 ENTRIES SKIPPED

---- Tobj Objective function for the technoogy only problem

Tobj

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 Tobjective

---- Volume volume of waste treated by each industry using each technology (def

ined over i and j)

Volume(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0028 Tc2(1)

-43.8021 DFREq(1,1)

-1.1574 CF01(1)

Volume(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0041 Tc2(1)

-43.8021 DFREq(1,2)

(-7.37701E+16) GAC01(1)

(-8.53308E+15) GAC02(1)

Volume(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0014 Tc2(1)

-43.8021 DFREq(1,3)

REMAINING 84 ENTRIES SKIPPED

---- DFR Desired flow rate for the industry in liters per sec

DFR(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,1)

-1.0067 CF03(1)

1 CF04(1)

-1.0603 CF09(1)

-43.7993 CF25(1)

-8.7599 CF27(1)

DFR(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,2)

DFR(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,3)

-0.18 IX01(1)

-0.0156 IX04(1)

REMAINING 84 ENTRIES SKIPPED

---- NonlinearTechCost

NonlinearTechCost(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost01(1)

NonlinearTechCost(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost02(1)

NonlinearTechCost(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost03(1)

REMAINING 84 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE TechProblem Using NLP From line 868

LOOPS FOR/WHILE 1

FOR/WHILE 7

MODEL STATISTICS

BLOCKS OF EQUATIONS 54 SINGLE EQUATIONS 1,596

BLOCKS OF VARIABLES 51 SINGLE VARIABLES 1,625

NON ZERO ELEMENTS 4,003 NON LINEAR N-Z 174

DERIVATIVE POOL 10 CONSTANT POOL 31

CODE LENGTH 1,508

GENERATION TIME = 0.016 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.016 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 7

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE TechProblem Using NLP From line 868

S O L V E S U M M A R Y

MODEL TechProblem OBJECTIVE Tobj

TYPE NLP DIRECTION MINIMIZE

SOLVER CONOPT FROM LINE 868

\*\*\*\* SOLVER STATUS 7 Licensing Problems

\*\*\*\* MODEL STATUS 11 Licensing Problem

\*\*\*\* OBJECTIVE VALUE NA

RESOURCE USAGE, LIMIT 0.000 1000.000

ITERATION COUNT, LIMIT 0 2000000000

EVALUATION ERRORS 0 0

CONOPT 3 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

\*\*\* No license found

\*\*\* To update your license, please contact your distributor.

\*\*\* Too many equations for demo mode

\*\*\* Number of equations : 1596

\*\*\* Maximum allowed : 300

\*\*\* Too many variables for demo mode

\*\*\* Number of variables : 1625

\*\*\* Maximum allowed : 300

\*\*\* Too many nonzero elements for demo mode

\*\*\* Number of nonzeros : 4003

\*\*\* Maximum allowed : 2000

No solution returned

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE TechProblem Using NLP From line 868

---- Tobjective =E=

Tobjective.. Tobj - NonlinearTechCost(1,1) - NonlinearTechCost(1,2)

- NonlinearTechCost(1,3) - NonlinearTechCost(2,1) - NonlinearTechCost(2,2)

- NonlinearTechCost(2,3) - NonlinearTechCost(3,1) - NonlinearTechCost(3,2)

- NonlinearTechCost(3,3) - NonlinearTechCost(4,1) - NonlinearTechCost(4,2)

- NonlinearTechCost(4,3) - NonlinearTechCost(5,1) - NonlinearTechCost(5,2)

- NonlinearTechCost(5,3) - NonlinearTechCost(6,1) - NonlinearTechCost(6,2)

- NonlinearTechCost(6,3) - NonlinearTechCost(7,1) - NonlinearTechCost(7,2)

- NonlinearTechCost(7,3) - NonlinearTechCost(8,1) - NonlinearTechCost(8,2)

- NonlinearTechCost(8,3) - NonlinearTechCost(9,1) - NonlinearTechCost(9,2)

- NonlinearTechCost(9,3) - NonlinearTechCost(10,1)

- NonlinearTechCost(10,2) - NonlinearTechCost(10,3)

- NonlinearTechCost(11,1) - NonlinearTechCost(11,2)

- NonlinearTechCost(11,3) - NonlinearTechCost(12,1)

- NonlinearTechCost(12,2) - NonlinearTechCost(12,3)

- NonlinearTechCost(13,1) - NonlinearTechCost(13,2)

- NonlinearTechCost(13,3) - NonlinearTechCost(14,1)

- NonlinearTechCost(14,2) - NonlinearTechCost(14,3)

- NonlinearTechCost(15,1) - NonlinearTechCost(15,2)

- NonlinearTechCost(15,3) - NonlinearTechCost(16,1)

- NonlinearTechCost(16,2) - NonlinearTechCost(16,3)

- NonlinearTechCost(17,1) - NonlinearTechCost(17,2)

- NonlinearTechCost(17,3) - NonlinearTechCost(18,1)

- NonlinearTechCost(18,2) - NonlinearTechCost(18,3)

- NonlinearTechCost(19,1) - NonlinearTechCost(19,2)

- NonlinearTechCost(19,3) - NonlinearTechCost(20,1)

- NonlinearTechCost(20,2) - NonlinearTechCost(20,3)

- NonlinearTechCost(21,1) - NonlinearTechCost(21,2)

- NonlinearTechCost(21,3) - NonlinearTechCost(22,1)

- NonlinearTechCost(22,2) - NonlinearTechCost(22,3)

- NonlinearTechCost(23,1) - NonlinearTechCost(23,2)

- NonlinearTechCost(23,3) - NonlinearTechCost(24,1)

- NonlinearTechCost(24,2) - NonlinearTechCost(24,3)

- NonlinearTechCost(25,1) - NonlinearTechCost(25,2)

- NonlinearTechCost(25,3) - NonlinearTechCost(26,1)

- NonlinearTechCost(26,2) - NonlinearTechCost(26,3)

- NonlinearTechCost(27,1) - NonlinearTechCost(27,2)

- NonlinearTechCost(27,3) - NonlinearTechCost(28,1)

- NonlinearTechCost(28,2) - NonlinearTechCost(28,3)

- NonlinearTechCost(29,1) - NonlinearTechCost(29,2)

- NonlinearTechCost(29,3) =E= 0 ; (LHS = 0)

---- Tc1 =L=

Tc1(1).. Volume(1,1) + Volume(1,2) + Volume(1,3) =L= 46.1 ; (LHS = 0)

Tc1(2).. Volume(2,1) + Volume(2,2) + Volume(2,3) =L= 1.5 ; (LHS = 0)

Tc1(3).. Volume(3,1) + Volume(3,2) + Volume(3,3) =L= 4.6 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- Tc2 =G=

Tc2(1).. 0.002762685\*Volume(1,1) + 0.00414402749999999\*Volume(1,2)

+ 0.0013813425\*Volume(1,3) =G= 0.122832874808418 ;

(LHS = 0, INFES = 0.122832874808418 \*\*\*\*)

Tc2(2).. 0.002762685\*Volume(2,1) + 0.00414402749999999\*Volume(2,2)

+ 0.0013813425\*Volume(2,3) =G= 0.00202831822193877 ;

(LHS = 0, INFES = 0.00202831822193877 \*\*\*\*)

Tc2(3).. 0.002762685\*Volume(3,1) + 0.00414402749999999\*Volume(3,2)

+ 0.0013813425\*Volume(3,3) =G= 0.0100326811806122 ;

(LHS = 0, INFES = 0.0100326811806122 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- DFREq =E=

DFREq(1,1).. - 43.8020833333334\*Volume(1,1) + DFR(1,1) =E= 0 ; (LHS = 0)

DFREq(1,2).. - 43.8020833333334\*Volume(1,2) + DFR(1,2) =E= 0 ; (LHS = 0)

DFREq(1,3).. - 43.8020833333334\*Volume(1,3) + DFR(1,3) =E= 0 ; (LHS = 0)

REMAINING 84 ENTRIES SKIPPED

---- CF01 =E=

CF01(1).. CF\_NoOfModules(1) - 1.15740740740741\*Volume(1,1) =E= 0 ; (LHS = 0)

CF01(2).. CF\_NoOfModules(2) - 1.15740740740741\*Volume(2,1) =E= 0 ; (LHS = 0)

CF01(3).. CF\_NoOfModules(3) - 1.15740740740741\*Volume(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF03 =E=

CF03(1).. CF\_MFF(1) - 1.00671140939597\*DFR(1,1) =E= 0 ; (LHS = 0)

CF03(2).. CF\_MFF(2) - 1.00671140939597\*DFR(2,1) =E= 0 ; (LHS = 0)

CF03(3).. CF\_MFF(3) - 1.00671140939597\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF04 =E=

CF04(1).. CF\_BackwashFlow(1) - CF\_MFF(1) + DFR(1,1) =E= 0 ; (LHS = 0)

CF04(2).. CF\_BackwashFlow(2) - CF\_MFF(2) + DFR(2,1) =E= 0 ; (LHS = 0)

CF04(3).. CF\_BackwashFlow(3) - CF\_MFF(3) + DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF05 =E=

CF05(1).. CF\_FeedPumpHP(1) - 0.346809353943718\*CF\_MFF(1) =E= 0 ; (LHS = 0)

CF05(2).. CF\_FeedPumpHP(2) - 0.346809353943718\*CF\_MFF(2) =E= 0 ; (LHS = 0)

CF05(3).. CF\_FeedPumpHP(3) - 0.346809353943718\*CF\_MFF(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF06 =E=

CF06(1).. - 6534.96\*CF\_FeedPumpHP(1) + CF\_FeedPumpPower(1) =E= 0 ; (LHS = 0)

CF06(2).. - 6534.96\*CF\_FeedPumpHP(2) + CF\_FeedPumpPower(2) =E= 0 ; (LHS = 0)

CF06(3).. - 6534.96\*CF\_FeedPumpHP(3) + CF\_FeedPumpPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF07 =E=

CF07(1).. - 43.508\*CF\_FeedPumpHP(1) + CF\_BackflushPower(1) =E= 0 ; (LHS = 0)

CF07(2).. - 43.508\*CF\_FeedPumpHP(2) + CF\_BackflushPower(2) =E= 0 ; (LHS = 0)

CF07(3).. - 43.508\*CF\_FeedPumpHP(3) + CF\_BackflushPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF08 =E=

CF08(1).. - 90\*CF\_NoOfModules(1) + CF\_NoOfMembranes(1) =E= 0 ; (LHS = 0)

CF08(2).. - 90\*CF\_NoOfModules(2) + CF\_NoOfMembranes(2) =E= 0 ; (LHS = 0)

CF08(3).. - 90\*CF\_NoOfModules(3) + CF\_NoOfMembranes(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF09 =E=

CF09(1).. CF\_BuildingArea(1) - 1.060338816\*DFR(1,1) =E= 0 ; (LHS = 0)

CF09(2).. CF\_BuildingArea(2) - 1.060338816\*DFR(2,1) =E= 0 ; (LHS = 0)

CF09(3).. CF\_BuildingArea(3) - 1.060338816\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF10 =E=

CF10(1).. - 370000\*CF\_NoOfModules(1) + CF\_MembraneModuleCost(1) =E= 0 ;

(LHS = 0)

CF10(2).. - 370000\*CF\_NoOfModules(2) + CF\_MembraneModuleCost(2) =E= 0 ;

(LHS = 0)

CF10(3).. - 370000\*CF\_NoOfModules(3) + CF\_MembraneModuleCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF11 =E=

CF11(1).. - 1076\*CF\_BuildingArea(1) + CF\_BuildingCost(1) =E= 0 ; (LHS = 0)

CF11(2).. - 1076\*CF\_BuildingArea(2) + CF\_BuildingCost(2) =E= 0 ; (LHS = 0)

CF11(3).. - 1076\*CF\_BuildingArea(3) + CF\_BuildingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF12 =E=

CF12(1).. - 70000\*CF\_NoOfModules(1) + CF\_InstallationCost(1) =E= 0 ; (LHS = 0)

CF12(2).. - 70000\*CF\_NoOfModules(2) + CF\_InstallationCost(2) =E= 0 ; (LHS = 0)

CF12(3).. - 70000\*CF\_NoOfModules(3) + CF\_InstallationCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF13 =E=

CF13(1).. - 0.05\*CF\_MembraneModuleCost(1) + CF\_MiscCost(1) =E= 0 ; (LHS = 0)

CF13(2).. - 0.05\*CF\_MembraneModuleCost(2) + CF\_MiscCost(2) =E= 0 ; (LHS = 0)

CF13(3).. - 0.05\*CF\_MembraneModuleCost(3) + CF\_MiscCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF14 =E=

CF14(1).. - 0.05\*CF\_MembraneModuleCost(1) - 0.05\*CF\_MiscCost(1)

+ CF\_PlantPipingCost(1) =E= 0 ; (LHS = 0)

CF14(2).. - 0.05\*CF\_MembraneModuleCost(2) - 0.05\*CF\_MiscCost(2)

+ CF\_PlantPipingCost(2) =E= 0 ; (LHS = 0)

CF14(3).. - 0.05\*CF\_MembraneModuleCost(3) - 0.05\*CF\_MiscCost(3)

+ CF\_PlantPipingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF15 =E=

CF15(1).. - 0.1\*CF\_MembraneModuleCost(1) - 0.1\*CF\_MiscCost(1)

+ CF\_EngineeringCost(1) =E= 0 ; (LHS = 0)

CF15(2).. - 0.1\*CF\_MembraneModuleCost(2) - 0.1\*CF\_MiscCost(2)

+ CF\_EngineeringCost(2) =E= 0 ; (LHS = 0)

CF15(3).. - 0.1\*CF\_MembraneModuleCost(3) - 0.1\*CF\_MiscCost(3)

+ CF\_EngineeringCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF16 =E=

CF16(1).. - CF\_MembraneModuleCost(1) - CF\_BuildingCost(1)

- CF\_InstallationCost(1) - CF\_MiscCost(1) - CF\_PlantPipingCost(1)

- CF\_EngineeringCost(1) + CF\_DirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF16(2).. - CF\_MembraneModuleCost(2) - CF\_BuildingCost(2)

- CF\_InstallationCost(2) - CF\_MiscCost(2) - CF\_PlantPipingCost(2)

- CF\_EngineeringCost(2) + CF\_DirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF16(3).. - CF\_MembraneModuleCost(3) - CF\_BuildingCost(3)

- CF\_InstallationCost(3) - CF\_MiscCost(3) - CF\_PlantPipingCost(3)

- CF\_EngineeringCost(3) + CF\_DirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF17 =E=

CF17(1).. - 0.06\*CF\_DirectCapitalCost(1) + CF\_ConstructionInterest(1) =E= 0 ;

(LHS = 0)

CF17(2).. - 0.06\*CF\_DirectCapitalCost(2) + CF\_ConstructionInterest(2) =E= 0 ;

(LHS = 0)

CF17(3).. - 0.06\*CF\_DirectCapitalCost(3) + CF\_ConstructionInterest(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF18 =E=

CF18(1).. - 0.2\*CF\_DirectCapitalCost(1) + CF\_Contingencies(1) =E= 0 ; (LHS = 0)

CF18(2).. - 0.2\*CF\_DirectCapitalCost(2) + CF\_Contingencies(2) =E= 0 ; (LHS = 0)

CF18(3).. - 0.2\*CF\_DirectCapitalCost(3) + CF\_Contingencies(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF19 =E=

CF19(1).. - 0.1\*CF\_DirectCapitalCost(1) + CF\_ProjectManagement(1) =E= 0 ;

(LHS = 0)

CF19(2).. - 0.1\*CF\_DirectCapitalCost(2) + CF\_ProjectManagement(2) =E= 0 ;

(LHS = 0)

CF19(3).. - 0.1\*CF\_DirectCapitalCost(3) + CF\_ProjectManagement(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF20 =E=

CF20(1).. - 0.04\*CF\_DirectCapitalCost(1) + CF\_WorkingCapital(1) =E= 0 ;

(LHS = 0)

CF20(2).. - 0.04\*CF\_DirectCapitalCost(2) + CF\_WorkingCapital(2) =E= 0 ;

(LHS = 0)

CF20(3).. - 0.04\*CF\_DirectCapitalCost(3) + CF\_WorkingCapital(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF21 =E=

CF21(1).. - CF\_ConstructionInterest(1) - CF\_Contingencies(1)

- CF\_ProjectManagement(1) - CF\_WorkingCapital(1)

+ CF\_IndirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF21(2).. - CF\_ConstructionInterest(2) - CF\_Contingencies(2)

- CF\_ProjectManagement(2) - CF\_WorkingCapital(2)

+ CF\_IndirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF21(3).. - CF\_ConstructionInterest(3) - CF\_Contingencies(3)

- CF\_ProjectManagement(3) - CF\_WorkingCapital(3)

+ CF\_IndirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF22 =E=

CF22(1).. - CF\_DirectCapitalCost(1) - CF\_IndirectCapitalCost(1)

+ CF\_TotalConstructionCost(1) =E= 0 ; (LHS = 0)

CF22(2).. - CF\_DirectCapitalCost(2) - CF\_IndirectCapitalCost(2)

+ CF\_TotalConstructionCost(2) =E= 0 ; (LHS = 0)

CF22(3).. - CF\_DirectCapitalCost(3) - CF\_IndirectCapitalCost(3)

+ CF\_TotalConstructionCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF23 =E=

CF23(1).. - 0.085503060254\*CF\_FeedPumpPower(1)

- 0.085503060254\*CF\_BackflushPower(1) + CF\_ElectricityCost(1) =E= 0 ;

(LHS = 0)

CF23(2).. - 0.085503060254\*CF\_FeedPumpPower(2)

- 0.085503060254\*CF\_BackflushPower(2) + CF\_ElectricityCost(2) =E= 0 ;

(LHS = 0)

CF23(3).. - 0.085503060254\*CF\_FeedPumpPower(3)

- 0.085503060254\*CF\_BackflushPower(3) + CF\_ElectricityCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF24 =E=

CF24(1).. CF\_LaborCost(1) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(2).. CF\_LaborCost(2) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(3).. CF\_LaborCost(3) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF25 =E=

CF25(1).. CF\_ChemicalCost(1) - 52.3384154619738\*DFR(1,1) =E= -305.670579075782

; (LHS = 0, INFES = 305.670579075782 \*\*\*\*)

CF25(2).. CF\_ChemicalCost(2) - 52.3384154619738\*DFR(2,1) =E= -305.670579075782

; (LHS = 0, INFES = 305.670579075782 \*\*\*\*)

CF25(3).. CF\_ChemicalCost(3) - 52.3384154619738\*DFR(3,1) =E= -305.670579075782

; (LHS = 0, INFES = 305.670579075782 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF26 =E=

CF26(1).. - 136.376590983962\*CF\_NoOfMembranes(1)

+ CF\_MembraneReplacementCost(1) =E= 0 ; (LHS = 0)

CF26(2).. - 136.376590983962\*CF\_NoOfMembranes(2)

+ CF\_MembraneReplacementCost(2) =E= 0 ; (LHS = 0)

CF26(3).. - 136.376590983962\*CF\_NoOfMembranes(3)

+ CF\_MembraneReplacementCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF27 =E=

CF27(1).. CF\_CleaningChemicalCost(1) - 10.4676830923948\*DFR(1,1) =E=

61.1344826202181 ; (LHS = 0, INFES = 61.1344826202181 \*\*\*\*)

CF27(2).. CF\_CleaningChemicalCost(2) - 10.4676830923948\*DFR(2,1) =E=

61.1344826202181 ; (LHS = 0, INFES = 61.1344826202181 \*\*\*\*)

CF27(3).. CF\_CleaningChemicalCost(3) - 10.4676830923948\*DFR(3,1) =E=

61.1344826202181 ; (LHS = 0, INFES = 61.1344826202181 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF28 =E=

CF28(1).. - 0.02\*CF\_DirectCapitalCost(1) + CF\_Repairs(1) =E= 0 ; (LHS = 0)

CF28(2).. - 0.02\*CF\_DirectCapitalCost(2) + CF\_Repairs(2) =E= 0 ; (LHS = 0)

CF28(3).. - 0.02\*CF\_DirectCapitalCost(3) + CF\_Repairs(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF29 =E=

CF29(1).. - CF\_ElectricityCost(1) - CF\_LaborCost(1) - CF\_ChemicalCost(1)

- CF\_MembraneReplacementCost(1) - CF\_CleaningChemicalCost(1)

- CF\_Repairs(1) + CF\_TotalOMCost(1) =E= 0 ; (LHS = 0)

CF29(2).. - CF\_ElectricityCost(2) - CF\_LaborCost(2) - CF\_ChemicalCost(2)

- CF\_MembraneReplacementCost(2) - CF\_CleaningChemicalCost(2)

- CF\_Repairs(2) + CF\_TotalOMCost(2) =E= 0 ; (LHS = 0)

CF29(3).. - CF\_ElectricityCost(3) - CF\_LaborCost(3) - CF\_ChemicalCost(3)

- CF\_MembraneReplacementCost(3) - CF\_CleaningChemicalCost(3)

- CF\_Repairs(3) + CF\_TotalOMCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF30 =E=

CF30(1).. - 0.101852208823151\*CF\_TotalConstructionCost(1)

+ CF\_CapitalRecovery(1) =E= 0 ; (LHS = 0)

CF30(2).. - 0.101852208823151\*CF\_TotalConstructionCost(2)

+ CF\_CapitalRecovery(2) =E= 0 ; (LHS = 0)

CF30(3).. - 0.101852208823151\*CF\_TotalConstructionCost(3)

+ CF\_CapitalRecovery(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF31 =E=

CF31(1).. - 2\*CF\_TotalOMCost(1) - 2\*CF\_CapitalRecovery(1) + CF\_AnnualCost(1)

=E= 0 ; (LHS = 0)

CF31(2).. - 2\*CF\_TotalOMCost(2) - 2\*CF\_CapitalRecovery(2) + CF\_AnnualCost(2)

=E= 0 ; (LHS = 0)

CF31(3).. - 2\*CF\_TotalOMCost(3) - 2\*CF\_CapitalRecovery(3) + CF\_AnnualCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC01 =E=

GAC01(1).. GAC\_CapitalCost(1) - (7.37701051584E16)\*Volume(1,2) =E= 0 ;

(LHS = 0)

GAC01(2).. GAC\_CapitalCost(2) - (7.37701051584E16)\*Volume(2,2) =E= 0 ;

(LHS = 0)

GAC01(3).. GAC\_CapitalCost(3) - (7.37701051584E16)\*Volume(3,2) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC02 =E=

GAC02(1).. GAC\_OMCost(1) - (8.53307527956E15)\*Volume(1,2) =E= 0 ; (LHS = 0)

GAC02(2).. GAC\_OMCost(2) - (8.53307527956E15)\*Volume(2,2) =E= 0 ; (LHS = 0)

GAC02(3).. GAC\_OMCost(3) - (8.53307527956E15)\*Volume(3,2) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC03 =E=

GAC03(1).. - GAC\_CapitalCost(1) - GAC\_OMCost(1) + GAC\_TotalCost(1) =E= 0 ;

(LHS = 0)

GAC03(2).. - GAC\_CapitalCost(2) - GAC\_OMCost(2) + GAC\_TotalCost(2) =E= 0 ;

(LHS = 0)

GAC03(3).. - GAC\_CapitalCost(3) - GAC\_OMCost(3) + GAC\_TotalCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX01 =E=

IX01(1).. IX\_MinResinVolume(1) - 0.18\*DFR(1,3) =E= 0 ; (LHS = 0)

IX01(2).. IX\_MinResinVolume(2) - 0.18\*DFR(2,3) =E= 0 ; (LHS = 0)

IX01(3).. IX\_MinResinVolume(3) - 0.18\*DFR(3,3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX02 =E=

IX02(1).. IX\_MinVolExhaustionTime(1) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(2).. IX\_MinVolExhaustionTime(2) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(3).. IX\_MinVolExhaustionTime(3) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX04 =E=

IX04(1).. IX\_ExhaustionTimeResinVolume(1) - 0.0156384\*DFR(1,3) =E= 0 ;

(LHS = 0)

IX04(2).. IX\_ExhaustionTimeResinVolume(2) - 0.0156384\*DFR(2,3) =E= 0 ;

(LHS = 0)

IX04(3).. IX\_ExhaustionTimeResinVolume(3) - 0.0156384\*DFR(3,3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX05 =E=

IX05(1).. - 2\*IX\_ExhaustionTimeResinVolume(1) + IX\_VesselVolume(1) =E= 0 ;

(LHS = 0)

IX05(2).. - 2\*IX\_ExhaustionTimeResinVolume(2) + IX\_VesselVolume(2) =E= 0 ;

(LHS = 0)

IX05(3).. - 2\*IX\_ExhaustionTimeResinVolume(3) + IX\_VesselVolume(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX06 =E=

IX06(1).. - 1684.9266337152\*IX\_ExhaustionTimeResinVolume(1) + IX\_ResinCost(1)

=E= 0 ; (LHS = 0)

IX06(2).. - 1684.9266337152\*IX\_ExhaustionTimeResinVolume(2) + IX\_ResinCost(2)

=E= 0 ; (LHS = 0)

IX06(3).. - 1684.9266337152\*IX\_ExhaustionTimeResinVolume(3) + IX\_ResinCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX07 =E=

IX07(1).. - (609346.255906488)\*IX\_VesselVolume(1) + IX\_TankTotalCost(1) =E= 0 ;

(LHS = -12.7529353763942, INFES = 12.7529353763942 \*\*\*\*)

IX07(2).. - (609346.255906488)\*IX\_VesselVolume(2) + IX\_TankTotalCost(2) =E= 0 ;

(LHS = -12.7529353763942, INFES = 12.7529353763942 \*\*\*\*)

IX07(3).. - (609346.255906488)\*IX\_VesselVolume(3) + IX\_TankTotalCost(3) =E= 0 ;

(LHS = -12.7529353763942, INFES = 12.7529353763942 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX08 =E=

IX08(1).. - 150\*IX\_ExhaustionTimeResinVolume(1) + IX\_NaClReq(1) =E= 0 ;

(LHS = 0)

IX08(2).. - 150\*IX\_ExhaustionTimeResinVolume(2) + IX\_NaClReq(2) =E= 0 ;

(LHS = 0)

IX08(3).. - 150\*IX\_ExhaustionTimeResinVolume(3) + IX\_NaClReq(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX09 =E=

IX09(1).. - 0.01\*IX\_NaClReq(1) + IX\_RegFluidReq(1) =E= 0 ; (LHS = 0)

IX09(2).. - 0.01\*IX\_NaClReq(2) + IX\_RegFluidReq(2) =E= 0 ; (LHS = 0)

IX09(3).. - 0.01\*IX\_NaClReq(3) + IX\_RegFluidReq(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX10 =E=

IX10(1).. - 3.65\*IX\_NaClReq(1) + IX\_TotalChemCost(1) =E= 0 ; (LHS = 0)

IX10(2).. - 3.65\*IX\_NaClReq(2) + IX\_TotalChemCost(2) =E= 0 ; (LHS = 0)

IX10(3).. - 3.65\*IX\_NaClReq(3) + IX\_TotalChemCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX11 =E=

IX11(1).. - 250\*IX\_RegFluidReq(1) + IX\_StorageTankCost(1) =E= 0 ; (LHS = 0)

IX11(2).. - 250\*IX\_RegFluidReq(2) + IX\_StorageTankCost(2) =E= 0 ; (LHS = 0)

IX11(3).. - 250\*IX\_RegFluidReq(3) + IX\_StorageTankCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX12 =E=

IX12(1).. - (2500000000)\*IX\_VesselVolume(1) + IX\_BedArea(1) =E= 0 ; (LHS = 0)

IX12(2).. - (2500000000)\*IX\_VesselVolume(2) + IX\_BedArea(2) =E= 0 ; (LHS = 0)

IX12(3).. - (2500000000)\*IX\_VesselVolume(3) + IX\_BedArea(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX13 =E=

IX13(1).. - (1254.21)\*IX\_BedArea(1) + IX\_ConstructionCost(1) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(2).. - (1254.21)\*IX\_BedArea(2) + IX\_ConstructionCost(2) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(3).. - (1254.21)\*IX\_BedArea(3) + IX\_ConstructionCost(3) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX14 =E=

IX14(1).. - (733000000000)\*IX\_BedArea(1) + IX\_OMCost(1) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(2).. - (733000000000)\*IX\_BedArea(2) + IX\_OMCost(2) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(3).. - (733000000000)\*IX\_BedArea(3) + IX\_OMCost(3) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX15 =E=

IX15(1).. - 24\*IX\_ResinCost(1) - IX\_TankTotalCost(1) - IX\_TotalChemCost(1)

- IX\_StorageTankCost(1) - IX\_ConstructionCost(1) - IX\_OMCost(1)

+ IX\_TotalCost(1) =E= 0 ; (LHS = 0)

IX15(2).. - 24\*IX\_ResinCost(2) - IX\_TankTotalCost(2) - IX\_TotalChemCost(2)

- IX\_StorageTankCost(2) - IX\_ConstructionCost(2) - IX\_OMCost(2)

+ IX\_TotalCost(2) =E= 0 ; (LHS = 0)

IX15(3).. - 24\*IX\_ResinCost(3) - IX\_TankTotalCost(3) - IX\_TotalChemCost(3)

- IX\_StorageTankCost(3) - IX\_ConstructionCost(3) - IX\_OMCost(3)

+ IX\_TotalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost01 =E=

NonlinearTechCost01(1).. - 1E-5\*CF\_AnnualCost(1) + NonlinearTechCost(1,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(2).. - 1E-5\*CF\_AnnualCost(2) + NonlinearTechCost(2,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(3).. - 1E-5\*CF\_AnnualCost(3) + NonlinearTechCost(3,1) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost02 =E=

NonlinearTechCost02(1).. - 1E-5\*GAC\_TotalCost(1) + NonlinearTechCost(1,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(2).. - 1E-5\*GAC\_TotalCost(2) + NonlinearTechCost(2,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(3).. - 1E-5\*GAC\_TotalCost(3) + NonlinearTechCost(3,2) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost03 =E=

NonlinearTechCost03(1).. - 1E-5\*IX\_TotalCost(1) + NonlinearTechCost(1,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(2).. - 1E-5\*IX\_TotalCost(2) + NonlinearTechCost(2,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(3).. - 1E-5\*IX\_TotalCost(3) + NonlinearTechCost(3,3) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE TechProblem Using NLP From line 868

---- CF\_NoOfModules Number of modules

CF\_NoOfModules(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(1)

-90 CF08(1)

-370000 CF10(1)

-70000 CF12(1)

CF\_NoOfModules(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(2)

-90 CF08(2)

-370000 CF10(2)

-70000 CF12(2)

CF\_NoOfModules(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(3)

-90 CF08(3)

-370000 CF10(3)

-70000 CF12(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackwashFlow Backwash flow

CF\_BackwashFlow(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(1)

CF\_BackwashFlow(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(2)

CF\_BackwashFlow(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpHP Feed pump horsepower

CF\_FeedPumpHP(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(1)

-6534.96 CF06(1)

-43.508 CF07(1)

CF\_FeedPumpHP(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(2)

-6534.96 CF06(2)

-43.508 CF07(2)

CF\_FeedPumpHP(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(3)

-6534.96 CF06(3)

-43.508 CF07(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpPower Feed pump power requirement in kWh

CF\_FeedPumpPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(1)

-0.0855 CF23(1)

CF\_FeedPumpPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(2)

-0.0855 CF23(2)

CF\_FeedPumpPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(3)

-0.0855 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackflushPower Backflush power requirement in kWh

CF\_BackflushPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(1)

-0.0855 CF23(1)

CF\_BackflushPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(2)

-0.0855 CF23(2)

CF\_BackflushPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(3)

-0.0855 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MFF Microfiltration feed flow in liters per sec

CF\_MFF(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(1)

-1 CF04(1)

-0.3468 CF05(1)

CF\_MFF(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(2)

-1 CF04(2)

-0.3468 CF05(2)

CF\_MFF(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(3)

-1 CF04(3)

-0.3468 CF05(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_NoOfMembranes Number of membranes used

CF\_NoOfMembranes(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(1)

-136.3766 CF26(1)

CF\_NoOfMembranes(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(2)

-136.3766 CF26(2)

CF\_NoOfMembranes(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(3)

-136.3766 CF26(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingArea Building area for the process implementation

CF\_BuildingArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(1)

-1076 CF11(1)

CF\_BuildingArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(2)

-1076 CF11(2)

CF\_BuildingArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(3)

-1076 CF11(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneModuleCost Membrane module cost

CF\_MembraneModuleCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(1)

-0.05 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MembraneModuleCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(2)

-0.05 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MembraneModuleCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(3)

-0.05 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingCost Building cost - based on the building area

CF\_BuildingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(1)

-1 CF16(1)

CF\_BuildingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(2)

-1 CF16(2)

CF\_BuildingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_InstallationCost Installation cost for the process

CF\_InstallationCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(1)

-1 CF16(1)

CF\_InstallationCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(2)

-1 CF16(2)

CF\_InstallationCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MiscCost Miscellaneous cost (taken as 5% of the module cost)

CF\_MiscCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MiscCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MiscCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_PlantPipingCost Plant piping cost (taken as 5% of the module and misc c

ost)

CF\_PlantPipingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(1)

-1 CF16(1)

CF\_PlantPipingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(2)

-1 CF16(2)

CF\_PlantPipingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_EngineeringCost Engineering cost (taken as 10% of the module and misc c

ost)

CF\_EngineeringCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(1)

-1 CF16(1)

CF\_EngineeringCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(2)

-1 CF16(2)

CF\_EngineeringCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_DirectCapitalCost Total direct capital cost

CF\_DirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(1)

-0.06 CF17(1)

-0.2 CF18(1)

-0.1 CF19(1)

-0.04 CF20(1)

-1 CF22(1)

-0.02 CF28(1)

CF\_DirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(2)

-0.06 CF17(2)

-0.2 CF18(2)

-0.1 CF19(2)

-0.04 CF20(2)

-1 CF22(2)

-0.02 CF28(2)

CF\_DirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(3)

-0.06 CF17(3)

-0.2 CF18(3)

-0.1 CF19(3)

-0.04 CF20(3)

-1 CF22(3)

-0.02 CF28(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ConstructionInterest Expense on interest during construction (taken as

6% of total direct capital cost)

CF\_ConstructionInterest(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(1)

-1 CF21(1)

CF\_ConstructionInterest(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(2)

-1 CF21(2)

CF\_ConstructionInterest(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Contingencies Contingencies (taken as 20% of total direct capital cost)

CF\_Contingencies(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(1)

-1 CF21(1)

CF\_Contingencies(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(2)

-1 CF21(2)

CF\_Contingencies(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ProjectManagement Fees and project management (taken as 10% of total di

rect capital cost)

CF\_ProjectManagement(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(1)

-1 CF21(1)

CF\_ProjectManagement(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(2)

-1 CF21(2)

CF\_ProjectManagement(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_WorkingCapital Working capital (taken as 4% of total direct capital cos

t)

CF\_WorkingCapital(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(1)

-1 CF21(1)

CF\_WorkingCapital(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(2)

-1 CF21(2)

CF\_WorkingCapital(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_IndirectCapitalCost Total indirect capital cost

CF\_IndirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(1)

-1 CF22(1)

CF\_IndirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(2)

-1 CF22(2)

CF\_IndirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(3)

-1 CF22(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalConstructionCost Total (direct and indirect) construction cost

CF\_TotalConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(1)

-0.1019 CF30(1)

CF\_TotalConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(2)

-0.1019 CF30(2)

CF\_TotalConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(3)

-0.1019 CF30(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ElectricityCost Electricity cost for the implementation of the process

CF\_ElectricityCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(1)

-1 CF29(1)

CF\_ElectricityCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(2)

-1 CF29(2)

CF\_ElectricityCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_LaborCost Labor cost for the implementation of the process

CF\_LaborCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(1)

-1 CF29(1)

CF\_LaborCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(2)

-1 CF29(2)

CF\_LaborCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ChemicalCost Chemical cost for the process

CF\_ChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(1)

-1 CF29(1)

CF\_ChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(2)

-1 CF29(2)

CF\_ChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneReplacementCost Membrane replacement cost for the process

CF\_MembraneReplacementCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(1)

-1 CF29(1)

CF\_MembraneReplacementCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(2)

-1 CF29(2)

CF\_MembraneReplacementCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CleaningChemicalCost Cleaning chemical (NaOCl) cost

CF\_CleaningChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(1)

-1 CF29(1)

CF\_CleaningChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(2)

-1 CF29(2)

CF\_CleaningChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Repairs Repairs replacement and misc cost (taken as 2% of the direct ca

pital cost)

CF\_Repairs(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(1)

-1 CF29(1)

CF\_Repairs(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(2)

-1 CF29(2)

CF\_Repairs(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalOMCost Total operating and maintenance cost

CF\_TotalOMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(1)

-2 CF31(1)

CF\_TotalOMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(2)

-2 CF31(2)

CF\_TotalOMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CapitalRecovery Capital recovery - calculate from the total captical co

st

CF\_CapitalRecovery(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(1)

-2 CF31(1)

CF\_CapitalRecovery(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(2)

-2 CF31(2)

CF\_CapitalRecovery(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_AnnualCost Annual cost depending on the Capital recovery and OM cost

CF\_AnnualCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(1)

-1.000000E-5 NonlinearTechCost01(1)

CF\_AnnualCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(2)

-1.000000E-5 NonlinearTechCost01(2)

CF\_AnnualCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(3)

-1.000000E-5 NonlinearTechCost01(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_CapitalCost Capital cost for the activated carbon process

GAC\_CapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(1)

-1 GAC03(1)

GAC\_CapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(2)

-1 GAC03(2)

GAC\_CapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_OMCost Operational and maintenance cost for the activated carbon proce

ss

GAC\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(1)

-1 GAC03(1)

GAC\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(2)

-1 GAC03(2)

GAC\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_TotalCost Total cost for the activated carbon process implementation

GAC\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(1)

-1.000000E-5 NonlinearTechCost02(1)

GAC\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(2)

-1.000000E-5 NonlinearTechCost02(2)

GAC\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(3)

-1.000000E-5 NonlinearTechCost02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinResinVolume Minimum volume of the medium in m3

IX\_MinResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(1)

IX\_MinResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(2)

IX\_MinResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinVolExhaustionTime Minimum volume exhaustion time in days

IX\_MinVolExhaustionTime(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(1)

IX\_MinVolExhaustionTime(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(2)

IX\_MinVolExhaustionTime(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ExhaustionTimeResinVolume Resin volume in m3 for the minimum exhaustion

time

IX\_ExhaustionTimeResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(1)

-2 IX05(1)

-1684.9266 IX06(1)

-150 IX08(1)

IX\_ExhaustionTimeResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(2)

-2 IX05(2)

-1684.9266 IX06(2)

-150 IX08(2)

IX\_ExhaustionTimeResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(3)

-2 IX05(3)

-1684.9266 IX06(3)

-150 IX08(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_VesselVolume Total vessel volume in m3

IX\_VesselVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(1)

(-609346.2559) IX07(1)

(-2.500000E+9) IX12(1)

IX\_VesselVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(2)

(-609346.2559) IX07(2)

(-2.500000E+9) IX12(2)

IX\_VesselVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(3)

(-609346.2559) IX07(3)

(-2.500000E+9) IX12(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ResinCost Total resin cost (in $ per day -- need to check)

IX\_ResinCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(1)

-24 IX15(1)

IX\_ResinCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(2)

-24 IX15(2)

IX\_ResinCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(3)

-24 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_BedArea Bed area for the vessel in m2

IX\_BedArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(1)

(-1254.21) IX13(1)

(-7.33000E+11) IX14(1)

IX\_BedArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(2)

(-1254.21) IX13(2)

(-7.33000E+11) IX14(2)

IX\_BedArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(3)

(-1254.21) IX13(3)

(-7.33000E+11) IX14(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TankTotalCost Total Tank cost in $

IX\_TankTotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(1)

-1 IX15(1)

IX\_TankTotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(2)

-1 IX15(2)

IX\_TankTotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_NaClReq NaCl requirement in Kg per day

IX\_NaClReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(1)

-0.01 IX09(1)

-3.65 IX10(1)

IX\_NaClReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(2)

-0.01 IX09(2)

-3.65 IX10(2)

IX\_NaClReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(3)

-0.01 IX09(3)

-3.65 IX10(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalChemCost Total chemical cost per year

IX\_TotalChemCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(1)

-1 IX15(1)

IX\_TotalChemCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(2)

-1 IX15(2)

IX\_TotalChemCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_RegFluidReq Regeneration fluid requirement

IX\_RegFluidReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(1)

-250 IX11(1)

IX\_RegFluidReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(2)

-250 IX11(2)

IX\_RegFluidReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(3)

-250 IX11(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_StorageTankCost Storage tank cost

IX\_StorageTankCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(1)

-1 IX15(1)

IX\_StorageTankCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(2)

-1 IX15(2)

IX\_StorageTankCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ConstructionCost Construction cost

IX\_ConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(1)

-1 IX15(1)

IX\_ConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(2)

-1 IX15(2)

IX\_ConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_OMCost Operating and maintenance cost

IX\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(1)

-1 IX15(1)

IX\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(2)

-1 IX15(2)

IX\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalCost Total cost for the implementation of ion exchange process for

each industry

IX\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(1)

-1.000000E-5 NonlinearTechCost03(1)

IX\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(2)

-1.000000E-5 NonlinearTechCost03(2)

IX\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(3)

-1.000000E-5 NonlinearTechCost03(3)

REMAINING 26 ENTRIES SKIPPED

---- Tobj Objective function for the technoogy only problem

Tobj

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 Tobjective

---- Volume volume of waste treated by each industry using each technology (def

ined over i and j)

Volume(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0028 Tc2(1)

-43.8021 DFREq(1,1)

-1.1574 CF01(1)

Volume(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0041 Tc2(1)

-43.8021 DFREq(1,2)

(-7.37701E+16) GAC01(1)

(-8.53308E+15) GAC02(1)

Volume(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0014 Tc2(1)

-43.8021 DFREq(1,3)

REMAINING 84 ENTRIES SKIPPED

---- DFR Desired flow rate for the industry in liters per sec

DFR(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,1)

-1.0067 CF03(1)

1 CF04(1)

-1.0603 CF09(1)

-52.3384 CF25(1)

-10.4677 CF27(1)

DFR(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,2)

DFR(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,3)

-0.18 IX01(1)

-0.0156 IX04(1)

REMAINING 84 ENTRIES SKIPPED

---- NonlinearTechCost

NonlinearTechCost(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost01(1)

NonlinearTechCost(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost02(1)

NonlinearTechCost(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost03(1)

REMAINING 84 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE TechProblem Using NLP From line 868

LOOPS FOR/WHILE 1

FOR/WHILE 8

MODEL STATISTICS

BLOCKS OF EQUATIONS 54 SINGLE EQUATIONS 1,596

BLOCKS OF VARIABLES 51 SINGLE VARIABLES 1,625

NON ZERO ELEMENTS 4,003 NON LINEAR N-Z 174

DERIVATIVE POOL 10 CONSTANT POOL 31

CODE LENGTH 1,508

GENERATION TIME = 0.015 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.015 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 8

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE TechProblem Using NLP From line 868

S O L V E S U M M A R Y

MODEL TechProblem OBJECTIVE Tobj

TYPE NLP DIRECTION MINIMIZE

SOLVER CONOPT FROM LINE 868

\*\*\*\* SOLVER STATUS 7 Licensing Problems

\*\*\*\* MODEL STATUS 11 Licensing Problem

\*\*\*\* OBJECTIVE VALUE NA

RESOURCE USAGE, LIMIT 0.000 1000.000

ITERATION COUNT, LIMIT 0 2000000000

EVALUATION ERRORS 0 0

CONOPT 3 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

\*\*\* No license found

\*\*\* To update your license, please contact your distributor.

\*\*\* Too many equations for demo mode

\*\*\* Number of equations : 1596

\*\*\* Maximum allowed : 300

\*\*\* Too many variables for demo mode

\*\*\* Number of variables : 1625

\*\*\* Maximum allowed : 300

\*\*\* Too many nonzero elements for demo mode

\*\*\* Number of nonzeros : 4003

\*\*\* Maximum allowed : 2000

No solution returned

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE TechProblem Using NLP From line 868

---- Tobjective =E=

Tobjective.. Tobj - NonlinearTechCost(1,1) - NonlinearTechCost(1,2)

- NonlinearTechCost(1,3) - NonlinearTechCost(2,1) - NonlinearTechCost(2,2)

- NonlinearTechCost(2,3) - NonlinearTechCost(3,1) - NonlinearTechCost(3,2)

- NonlinearTechCost(3,3) - NonlinearTechCost(4,1) - NonlinearTechCost(4,2)

- NonlinearTechCost(4,3) - NonlinearTechCost(5,1) - NonlinearTechCost(5,2)

- NonlinearTechCost(5,3) - NonlinearTechCost(6,1) - NonlinearTechCost(6,2)

- NonlinearTechCost(6,3) - NonlinearTechCost(7,1) - NonlinearTechCost(7,2)

- NonlinearTechCost(7,3) - NonlinearTechCost(8,1) - NonlinearTechCost(8,2)

- NonlinearTechCost(8,3) - NonlinearTechCost(9,1) - NonlinearTechCost(9,2)

- NonlinearTechCost(9,3) - NonlinearTechCost(10,1)

- NonlinearTechCost(10,2) - NonlinearTechCost(10,3)

- NonlinearTechCost(11,1) - NonlinearTechCost(11,2)

- NonlinearTechCost(11,3) - NonlinearTechCost(12,1)

- NonlinearTechCost(12,2) - NonlinearTechCost(12,3)

- NonlinearTechCost(13,1) - NonlinearTechCost(13,2)

- NonlinearTechCost(13,3) - NonlinearTechCost(14,1)

- NonlinearTechCost(14,2) - NonlinearTechCost(14,3)

- NonlinearTechCost(15,1) - NonlinearTechCost(15,2)

- NonlinearTechCost(15,3) - NonlinearTechCost(16,1)

- NonlinearTechCost(16,2) - NonlinearTechCost(16,3)

- NonlinearTechCost(17,1) - NonlinearTechCost(17,2)

- NonlinearTechCost(17,3) - NonlinearTechCost(18,1)

- NonlinearTechCost(18,2) - NonlinearTechCost(18,3)

- NonlinearTechCost(19,1) - NonlinearTechCost(19,2)

- NonlinearTechCost(19,3) - NonlinearTechCost(20,1)

- NonlinearTechCost(20,2) - NonlinearTechCost(20,3)

- NonlinearTechCost(21,1) - NonlinearTechCost(21,2)

- NonlinearTechCost(21,3) - NonlinearTechCost(22,1)

- NonlinearTechCost(22,2) - NonlinearTechCost(22,3)

- NonlinearTechCost(23,1) - NonlinearTechCost(23,2)

- NonlinearTechCost(23,3) - NonlinearTechCost(24,1)

- NonlinearTechCost(24,2) - NonlinearTechCost(24,3)

- NonlinearTechCost(25,1) - NonlinearTechCost(25,2)

- NonlinearTechCost(25,3) - NonlinearTechCost(26,1)

- NonlinearTechCost(26,2) - NonlinearTechCost(26,3)

- NonlinearTechCost(27,1) - NonlinearTechCost(27,2)

- NonlinearTechCost(27,3) - NonlinearTechCost(28,1)

- NonlinearTechCost(28,2) - NonlinearTechCost(28,3)

- NonlinearTechCost(29,1) - NonlinearTechCost(29,2)

- NonlinearTechCost(29,3) =E= 0 ; (LHS = 0)

---- Tc1 =L=

Tc1(1).. Volume(1,1) + Volume(1,2) + Volume(1,3) =L= 46.1 ; (LHS = 0)

Tc1(2).. Volume(2,1) + Volume(2,2) + Volume(2,3) =L= 1.5 ; (LHS = 0)

Tc1(3).. Volume(3,1) + Volume(3,2) + Volume(3,3) =L= 4.6 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- Tc2 =G=

Tc2(1).. 0.002762685\*Volume(1,1) + 0.00414402749999999\*Volume(1,2)

+ 0.0013813425\*Volume(1,3) =G= 0.122832874808418 ;

(LHS = 0, INFES = 0.122832874808418 \*\*\*\*)

Tc2(2).. 0.002762685\*Volume(2,1) + 0.00414402749999999\*Volume(2,2)

+ 0.0013813425\*Volume(2,3) =G= 0.00202831822193877 ;

(LHS = 0, INFES = 0.00202831822193877 \*\*\*\*)

Tc2(3).. 0.002762685\*Volume(3,1) + 0.00414402749999999\*Volume(3,2)

+ 0.0013813425\*Volume(3,3) =G= 0.0100326811806122 ;

(LHS = 0, INFES = 0.0100326811806122 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- DFREq =E=

DFREq(1,1).. - 43.8020833333334\*Volume(1,1) + DFR(1,1) =E= 0 ; (LHS = 0)

DFREq(1,2).. - 43.8020833333334\*Volume(1,2) + DFR(1,2) =E= 0 ; (LHS = 0)

DFREq(1,3).. - 43.8020833333334\*Volume(1,3) + DFR(1,3) =E= 0 ; (LHS = 0)

REMAINING 84 ENTRIES SKIPPED

---- CF01 =E=

CF01(1).. CF\_NoOfModules(1) - 1.15740740740741\*Volume(1,1) =E= 0 ; (LHS = 0)

CF01(2).. CF\_NoOfModules(2) - 1.15740740740741\*Volume(2,1) =E= 0 ; (LHS = 0)

CF01(3).. CF\_NoOfModules(3) - 1.15740740740741\*Volume(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF03 =E=

CF03(1).. CF\_MFF(1) - 1.00671140939597\*DFR(1,1) =E= 0 ; (LHS = 0)

CF03(2).. CF\_MFF(2) - 1.00671140939597\*DFR(2,1) =E= 0 ; (LHS = 0)

CF03(3).. CF\_MFF(3) - 1.00671140939597\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF04 =E=

CF04(1).. CF\_BackwashFlow(1) - CF\_MFF(1) + DFR(1,1) =E= 0 ; (LHS = 0)

CF04(2).. CF\_BackwashFlow(2) - CF\_MFF(2) + DFR(2,1) =E= 0 ; (LHS = 0)

CF04(3).. CF\_BackwashFlow(3) - CF\_MFF(3) + DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF05 =E=

CF05(1).. CF\_FeedPumpHP(1) - 0.346809353943718\*CF\_MFF(1) =E= 0 ; (LHS = 0)

CF05(2).. CF\_FeedPumpHP(2) - 0.346809353943718\*CF\_MFF(2) =E= 0 ; (LHS = 0)

CF05(3).. CF\_FeedPumpHP(3) - 0.346809353943718\*CF\_MFF(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF06 =E=

CF06(1).. - 6534.96\*CF\_FeedPumpHP(1) + CF\_FeedPumpPower(1) =E= 0 ; (LHS = 0)

CF06(2).. - 6534.96\*CF\_FeedPumpHP(2) + CF\_FeedPumpPower(2) =E= 0 ; (LHS = 0)

CF06(3).. - 6534.96\*CF\_FeedPumpHP(3) + CF\_FeedPumpPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF07 =E=

CF07(1).. - 43.508\*CF\_FeedPumpHP(1) + CF\_BackflushPower(1) =E= 0 ; (LHS = 0)

CF07(2).. - 43.508\*CF\_FeedPumpHP(2) + CF\_BackflushPower(2) =E= 0 ; (LHS = 0)

CF07(3).. - 43.508\*CF\_FeedPumpHP(3) + CF\_BackflushPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF08 =E=

CF08(1).. - 90\*CF\_NoOfModules(1) + CF\_NoOfMembranes(1) =E= 0 ; (LHS = 0)

CF08(2).. - 90\*CF\_NoOfModules(2) + CF\_NoOfMembranes(2) =E= 0 ; (LHS = 0)

CF08(3).. - 90\*CF\_NoOfModules(3) + CF\_NoOfMembranes(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF09 =E=

CF09(1).. CF\_BuildingArea(1) - 1.060338816\*DFR(1,1) =E= 0 ; (LHS = 0)

CF09(2).. CF\_BuildingArea(2) - 1.060338816\*DFR(2,1) =E= 0 ; (LHS = 0)

CF09(3).. CF\_BuildingArea(3) - 1.060338816\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF10 =E=

CF10(1).. - 370000\*CF\_NoOfModules(1) + CF\_MembraneModuleCost(1) =E= 0 ;

(LHS = 0)

CF10(2).. - 370000\*CF\_NoOfModules(2) + CF\_MembraneModuleCost(2) =E= 0 ;

(LHS = 0)

CF10(3).. - 370000\*CF\_NoOfModules(3) + CF\_MembraneModuleCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF11 =E=

CF11(1).. - 1076\*CF\_BuildingArea(1) + CF\_BuildingCost(1) =E= 0 ; (LHS = 0)

CF11(2).. - 1076\*CF\_BuildingArea(2) + CF\_BuildingCost(2) =E= 0 ; (LHS = 0)

CF11(3).. - 1076\*CF\_BuildingArea(3) + CF\_BuildingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF12 =E=

CF12(1).. - 70000\*CF\_NoOfModules(1) + CF\_InstallationCost(1) =E= 0 ; (LHS = 0)

CF12(2).. - 70000\*CF\_NoOfModules(2) + CF\_InstallationCost(2) =E= 0 ; (LHS = 0)

CF12(3).. - 70000\*CF\_NoOfModules(3) + CF\_InstallationCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF13 =E=

CF13(1).. - 0.05\*CF\_MembraneModuleCost(1) + CF\_MiscCost(1) =E= 0 ; (LHS = 0)

CF13(2).. - 0.05\*CF\_MembraneModuleCost(2) + CF\_MiscCost(2) =E= 0 ; (LHS = 0)

CF13(3).. - 0.05\*CF\_MembraneModuleCost(3) + CF\_MiscCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF14 =E=

CF14(1).. - 0.05\*CF\_MembraneModuleCost(1) - 0.05\*CF\_MiscCost(1)

+ CF\_PlantPipingCost(1) =E= 0 ; (LHS = 0)

CF14(2).. - 0.05\*CF\_MembraneModuleCost(2) - 0.05\*CF\_MiscCost(2)

+ CF\_PlantPipingCost(2) =E= 0 ; (LHS = 0)

CF14(3).. - 0.05\*CF\_MembraneModuleCost(3) - 0.05\*CF\_MiscCost(3)

+ CF\_PlantPipingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF15 =E=

CF15(1).. - 0.1\*CF\_MembraneModuleCost(1) - 0.1\*CF\_MiscCost(1)

+ CF\_EngineeringCost(1) =E= 0 ; (LHS = 0)

CF15(2).. - 0.1\*CF\_MembraneModuleCost(2) - 0.1\*CF\_MiscCost(2)

+ CF\_EngineeringCost(2) =E= 0 ; (LHS = 0)

CF15(3).. - 0.1\*CF\_MembraneModuleCost(3) - 0.1\*CF\_MiscCost(3)

+ CF\_EngineeringCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF16 =E=

CF16(1).. - CF\_MembraneModuleCost(1) - CF\_BuildingCost(1)

- CF\_InstallationCost(1) - CF\_MiscCost(1) - CF\_PlantPipingCost(1)

- CF\_EngineeringCost(1) + CF\_DirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF16(2).. - CF\_MembraneModuleCost(2) - CF\_BuildingCost(2)

- CF\_InstallationCost(2) - CF\_MiscCost(2) - CF\_PlantPipingCost(2)

- CF\_EngineeringCost(2) + CF\_DirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF16(3).. - CF\_MembraneModuleCost(3) - CF\_BuildingCost(3)

- CF\_InstallationCost(3) - CF\_MiscCost(3) - CF\_PlantPipingCost(3)

- CF\_EngineeringCost(3) + CF\_DirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF17 =E=

CF17(1).. - 0.06\*CF\_DirectCapitalCost(1) + CF\_ConstructionInterest(1) =E= 0 ;

(LHS = 0)

CF17(2).. - 0.06\*CF\_DirectCapitalCost(2) + CF\_ConstructionInterest(2) =E= 0 ;

(LHS = 0)

CF17(3).. - 0.06\*CF\_DirectCapitalCost(3) + CF\_ConstructionInterest(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF18 =E=

CF18(1).. - 0.2\*CF\_DirectCapitalCost(1) + CF\_Contingencies(1) =E= 0 ; (LHS = 0)

CF18(2).. - 0.2\*CF\_DirectCapitalCost(2) + CF\_Contingencies(2) =E= 0 ; (LHS = 0)

CF18(3).. - 0.2\*CF\_DirectCapitalCost(3) + CF\_Contingencies(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF19 =E=

CF19(1).. - 0.1\*CF\_DirectCapitalCost(1) + CF\_ProjectManagement(1) =E= 0 ;

(LHS = 0)

CF19(2).. - 0.1\*CF\_DirectCapitalCost(2) + CF\_ProjectManagement(2) =E= 0 ;

(LHS = 0)

CF19(3).. - 0.1\*CF\_DirectCapitalCost(3) + CF\_ProjectManagement(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF20 =E=

CF20(1).. - 0.04\*CF\_DirectCapitalCost(1) + CF\_WorkingCapital(1) =E= 0 ;

(LHS = 0)

CF20(2).. - 0.04\*CF\_DirectCapitalCost(2) + CF\_WorkingCapital(2) =E= 0 ;

(LHS = 0)

CF20(3).. - 0.04\*CF\_DirectCapitalCost(3) + CF\_WorkingCapital(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF21 =E=

CF21(1).. - CF\_ConstructionInterest(1) - CF\_Contingencies(1)

- CF\_ProjectManagement(1) - CF\_WorkingCapital(1)

+ CF\_IndirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF21(2).. - CF\_ConstructionInterest(2) - CF\_Contingencies(2)

- CF\_ProjectManagement(2) - CF\_WorkingCapital(2)

+ CF\_IndirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF21(3).. - CF\_ConstructionInterest(3) - CF\_Contingencies(3)

- CF\_ProjectManagement(3) - CF\_WorkingCapital(3)

+ CF\_IndirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF22 =E=

CF22(1).. - CF\_DirectCapitalCost(1) - CF\_IndirectCapitalCost(1)

+ CF\_TotalConstructionCost(1) =E= 0 ; (LHS = 0)

CF22(2).. - CF\_DirectCapitalCost(2) - CF\_IndirectCapitalCost(2)

+ CF\_TotalConstructionCost(2) =E= 0 ; (LHS = 0)

CF22(3).. - CF\_DirectCapitalCost(3) - CF\_IndirectCapitalCost(3)

+ CF\_TotalConstructionCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF23 =E=

CF23(1).. - 0.101419287142\*CF\_FeedPumpPower(1)

- 0.101419287142\*CF\_BackflushPower(1) + CF\_ElectricityCost(1) =E= 0 ;

(LHS = 0)

CF23(2).. - 0.101419287142\*CF\_FeedPumpPower(2)

- 0.101419287142\*CF\_BackflushPower(2) + CF\_ElectricityCost(2) =E= 0 ;

(LHS = 0)

CF23(3).. - 0.101419287142\*CF\_FeedPumpPower(3)

- 0.101419287142\*CF\_BackflushPower(3) + CF\_ElectricityCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF24 =E=

CF24(1).. CF\_LaborCost(1) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(2).. CF\_LaborCost(2) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(3).. CF\_LaborCost(3) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF25 =E=

CF25(1).. CF\_ChemicalCost(1) - 54.5005479075767\*DFR(1,1) =E= -318.298020522995

; (LHS = 0, INFES = 318.298020522995 \*\*\*\*)

CF25(2).. CF\_ChemicalCost(2) - 54.5005479075767\*DFR(2,1) =E= -318.298020522995

; (LHS = 0, INFES = 318.298020522995 \*\*\*\*)

CF25(3).. CF\_ChemicalCost(3) - 54.5005479075767\*DFR(3,1) =E= -318.298020522995

; (LHS = 0, INFES = 318.298020522995 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF26 =E=

CF26(1).. - 102.244809002143\*CF\_NoOfMembranes(1)

+ CF\_MembraneReplacementCost(1) =E= 0 ; (LHS = 0)

CF26(2).. - 102.244809002143\*CF\_NoOfMembranes(2)

+ CF\_MembraneReplacementCost(2) =E= 0 ; (LHS = 0)

CF26(3).. - 102.244809002143\*CF\_NoOfMembranes(3)

+ CF\_MembraneReplacementCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF27 =E=

CF27(1).. CF\_CleaningChemicalCost(1) - 10.9001095815153\*DFR(1,1) =E=

63.6599860626055 ; (LHS = 0, INFES = 63.6599860626055 \*\*\*\*)

CF27(2).. CF\_CleaningChemicalCost(2) - 10.9001095815153\*DFR(2,1) =E=

63.6599860626055 ; (LHS = 0, INFES = 63.6599860626055 \*\*\*\*)

CF27(3).. CF\_CleaningChemicalCost(3) - 10.9001095815153\*DFR(3,1) =E=

63.6599860626055 ; (LHS = 0, INFES = 63.6599860626055 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF28 =E=

CF28(1).. - 0.02\*CF\_DirectCapitalCost(1) + CF\_Repairs(1) =E= 0 ; (LHS = 0)

CF28(2).. - 0.02\*CF\_DirectCapitalCost(2) + CF\_Repairs(2) =E= 0 ; (LHS = 0)

CF28(3).. - 0.02\*CF\_DirectCapitalCost(3) + CF\_Repairs(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF29 =E=

CF29(1).. - CF\_ElectricityCost(1) - CF\_LaborCost(1) - CF\_ChemicalCost(1)

- CF\_MembraneReplacementCost(1) - CF\_CleaningChemicalCost(1)

- CF\_Repairs(1) + CF\_TotalOMCost(1) =E= 0 ; (LHS = 0)

CF29(2).. - CF\_ElectricityCost(2) - CF\_LaborCost(2) - CF\_ChemicalCost(2)

- CF\_MembraneReplacementCost(2) - CF\_CleaningChemicalCost(2)

- CF\_Repairs(2) + CF\_TotalOMCost(2) =E= 0 ; (LHS = 0)

CF29(3).. - CF\_ElectricityCost(3) - CF\_LaborCost(3) - CF\_ChemicalCost(3)

- CF\_MembraneReplacementCost(3) - CF\_CleaningChemicalCost(3)

- CF\_Repairs(3) + CF\_TotalOMCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF30 =E=

CF30(1).. - 0.101852208823151\*CF\_TotalConstructionCost(1)

+ CF\_CapitalRecovery(1) =E= 0 ; (LHS = 0)

CF30(2).. - 0.101852208823151\*CF\_TotalConstructionCost(2)

+ CF\_CapitalRecovery(2) =E= 0 ; (LHS = 0)

CF30(3).. - 0.101852208823151\*CF\_TotalConstructionCost(3)

+ CF\_CapitalRecovery(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF31 =E=

CF31(1).. - 2\*CF\_TotalOMCost(1) - 2\*CF\_CapitalRecovery(1) + CF\_AnnualCost(1)

=E= 0 ; (LHS = 0)

CF31(2).. - 2\*CF\_TotalOMCost(2) - 2\*CF\_CapitalRecovery(2) + CF\_AnnualCost(2)

=E= 0 ; (LHS = 0)

CF31(3).. - 2\*CF\_TotalOMCost(3) - 2\*CF\_CapitalRecovery(3) + CF\_AnnualCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC01 =E=

GAC01(1).. GAC\_CapitalCost(1) - (7.37701051584E16)\*Volume(1,2) =E= 0 ;

(LHS = 0)

GAC01(2).. GAC\_CapitalCost(2) - (7.37701051584E16)\*Volume(2,2) =E= 0 ;

(LHS = 0)

GAC01(3).. GAC\_CapitalCost(3) - (7.37701051584E16)\*Volume(3,2) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC02 =E=

GAC02(1).. GAC\_OMCost(1) - (8.53307527956E15)\*Volume(1,2) =E= 0 ; (LHS = 0)

GAC02(2).. GAC\_OMCost(2) - (8.53307527956E15)\*Volume(2,2) =E= 0 ; (LHS = 0)

GAC02(3).. GAC\_OMCost(3) - (8.53307527956E15)\*Volume(3,2) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC03 =E=

GAC03(1).. - GAC\_CapitalCost(1) - GAC\_OMCost(1) + GAC\_TotalCost(1) =E= 0 ;

(LHS = 0)

GAC03(2).. - GAC\_CapitalCost(2) - GAC\_OMCost(2) + GAC\_TotalCost(2) =E= 0 ;

(LHS = 0)

GAC03(3).. - GAC\_CapitalCost(3) - GAC\_OMCost(3) + GAC\_TotalCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX01 =E=

IX01(1).. IX\_MinResinVolume(1) - 0.18\*DFR(1,3) =E= 0 ; (LHS = 0)

IX01(2).. IX\_MinResinVolume(2) - 0.18\*DFR(2,3) =E= 0 ; (LHS = 0)

IX01(3).. IX\_MinResinVolume(3) - 0.18\*DFR(3,3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX02 =E=

IX02(1).. IX\_MinVolExhaustionTime(1) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(2).. IX\_MinVolExhaustionTime(2) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(3).. IX\_MinVolExhaustionTime(3) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX04 =E=

IX04(1).. IX\_ExhaustionTimeResinVolume(1) - 0.0156384\*DFR(1,3) =E= 0 ;

(LHS = 0)

IX04(2).. IX\_ExhaustionTimeResinVolume(2) - 0.0156384\*DFR(2,3) =E= 0 ;

(LHS = 0)

IX04(3).. IX\_ExhaustionTimeResinVolume(3) - 0.0156384\*DFR(3,3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX05 =E=

IX05(1).. - 2\*IX\_ExhaustionTimeResinVolume(1) + IX\_VesselVolume(1) =E= 0 ;

(LHS = 0)

IX05(2).. - 2\*IX\_ExhaustionTimeResinVolume(2) + IX\_VesselVolume(2) =E= 0 ;

(LHS = 0)

IX05(3).. - 2\*IX\_ExhaustionTimeResinVolume(3) + IX\_VesselVolume(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX06 =E=

IX06(1).. - 1535.88182932\*IX\_ExhaustionTimeResinVolume(1) + IX\_ResinCost(1)

=E= 0 ; (LHS = 0)

IX06(2).. - 1535.88182932\*IX\_ExhaustionTimeResinVolume(2) + IX\_ResinCost(2)

=E= 0 ; (LHS = 0)

IX06(3).. - 1535.88182932\*IX\_ExhaustionTimeResinVolume(3) + IX\_ResinCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX07 =E=

IX07(1).. - (159592.073548155)\*IX\_VesselVolume(1) + IX\_TankTotalCost(1) =E= 0 ;

(LHS = -2.58261792165373, INFES = 2.58261792165373 \*\*\*\*)

IX07(2).. - (159592.073548155)\*IX\_VesselVolume(2) + IX\_TankTotalCost(2) =E= 0 ;

(LHS = -2.58261792165373, INFES = 2.58261792165373 \*\*\*\*)

IX07(3).. - (159592.073548155)\*IX\_VesselVolume(3) + IX\_TankTotalCost(3) =E= 0 ;

(LHS = -2.58261792165373, INFES = 2.58261792165373 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX08 =E=

IX08(1).. - 150\*IX\_ExhaustionTimeResinVolume(1) + IX\_NaClReq(1) =E= 0 ;

(LHS = 0)

IX08(2).. - 150\*IX\_ExhaustionTimeResinVolume(2) + IX\_NaClReq(2) =E= 0 ;

(LHS = 0)

IX08(3).. - 150\*IX\_ExhaustionTimeResinVolume(3) + IX\_NaClReq(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX09 =E=

IX09(1).. - 0.01\*IX\_NaClReq(1) + IX\_RegFluidReq(1) =E= 0 ; (LHS = 0)

IX09(2).. - 0.01\*IX\_NaClReq(2) + IX\_RegFluidReq(2) =E= 0 ; (LHS = 0)

IX09(3).. - 0.01\*IX\_NaClReq(3) + IX\_RegFluidReq(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX10 =E=

IX10(1).. - 3.65\*IX\_NaClReq(1) + IX\_TotalChemCost(1) =E= 0 ; (LHS = 0)

IX10(2).. - 3.65\*IX\_NaClReq(2) + IX\_TotalChemCost(2) =E= 0 ; (LHS = 0)

IX10(3).. - 3.65\*IX\_NaClReq(3) + IX\_TotalChemCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX11 =E=

IX11(1).. - 250\*IX\_RegFluidReq(1) + IX\_StorageTankCost(1) =E= 0 ; (LHS = 0)

IX11(2).. - 250\*IX\_RegFluidReq(2) + IX\_StorageTankCost(2) =E= 0 ; (LHS = 0)

IX11(3).. - 250\*IX\_RegFluidReq(3) + IX\_StorageTankCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX12 =E=

IX12(1).. - (2500000000)\*IX\_VesselVolume(1) + IX\_BedArea(1) =E= 0 ; (LHS = 0)

IX12(2).. - (2500000000)\*IX\_VesselVolume(2) + IX\_BedArea(2) =E= 0 ; (LHS = 0)

IX12(3).. - (2500000000)\*IX\_VesselVolume(3) + IX\_BedArea(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX13 =E=

IX13(1).. - (1254.21)\*IX\_BedArea(1) + IX\_ConstructionCost(1) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(2).. - (1254.21)\*IX\_BedArea(2) + IX\_ConstructionCost(2) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(3).. - (1254.21)\*IX\_BedArea(3) + IX\_ConstructionCost(3) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX14 =E=

IX14(1).. - (733000000000)\*IX\_BedArea(1) + IX\_OMCost(1) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(2).. - (733000000000)\*IX\_BedArea(2) + IX\_OMCost(2) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(3).. - (733000000000)\*IX\_BedArea(3) + IX\_OMCost(3) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX15 =E=

IX15(1).. - 24\*IX\_ResinCost(1) - IX\_TankTotalCost(1) - IX\_TotalChemCost(1)

- IX\_StorageTankCost(1) - IX\_ConstructionCost(1) - IX\_OMCost(1)

+ IX\_TotalCost(1) =E= 0 ; (LHS = 0)

IX15(2).. - 24\*IX\_ResinCost(2) - IX\_TankTotalCost(2) - IX\_TotalChemCost(2)

- IX\_StorageTankCost(2) - IX\_ConstructionCost(2) - IX\_OMCost(2)

+ IX\_TotalCost(2) =E= 0 ; (LHS = 0)

IX15(3).. - 24\*IX\_ResinCost(3) - IX\_TankTotalCost(3) - IX\_TotalChemCost(3)

- IX\_StorageTankCost(3) - IX\_ConstructionCost(3) - IX\_OMCost(3)

+ IX\_TotalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost01 =E=

NonlinearTechCost01(1).. - 1E-5\*CF\_AnnualCost(1) + NonlinearTechCost(1,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(2).. - 1E-5\*CF\_AnnualCost(2) + NonlinearTechCost(2,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(3).. - 1E-5\*CF\_AnnualCost(3) + NonlinearTechCost(3,1) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost02 =E=

NonlinearTechCost02(1).. - 1E-5\*GAC\_TotalCost(1) + NonlinearTechCost(1,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(2).. - 1E-5\*GAC\_TotalCost(2) + NonlinearTechCost(2,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(3).. - 1E-5\*GAC\_TotalCost(3) + NonlinearTechCost(3,2) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost03 =E=

NonlinearTechCost03(1).. - 1E-5\*IX\_TotalCost(1) + NonlinearTechCost(1,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(2).. - 1E-5\*IX\_TotalCost(2) + NonlinearTechCost(2,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(3).. - 1E-5\*IX\_TotalCost(3) + NonlinearTechCost(3,3) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE TechProblem Using NLP From line 868

---- CF\_NoOfModules Number of modules

CF\_NoOfModules(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(1)

-90 CF08(1)

-370000 CF10(1)

-70000 CF12(1)

CF\_NoOfModules(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(2)

-90 CF08(2)

-370000 CF10(2)

-70000 CF12(2)

CF\_NoOfModules(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(3)

-90 CF08(3)

-370000 CF10(3)

-70000 CF12(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackwashFlow Backwash flow

CF\_BackwashFlow(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(1)

CF\_BackwashFlow(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(2)

CF\_BackwashFlow(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpHP Feed pump horsepower

CF\_FeedPumpHP(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(1)

-6534.96 CF06(1)

-43.508 CF07(1)

CF\_FeedPumpHP(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(2)

-6534.96 CF06(2)

-43.508 CF07(2)

CF\_FeedPumpHP(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(3)

-6534.96 CF06(3)

-43.508 CF07(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpPower Feed pump power requirement in kWh

CF\_FeedPumpPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(1)

-0.1014 CF23(1)

CF\_FeedPumpPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(2)

-0.1014 CF23(2)

CF\_FeedPumpPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(3)

-0.1014 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackflushPower Backflush power requirement in kWh

CF\_BackflushPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(1)

-0.1014 CF23(1)

CF\_BackflushPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(2)

-0.1014 CF23(2)

CF\_BackflushPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(3)

-0.1014 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MFF Microfiltration feed flow in liters per sec

CF\_MFF(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(1)

-1 CF04(1)

-0.3468 CF05(1)

CF\_MFF(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(2)

-1 CF04(2)

-0.3468 CF05(2)

CF\_MFF(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(3)

-1 CF04(3)

-0.3468 CF05(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_NoOfMembranes Number of membranes used

CF\_NoOfMembranes(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(1)

-102.2448 CF26(1)

CF\_NoOfMembranes(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(2)

-102.2448 CF26(2)

CF\_NoOfMembranes(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(3)

-102.2448 CF26(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingArea Building area for the process implementation

CF\_BuildingArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(1)

-1076 CF11(1)

CF\_BuildingArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(2)

-1076 CF11(2)

CF\_BuildingArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(3)

-1076 CF11(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneModuleCost Membrane module cost

CF\_MembraneModuleCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(1)

-0.05 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MembraneModuleCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(2)

-0.05 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MembraneModuleCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(3)

-0.05 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingCost Building cost - based on the building area

CF\_BuildingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(1)

-1 CF16(1)

CF\_BuildingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(2)

-1 CF16(2)

CF\_BuildingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_InstallationCost Installation cost for the process

CF\_InstallationCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(1)

-1 CF16(1)

CF\_InstallationCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(2)

-1 CF16(2)

CF\_InstallationCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MiscCost Miscellaneous cost (taken as 5% of the module cost)

CF\_MiscCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MiscCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MiscCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_PlantPipingCost Plant piping cost (taken as 5% of the module and misc c

ost)

CF\_PlantPipingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(1)

-1 CF16(1)

CF\_PlantPipingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(2)

-1 CF16(2)

CF\_PlantPipingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_EngineeringCost Engineering cost (taken as 10% of the module and misc c

ost)

CF\_EngineeringCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(1)

-1 CF16(1)

CF\_EngineeringCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(2)

-1 CF16(2)

CF\_EngineeringCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_DirectCapitalCost Total direct capital cost

CF\_DirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(1)

-0.06 CF17(1)

-0.2 CF18(1)

-0.1 CF19(1)

-0.04 CF20(1)

-1 CF22(1)

-0.02 CF28(1)

CF\_DirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(2)

-0.06 CF17(2)

-0.2 CF18(2)

-0.1 CF19(2)

-0.04 CF20(2)

-1 CF22(2)

-0.02 CF28(2)

CF\_DirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(3)

-0.06 CF17(3)

-0.2 CF18(3)

-0.1 CF19(3)

-0.04 CF20(3)

-1 CF22(3)

-0.02 CF28(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ConstructionInterest Expense on interest during construction (taken as

6% of total direct capital cost)

CF\_ConstructionInterest(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(1)

-1 CF21(1)

CF\_ConstructionInterest(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(2)

-1 CF21(2)

CF\_ConstructionInterest(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Contingencies Contingencies (taken as 20% of total direct capital cost)

CF\_Contingencies(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(1)

-1 CF21(1)

CF\_Contingencies(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(2)

-1 CF21(2)

CF\_Contingencies(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ProjectManagement Fees and project management (taken as 10% of total di

rect capital cost)

CF\_ProjectManagement(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(1)

-1 CF21(1)

CF\_ProjectManagement(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(2)

-1 CF21(2)

CF\_ProjectManagement(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_WorkingCapital Working capital (taken as 4% of total direct capital cos

t)

CF\_WorkingCapital(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(1)

-1 CF21(1)

CF\_WorkingCapital(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(2)

-1 CF21(2)

CF\_WorkingCapital(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_IndirectCapitalCost Total indirect capital cost

CF\_IndirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(1)

-1 CF22(1)

CF\_IndirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(2)

-1 CF22(2)

CF\_IndirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(3)

-1 CF22(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalConstructionCost Total (direct and indirect) construction cost

CF\_TotalConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(1)

-0.1019 CF30(1)

CF\_TotalConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(2)

-0.1019 CF30(2)

CF\_TotalConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(3)

-0.1019 CF30(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ElectricityCost Electricity cost for the implementation of the process

CF\_ElectricityCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(1)

-1 CF29(1)

CF\_ElectricityCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(2)

-1 CF29(2)

CF\_ElectricityCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_LaborCost Labor cost for the implementation of the process

CF\_LaborCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(1)

-1 CF29(1)

CF\_LaborCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(2)

-1 CF29(2)

CF\_LaborCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ChemicalCost Chemical cost for the process

CF\_ChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(1)

-1 CF29(1)

CF\_ChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(2)

-1 CF29(2)

CF\_ChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneReplacementCost Membrane replacement cost for the process

CF\_MembraneReplacementCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(1)

-1 CF29(1)

CF\_MembraneReplacementCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(2)

-1 CF29(2)

CF\_MembraneReplacementCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CleaningChemicalCost Cleaning chemical (NaOCl) cost

CF\_CleaningChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(1)

-1 CF29(1)

CF\_CleaningChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(2)

-1 CF29(2)

CF\_CleaningChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Repairs Repairs replacement and misc cost (taken as 2% of the direct ca

pital cost)

CF\_Repairs(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(1)

-1 CF29(1)

CF\_Repairs(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(2)

-1 CF29(2)

CF\_Repairs(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalOMCost Total operating and maintenance cost

CF\_TotalOMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(1)

-2 CF31(1)

CF\_TotalOMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(2)

-2 CF31(2)

CF\_TotalOMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CapitalRecovery Capital recovery - calculate from the total captical co

st

CF\_CapitalRecovery(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(1)

-2 CF31(1)

CF\_CapitalRecovery(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(2)

-2 CF31(2)

CF\_CapitalRecovery(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_AnnualCost Annual cost depending on the Capital recovery and OM cost

CF\_AnnualCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(1)

-1.000000E-5 NonlinearTechCost01(1)

CF\_AnnualCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(2)

-1.000000E-5 NonlinearTechCost01(2)

CF\_AnnualCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(3)

-1.000000E-5 NonlinearTechCost01(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_CapitalCost Capital cost for the activated carbon process

GAC\_CapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(1)

-1 GAC03(1)

GAC\_CapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(2)

-1 GAC03(2)

GAC\_CapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_OMCost Operational and maintenance cost for the activated carbon proce

ss

GAC\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(1)

-1 GAC03(1)

GAC\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(2)

-1 GAC03(2)

GAC\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_TotalCost Total cost for the activated carbon process implementation

GAC\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(1)

-1.000000E-5 NonlinearTechCost02(1)

GAC\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(2)

-1.000000E-5 NonlinearTechCost02(2)

GAC\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(3)

-1.000000E-5 NonlinearTechCost02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinResinVolume Minimum volume of the medium in m3

IX\_MinResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(1)

IX\_MinResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(2)

IX\_MinResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinVolExhaustionTime Minimum volume exhaustion time in days

IX\_MinVolExhaustionTime(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(1)

IX\_MinVolExhaustionTime(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(2)

IX\_MinVolExhaustionTime(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ExhaustionTimeResinVolume Resin volume in m3 for the minimum exhaustion

time

IX\_ExhaustionTimeResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(1)

-2 IX05(1)

-1535.8818 IX06(1)

-150 IX08(1)

IX\_ExhaustionTimeResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(2)

-2 IX05(2)

-1535.8818 IX06(2)

-150 IX08(2)

IX\_ExhaustionTimeResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(3)

-2 IX05(3)

-1535.8818 IX06(3)

-150 IX08(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_VesselVolume Total vessel volume in m3

IX\_VesselVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(1)

(-159592.0735) IX07(1)

(-2.500000E+9) IX12(1)

IX\_VesselVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(2)

(-159592.0735) IX07(2)

(-2.500000E+9) IX12(2)

IX\_VesselVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(3)

(-159592.0735) IX07(3)

(-2.500000E+9) IX12(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ResinCost Total resin cost (in $ per day -- need to check)

IX\_ResinCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(1)

-24 IX15(1)

IX\_ResinCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(2)

-24 IX15(2)

IX\_ResinCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(3)

-24 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_BedArea Bed area for the vessel in m2

IX\_BedArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(1)

(-1254.21) IX13(1)

(-7.33000E+11) IX14(1)

IX\_BedArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(2)

(-1254.21) IX13(2)

(-7.33000E+11) IX14(2)

IX\_BedArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(3)

(-1254.21) IX13(3)

(-7.33000E+11) IX14(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TankTotalCost Total Tank cost in $

IX\_TankTotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(1)

-1 IX15(1)

IX\_TankTotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(2)

-1 IX15(2)

IX\_TankTotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_NaClReq NaCl requirement in Kg per day

IX\_NaClReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(1)

-0.01 IX09(1)

-3.65 IX10(1)

IX\_NaClReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(2)

-0.01 IX09(2)

-3.65 IX10(2)

IX\_NaClReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(3)

-0.01 IX09(3)

-3.65 IX10(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalChemCost Total chemical cost per year

IX\_TotalChemCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(1)

-1 IX15(1)

IX\_TotalChemCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(2)

-1 IX15(2)

IX\_TotalChemCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_RegFluidReq Regeneration fluid requirement

IX\_RegFluidReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(1)

-250 IX11(1)

IX\_RegFluidReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(2)

-250 IX11(2)

IX\_RegFluidReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(3)

-250 IX11(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_StorageTankCost Storage tank cost

IX\_StorageTankCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(1)

-1 IX15(1)

IX\_StorageTankCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(2)

-1 IX15(2)

IX\_StorageTankCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ConstructionCost Construction cost

IX\_ConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(1)

-1 IX15(1)

IX\_ConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(2)

-1 IX15(2)

IX\_ConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_OMCost Operating and maintenance cost

IX\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(1)

-1 IX15(1)

IX\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(2)

-1 IX15(2)

IX\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalCost Total cost for the implementation of ion exchange process for

each industry

IX\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(1)

-1.000000E-5 NonlinearTechCost03(1)

IX\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(2)

-1.000000E-5 NonlinearTechCost03(2)

IX\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(3)

-1.000000E-5 NonlinearTechCost03(3)

REMAINING 26 ENTRIES SKIPPED

---- Tobj Objective function for the technoogy only problem

Tobj

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 Tobjective

---- Volume volume of waste treated by each industry using each technology (def

ined over i and j)

Volume(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0028 Tc2(1)

-43.8021 DFREq(1,1)

-1.1574 CF01(1)

Volume(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0041 Tc2(1)

-43.8021 DFREq(1,2)

(-7.37701E+16) GAC01(1)

(-8.53308E+15) GAC02(1)

Volume(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0014 Tc2(1)

-43.8021 DFREq(1,3)

REMAINING 84 ENTRIES SKIPPED

---- DFR Desired flow rate for the industry in liters per sec

DFR(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,1)

-1.0067 CF03(1)

1 CF04(1)

-1.0603 CF09(1)

-54.5005 CF25(1)

-10.9001 CF27(1)

DFR(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,2)

DFR(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,3)

-0.18 IX01(1)

-0.0156 IX04(1)

REMAINING 84 ENTRIES SKIPPED

---- NonlinearTechCost

NonlinearTechCost(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost01(1)

NonlinearTechCost(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost02(1)

NonlinearTechCost(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost03(1)

REMAINING 84 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE TechProblem Using NLP From line 868

LOOPS FOR/WHILE 1

FOR/WHILE 9

MODEL STATISTICS

BLOCKS OF EQUATIONS 54 SINGLE EQUATIONS 1,596

BLOCKS OF VARIABLES 51 SINGLE VARIABLES 1,625

NON ZERO ELEMENTS 4,003 NON LINEAR N-Z 174

DERIVATIVE POOL 10 CONSTANT POOL 31

CODE LENGTH 1,508

GENERATION TIME = 0.015 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.015 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 9

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE TechProblem Using NLP From line 868

S O L V E S U M M A R Y

MODEL TechProblem OBJECTIVE Tobj

TYPE NLP DIRECTION MINIMIZE

SOLVER CONOPT FROM LINE 868

\*\*\*\* SOLVER STATUS 7 Licensing Problems

\*\*\*\* MODEL STATUS 11 Licensing Problem

\*\*\*\* OBJECTIVE VALUE NA

RESOURCE USAGE, LIMIT 0.000 1000.000

ITERATION COUNT, LIMIT 0 2000000000

EVALUATION ERRORS 0 0

CONOPT 3 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

\*\*\* No license found

\*\*\* To update your license, please contact your distributor.

\*\*\* Too many equations for demo mode

\*\*\* Number of equations : 1596

\*\*\* Maximum allowed : 300

\*\*\* Too many variables for demo mode

\*\*\* Number of variables : 1625

\*\*\* Maximum allowed : 300

\*\*\* Too many nonzero elements for demo mode

\*\*\* Number of nonzeros : 4003

\*\*\* Maximum allowed : 2000

No solution returned

GAMS 24.1.3 r41464 Released Jul 26, 2013 WEX-WEI x86\_64/MS Windows 01/19/16 16:16:30 Page 38

G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE TechProblem Using NLP From line 868

---- Tobjective =E=

Tobjective.. Tobj - NonlinearTechCost(1,1) - NonlinearTechCost(1,2)

- NonlinearTechCost(1,3) - NonlinearTechCost(2,1) - NonlinearTechCost(2,2)

- NonlinearTechCost(2,3) - NonlinearTechCost(3,1) - NonlinearTechCost(3,2)

- NonlinearTechCost(3,3) - NonlinearTechCost(4,1) - NonlinearTechCost(4,2)

- NonlinearTechCost(4,3) - NonlinearTechCost(5,1) - NonlinearTechCost(5,2)

- NonlinearTechCost(5,3) - NonlinearTechCost(6,1) - NonlinearTechCost(6,2)

- NonlinearTechCost(6,3) - NonlinearTechCost(7,1) - NonlinearTechCost(7,2)

- NonlinearTechCost(7,3) - NonlinearTechCost(8,1) - NonlinearTechCost(8,2)

- NonlinearTechCost(8,3) - NonlinearTechCost(9,1) - NonlinearTechCost(9,2)

- NonlinearTechCost(9,3) - NonlinearTechCost(10,1)

- NonlinearTechCost(10,2) - NonlinearTechCost(10,3)

- NonlinearTechCost(11,1) - NonlinearTechCost(11,2)

- NonlinearTechCost(11,3) - NonlinearTechCost(12,1)

- NonlinearTechCost(12,2) - NonlinearTechCost(12,3)

- NonlinearTechCost(13,1) - NonlinearTechCost(13,2)

- NonlinearTechCost(13,3) - NonlinearTechCost(14,1)

- NonlinearTechCost(14,2) - NonlinearTechCost(14,3)

- NonlinearTechCost(15,1) - NonlinearTechCost(15,2)

- NonlinearTechCost(15,3) - NonlinearTechCost(16,1)

- NonlinearTechCost(16,2) - NonlinearTechCost(16,3)

- NonlinearTechCost(17,1) - NonlinearTechCost(17,2)

- NonlinearTechCost(17,3) - NonlinearTechCost(18,1)

- NonlinearTechCost(18,2) - NonlinearTechCost(18,3)

- NonlinearTechCost(19,1) - NonlinearTechCost(19,2)

- NonlinearTechCost(19,3) - NonlinearTechCost(20,1)

- NonlinearTechCost(20,2) - NonlinearTechCost(20,3)

- NonlinearTechCost(21,1) - NonlinearTechCost(21,2)

- NonlinearTechCost(21,3) - NonlinearTechCost(22,1)

- NonlinearTechCost(22,2) - NonlinearTechCost(22,3)

- NonlinearTechCost(23,1) - NonlinearTechCost(23,2)

- NonlinearTechCost(23,3) - NonlinearTechCost(24,1)

- NonlinearTechCost(24,2) - NonlinearTechCost(24,3)

- NonlinearTechCost(25,1) - NonlinearTechCost(25,2)

- NonlinearTechCost(25,3) - NonlinearTechCost(26,1)

- NonlinearTechCost(26,2) - NonlinearTechCost(26,3)

- NonlinearTechCost(27,1) - NonlinearTechCost(27,2)

- NonlinearTechCost(27,3) - NonlinearTechCost(28,1)

- NonlinearTechCost(28,2) - NonlinearTechCost(28,3)

- NonlinearTechCost(29,1) - NonlinearTechCost(29,2)

- NonlinearTechCost(29,3) =E= 0 ; (LHS = 0)

---- Tc1 =L=

Tc1(1).. Volume(1,1) + Volume(1,2) + Volume(1,3) =L= 46.1 ; (LHS = 0)

Tc1(2).. Volume(2,1) + Volume(2,2) + Volume(2,3) =L= 1.5 ; (LHS = 0)

Tc1(3).. Volume(3,1) + Volume(3,2) + Volume(3,3) =L= 4.6 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- Tc2 =G=

Tc2(1).. 0.002762685\*Volume(1,1) + 0.00414402749999999\*Volume(1,2)

+ 0.0013813425\*Volume(1,3) =G= 0.122832874808418 ;

(LHS = 0, INFES = 0.122832874808418 \*\*\*\*)

Tc2(2).. 0.002762685\*Volume(2,1) + 0.00414402749999999\*Volume(2,2)

+ 0.0013813425\*Volume(2,3) =G= 0.00202831822193877 ;

(LHS = 0, INFES = 0.00202831822193877 \*\*\*\*)

Tc2(3).. 0.002762685\*Volume(3,1) + 0.00414402749999999\*Volume(3,2)

+ 0.0013813425\*Volume(3,3) =G= 0.0100326811806122 ;

(LHS = 0, INFES = 0.0100326811806122 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- DFREq =E=

DFREq(1,1).. - 43.8020833333334\*Volume(1,1) + DFR(1,1) =E= 0 ; (LHS = 0)

DFREq(1,2).. - 43.8020833333334\*Volume(1,2) + DFR(1,2) =E= 0 ; (LHS = 0)

DFREq(1,3).. - 43.8020833333334\*Volume(1,3) + DFR(1,3) =E= 0 ; (LHS = 0)

REMAINING 84 ENTRIES SKIPPED

---- CF01 =E=

CF01(1).. CF\_NoOfModules(1) - 1.15740740740741\*Volume(1,1) =E= 0 ; (LHS = 0)

CF01(2).. CF\_NoOfModules(2) - 1.15740740740741\*Volume(2,1) =E= 0 ; (LHS = 0)

CF01(3).. CF\_NoOfModules(3) - 1.15740740740741\*Volume(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF03 =E=

CF03(1).. CF\_MFF(1) - 1.00671140939597\*DFR(1,1) =E= 0 ; (LHS = 0)

CF03(2).. CF\_MFF(2) - 1.00671140939597\*DFR(2,1) =E= 0 ; (LHS = 0)

CF03(3).. CF\_MFF(3) - 1.00671140939597\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF04 =E=

CF04(1).. CF\_BackwashFlow(1) - CF\_MFF(1) + DFR(1,1) =E= 0 ; (LHS = 0)

CF04(2).. CF\_BackwashFlow(2) - CF\_MFF(2) + DFR(2,1) =E= 0 ; (LHS = 0)

CF04(3).. CF\_BackwashFlow(3) - CF\_MFF(3) + DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF05 =E=

CF05(1).. CF\_FeedPumpHP(1) - 0.346809353943718\*CF\_MFF(1) =E= 0 ; (LHS = 0)

CF05(2).. CF\_FeedPumpHP(2) - 0.346809353943718\*CF\_MFF(2) =E= 0 ; (LHS = 0)

CF05(3).. CF\_FeedPumpHP(3) - 0.346809353943718\*CF\_MFF(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF06 =E=

CF06(1).. - 6534.96\*CF\_FeedPumpHP(1) + CF\_FeedPumpPower(1) =E= 0 ; (LHS = 0)

CF06(2).. - 6534.96\*CF\_FeedPumpHP(2) + CF\_FeedPumpPower(2) =E= 0 ; (LHS = 0)

CF06(3).. - 6534.96\*CF\_FeedPumpHP(3) + CF\_FeedPumpPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF07 =E=

CF07(1).. - 43.508\*CF\_FeedPumpHP(1) + CF\_BackflushPower(1) =E= 0 ; (LHS = 0)

CF07(2).. - 43.508\*CF\_FeedPumpHP(2) + CF\_BackflushPower(2) =E= 0 ; (LHS = 0)

CF07(3).. - 43.508\*CF\_FeedPumpHP(3) + CF\_BackflushPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF08 =E=

CF08(1).. - 90\*CF\_NoOfModules(1) + CF\_NoOfMembranes(1) =E= 0 ; (LHS = 0)

CF08(2).. - 90\*CF\_NoOfModules(2) + CF\_NoOfMembranes(2) =E= 0 ; (LHS = 0)

CF08(3).. - 90\*CF\_NoOfModules(3) + CF\_NoOfMembranes(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF09 =E=

CF09(1).. CF\_BuildingArea(1) - 1.060338816\*DFR(1,1) =E= 0 ; (LHS = 0)

CF09(2).. CF\_BuildingArea(2) - 1.060338816\*DFR(2,1) =E= 0 ; (LHS = 0)

CF09(3).. CF\_BuildingArea(3) - 1.060338816\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF10 =E=

CF10(1).. - 370000\*CF\_NoOfModules(1) + CF\_MembraneModuleCost(1) =E= 0 ;

(LHS = 0)

CF10(2).. - 370000\*CF\_NoOfModules(2) + CF\_MembraneModuleCost(2) =E= 0 ;

(LHS = 0)

CF10(3).. - 370000\*CF\_NoOfModules(3) + CF\_MembraneModuleCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF11 =E=

CF11(1).. - 1076\*CF\_BuildingArea(1) + CF\_BuildingCost(1) =E= 0 ; (LHS = 0)

CF11(2).. - 1076\*CF\_BuildingArea(2) + CF\_BuildingCost(2) =E= 0 ; (LHS = 0)

CF11(3).. - 1076\*CF\_BuildingArea(3) + CF\_BuildingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF12 =E=

CF12(1).. - 70000\*CF\_NoOfModules(1) + CF\_InstallationCost(1) =E= 0 ; (LHS = 0)

CF12(2).. - 70000\*CF\_NoOfModules(2) + CF\_InstallationCost(2) =E= 0 ; (LHS = 0)

CF12(3).. - 70000\*CF\_NoOfModules(3) + CF\_InstallationCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF13 =E=

CF13(1).. - 0.05\*CF\_MembraneModuleCost(1) + CF\_MiscCost(1) =E= 0 ; (LHS = 0)

CF13(2).. - 0.05\*CF\_MembraneModuleCost(2) + CF\_MiscCost(2) =E= 0 ; (LHS = 0)

CF13(3).. - 0.05\*CF\_MembraneModuleCost(3) + CF\_MiscCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF14 =E=

CF14(1).. - 0.05\*CF\_MembraneModuleCost(1) - 0.05\*CF\_MiscCost(1)

+ CF\_PlantPipingCost(1) =E= 0 ; (LHS = 0)

CF14(2).. - 0.05\*CF\_MembraneModuleCost(2) - 0.05\*CF\_MiscCost(2)

+ CF\_PlantPipingCost(2) =E= 0 ; (LHS = 0)

CF14(3).. - 0.05\*CF\_MembraneModuleCost(3) - 0.05\*CF\_MiscCost(3)

+ CF\_PlantPipingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF15 =E=

CF15(1).. - 0.1\*CF\_MembraneModuleCost(1) - 0.1\*CF\_MiscCost(1)

+ CF\_EngineeringCost(1) =E= 0 ; (LHS = 0)

CF15(2).. - 0.1\*CF\_MembraneModuleCost(2) - 0.1\*CF\_MiscCost(2)

+ CF\_EngineeringCost(2) =E= 0 ; (LHS = 0)

CF15(3).. - 0.1\*CF\_MembraneModuleCost(3) - 0.1\*CF\_MiscCost(3)

+ CF\_EngineeringCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF16 =E=

CF16(1).. - CF\_MembraneModuleCost(1) - CF\_BuildingCost(1)

- CF\_InstallationCost(1) - CF\_MiscCost(1) - CF\_PlantPipingCost(1)

- CF\_EngineeringCost(1) + CF\_DirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF16(2).. - CF\_MembraneModuleCost(2) - CF\_BuildingCost(2)

- CF\_InstallationCost(2) - CF\_MiscCost(2) - CF\_PlantPipingCost(2)

- CF\_EngineeringCost(2) + CF\_DirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF16(3).. - CF\_MembraneModuleCost(3) - CF\_BuildingCost(3)

- CF\_InstallationCost(3) - CF\_MiscCost(3) - CF\_PlantPipingCost(3)

- CF\_EngineeringCost(3) + CF\_DirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF17 =E=

CF17(1).. - 0.06\*CF\_DirectCapitalCost(1) + CF\_ConstructionInterest(1) =E= 0 ;

(LHS = 0)

CF17(2).. - 0.06\*CF\_DirectCapitalCost(2) + CF\_ConstructionInterest(2) =E= 0 ;

(LHS = 0)

CF17(3).. - 0.06\*CF\_DirectCapitalCost(3) + CF\_ConstructionInterest(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF18 =E=

CF18(1).. - 0.2\*CF\_DirectCapitalCost(1) + CF\_Contingencies(1) =E= 0 ; (LHS = 0)

CF18(2).. - 0.2\*CF\_DirectCapitalCost(2) + CF\_Contingencies(2) =E= 0 ; (LHS = 0)

CF18(3).. - 0.2\*CF\_DirectCapitalCost(3) + CF\_Contingencies(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF19 =E=

CF19(1).. - 0.1\*CF\_DirectCapitalCost(1) + CF\_ProjectManagement(1) =E= 0 ;

(LHS = 0)

CF19(2).. - 0.1\*CF\_DirectCapitalCost(2) + CF\_ProjectManagement(2) =E= 0 ;

(LHS = 0)

CF19(3).. - 0.1\*CF\_DirectCapitalCost(3) + CF\_ProjectManagement(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF20 =E=

CF20(1).. - 0.04\*CF\_DirectCapitalCost(1) + CF\_WorkingCapital(1) =E= 0 ;

(LHS = 0)

CF20(2).. - 0.04\*CF\_DirectCapitalCost(2) + CF\_WorkingCapital(2) =E= 0 ;

(LHS = 0)

CF20(3).. - 0.04\*CF\_DirectCapitalCost(3) + CF\_WorkingCapital(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF21 =E=

CF21(1).. - CF\_ConstructionInterest(1) - CF\_Contingencies(1)

- CF\_ProjectManagement(1) - CF\_WorkingCapital(1)

+ CF\_IndirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF21(2).. - CF\_ConstructionInterest(2) - CF\_Contingencies(2)

- CF\_ProjectManagement(2) - CF\_WorkingCapital(2)

+ CF\_IndirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF21(3).. - CF\_ConstructionInterest(3) - CF\_Contingencies(3)

- CF\_ProjectManagement(3) - CF\_WorkingCapital(3)

+ CF\_IndirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF22 =E=

CF22(1).. - CF\_DirectCapitalCost(1) - CF\_IndirectCapitalCost(1)

+ CF\_TotalConstructionCost(1) =E= 0 ; (LHS = 0)

CF22(2).. - CF\_DirectCapitalCost(2) - CF\_IndirectCapitalCost(2)

+ CF\_TotalConstructionCost(2) =E= 0 ; (LHS = 0)

CF22(3).. - CF\_DirectCapitalCost(3) - CF\_IndirectCapitalCost(3)

+ CF\_TotalConstructionCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF23 =E=

CF23(1).. - 0.092543542478\*CF\_FeedPumpPower(1)

- 0.092543542478\*CF\_BackflushPower(1) + CF\_ElectricityCost(1) =E= 0 ;

(LHS = 0)

CF23(2).. - 0.092543542478\*CF\_FeedPumpPower(2)

- 0.092543542478\*CF\_BackflushPower(2) + CF\_ElectricityCost(2) =E= 0 ;

(LHS = 0)

CF23(3).. - 0.092543542478\*CF\_FeedPumpPower(3)

- 0.092543542478\*CF\_BackflushPower(3) + CF\_ElectricityCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF24 =E=

CF24(1).. CF\_LaborCost(1) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(2).. CF\_LaborCost(2) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(3).. CF\_LaborCost(3) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF25 =E=

CF25(1).. CF\_ChemicalCost(1) - 45.2294991346302\*DFR(1,1) =E= -264.152574543161

; (LHS = 0, INFES = 264.152574543161 \*\*\*\*)

CF25(2).. CF\_ChemicalCost(2) - 45.2294991346302\*DFR(2,1) =E= -264.152574543161

; (LHS = 0, INFES = 264.152574543161 \*\*\*\*)

CF25(3).. CF\_ChemicalCost(3) - 45.2294991346302\*DFR(3,1) =E= -264.152574543161

; (LHS = 0, INFES = 264.152574543161 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF26 =E=

CF26(1).. - 131.921287694597\*CF\_NoOfMembranes(1)

+ CF\_MembraneReplacementCost(1) =E= 0 ; (LHS = 0)

CF26(2).. - 131.921287694597\*CF\_NoOfMembranes(2)

+ CF\_MembraneReplacementCost(2) =E= 0 ; (LHS = 0)

CF26(3).. - 131.921287694597\*CF\_NoOfMembranes(3)

+ CF\_MembraneReplacementCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF27 =E=

CF27(1).. CF\_CleaningChemicalCost(1) - 9.04589982692604\*DFR(1,1) =E=

52.8308318920387 ; (LHS = 0, INFES = 52.8308318920387 \*\*\*\*)

CF27(2).. CF\_CleaningChemicalCost(2) - 9.04589982692604\*DFR(2,1) =E=

52.8308318920387 ; (LHS = 0, INFES = 52.8308318920387 \*\*\*\*)

CF27(3).. CF\_CleaningChemicalCost(3) - 9.04589982692604\*DFR(3,1) =E=

52.8308318920387 ; (LHS = 0, INFES = 52.8308318920387 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF28 =E=

CF28(1).. - 0.02\*CF\_DirectCapitalCost(1) + CF\_Repairs(1) =E= 0 ; (LHS = 0)

CF28(2).. - 0.02\*CF\_DirectCapitalCost(2) + CF\_Repairs(2) =E= 0 ; (LHS = 0)

CF28(3).. - 0.02\*CF\_DirectCapitalCost(3) + CF\_Repairs(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF29 =E=

CF29(1).. - CF\_ElectricityCost(1) - CF\_LaborCost(1) - CF\_ChemicalCost(1)

- CF\_MembraneReplacementCost(1) - CF\_CleaningChemicalCost(1)

- CF\_Repairs(1) + CF\_TotalOMCost(1) =E= 0 ; (LHS = 0)

CF29(2).. - CF\_ElectricityCost(2) - CF\_LaborCost(2) - CF\_ChemicalCost(2)

- CF\_MembraneReplacementCost(2) - CF\_CleaningChemicalCost(2)

- CF\_Repairs(2) + CF\_TotalOMCost(2) =E= 0 ; (LHS = 0)

CF29(3).. - CF\_ElectricityCost(3) - CF\_LaborCost(3) - CF\_ChemicalCost(3)

- CF\_MembraneReplacementCost(3) - CF\_CleaningChemicalCost(3)

- CF\_Repairs(3) + CF\_TotalOMCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF30 =E=

CF30(1).. - 0.101852208823151\*CF\_TotalConstructionCost(1)

+ CF\_CapitalRecovery(1) =E= 0 ; (LHS = 0)

CF30(2).. - 0.101852208823151\*CF\_TotalConstructionCost(2)

+ CF\_CapitalRecovery(2) =E= 0 ; (LHS = 0)

CF30(3).. - 0.101852208823151\*CF\_TotalConstructionCost(3)

+ CF\_CapitalRecovery(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF31 =E=

CF31(1).. - 2\*CF\_TotalOMCost(1) - 2\*CF\_CapitalRecovery(1) + CF\_AnnualCost(1)

=E= 0 ; (LHS = 0)

CF31(2).. - 2\*CF\_TotalOMCost(2) - 2\*CF\_CapitalRecovery(2) + CF\_AnnualCost(2)

=E= 0 ; (LHS = 0)

CF31(3).. - 2\*CF\_TotalOMCost(3) - 2\*CF\_CapitalRecovery(3) + CF\_AnnualCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC01 =E=

GAC01(1).. GAC\_CapitalCost(1) - (7.37701051584E16)\*Volume(1,2) =E= 0 ;

(LHS = 0)

GAC01(2).. GAC\_CapitalCost(2) - (7.37701051584E16)\*Volume(2,2) =E= 0 ;

(LHS = 0)

GAC01(3).. GAC\_CapitalCost(3) - (7.37701051584E16)\*Volume(3,2) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC02 =E=

GAC02(1).. GAC\_OMCost(1) - (8.53307527956E15)\*Volume(1,2) =E= 0 ; (LHS = 0)

GAC02(2).. GAC\_OMCost(2) - (8.53307527956E15)\*Volume(2,2) =E= 0 ; (LHS = 0)

GAC02(3).. GAC\_OMCost(3) - (8.53307527956E15)\*Volume(3,2) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC03 =E=

GAC03(1).. - GAC\_CapitalCost(1) - GAC\_OMCost(1) + GAC\_TotalCost(1) =E= 0 ;

(LHS = 0)

GAC03(2).. - GAC\_CapitalCost(2) - GAC\_OMCost(2) + GAC\_TotalCost(2) =E= 0 ;

(LHS = 0)

GAC03(3).. - GAC\_CapitalCost(3) - GAC\_OMCost(3) + GAC\_TotalCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX01 =E=

IX01(1).. IX\_MinResinVolume(1) - 0.18\*DFR(1,3) =E= 0 ; (LHS = 0)

IX01(2).. IX\_MinResinVolume(2) - 0.18\*DFR(2,3) =E= 0 ; (LHS = 0)

IX01(3).. IX\_MinResinVolume(3) - 0.18\*DFR(3,3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX02 =E=

IX02(1).. IX\_MinVolExhaustionTime(1) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(2).. IX\_MinVolExhaustionTime(2) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(3).. IX\_MinVolExhaustionTime(3) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX04 =E=

IX04(1).. IX\_ExhaustionTimeResinVolume(1) - 0.0156384\*DFR(1,3) =E= 0 ;

(LHS = 0)

IX04(2).. IX\_ExhaustionTimeResinVolume(2) - 0.0156384\*DFR(2,3) =E= 0 ;

(LHS = 0)

IX04(3).. IX\_ExhaustionTimeResinVolume(3) - 0.0156384\*DFR(3,3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX05 =E=

IX05(1).. - 2\*IX\_ExhaustionTimeResinVolume(1) + IX\_VesselVolume(1) =E= 0 ;

(LHS = 0)

IX05(2).. - 2\*IX\_ExhaustionTimeResinVolume(2) + IX\_VesselVolume(2) =E= 0 ;

(LHS = 0)

IX05(3).. - 2\*IX\_ExhaustionTimeResinVolume(3) + IX\_VesselVolume(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX06 =E=

IX06(1).. - 1516.1814575484\*IX\_ExhaustionTimeResinVolume(1) + IX\_ResinCost(1)

=E= 0 ; (LHS = 0)

IX06(2).. - 1516.1814575484\*IX\_ExhaustionTimeResinVolume(2) + IX\_ResinCost(2)

=E= 0 ; (LHS = 0)

IX06(3).. - 1516.1814575484\*IX\_ExhaustionTimeResinVolume(3) + IX\_ResinCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX07 =E=

IX07(1).. - (5350122.17055354)\*IX\_VesselVolume(1) + IX\_TankTotalCost(1) =E= 0 ;

(LHS = -115.015960136027, INFES = 115.015960136027 \*\*\*\*)

IX07(2).. - (5350122.17055354)\*IX\_VesselVolume(2) + IX\_TankTotalCost(2) =E= 0 ;

(LHS = -115.015960136027, INFES = 115.015960136027 \*\*\*\*)

IX07(3).. - (5350122.17055354)\*IX\_VesselVolume(3) + IX\_TankTotalCost(3) =E= 0 ;

(LHS = -115.015960136027, INFES = 115.015960136027 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX08 =E=

IX08(1).. - 150\*IX\_ExhaustionTimeResinVolume(1) + IX\_NaClReq(1) =E= 0 ;

(LHS = 0)

IX08(2).. - 150\*IX\_ExhaustionTimeResinVolume(2) + IX\_NaClReq(2) =E= 0 ;

(LHS = 0)

IX08(3).. - 150\*IX\_ExhaustionTimeResinVolume(3) + IX\_NaClReq(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX09 =E=

IX09(1).. - 0.01\*IX\_NaClReq(1) + IX\_RegFluidReq(1) =E= 0 ; (LHS = 0)

IX09(2).. - 0.01\*IX\_NaClReq(2) + IX\_RegFluidReq(2) =E= 0 ; (LHS = 0)

IX09(3).. - 0.01\*IX\_NaClReq(3) + IX\_RegFluidReq(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX10 =E=

IX10(1).. - 3.65\*IX\_NaClReq(1) + IX\_TotalChemCost(1) =E= 0 ; (LHS = 0)

IX10(2).. - 3.65\*IX\_NaClReq(2) + IX\_TotalChemCost(2) =E= 0 ; (LHS = 0)

IX10(3).. - 3.65\*IX\_NaClReq(3) + IX\_TotalChemCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX11 =E=

IX11(1).. - 250\*IX\_RegFluidReq(1) + IX\_StorageTankCost(1) =E= 0 ; (LHS = 0)

IX11(2).. - 250\*IX\_RegFluidReq(2) + IX\_StorageTankCost(2) =E= 0 ; (LHS = 0)

IX11(3).. - 250\*IX\_RegFluidReq(3) + IX\_StorageTankCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX12 =E=

IX12(1).. - (2500000000)\*IX\_VesselVolume(1) + IX\_BedArea(1) =E= 0 ; (LHS = 0)

IX12(2).. - (2500000000)\*IX\_VesselVolume(2) + IX\_BedArea(2) =E= 0 ; (LHS = 0)

IX12(3).. - (2500000000)\*IX\_VesselVolume(3) + IX\_BedArea(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX13 =E=

IX13(1).. - (1254.21)\*IX\_BedArea(1) + IX\_ConstructionCost(1) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(2).. - (1254.21)\*IX\_BedArea(2) + IX\_ConstructionCost(2) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(3).. - (1254.21)\*IX\_BedArea(3) + IX\_ConstructionCost(3) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX14 =E=

IX14(1).. - (733000000000)\*IX\_BedArea(1) + IX\_OMCost(1) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(2).. - (733000000000)\*IX\_BedArea(2) + IX\_OMCost(2) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(3).. - (733000000000)\*IX\_BedArea(3) + IX\_OMCost(3) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX15 =E=

IX15(1).. - 24\*IX\_ResinCost(1) - IX\_TankTotalCost(1) - IX\_TotalChemCost(1)

- IX\_StorageTankCost(1) - IX\_ConstructionCost(1) - IX\_OMCost(1)

+ IX\_TotalCost(1) =E= 0 ; (LHS = 0)

IX15(2).. - 24\*IX\_ResinCost(2) - IX\_TankTotalCost(2) - IX\_TotalChemCost(2)

- IX\_StorageTankCost(2) - IX\_ConstructionCost(2) - IX\_OMCost(2)

+ IX\_TotalCost(2) =E= 0 ; (LHS = 0)

IX15(3).. - 24\*IX\_ResinCost(3) - IX\_TankTotalCost(3) - IX\_TotalChemCost(3)

- IX\_StorageTankCost(3) - IX\_ConstructionCost(3) - IX\_OMCost(3)

+ IX\_TotalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost01 =E=

NonlinearTechCost01(1).. - 1E-5\*CF\_AnnualCost(1) + NonlinearTechCost(1,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(2).. - 1E-5\*CF\_AnnualCost(2) + NonlinearTechCost(2,1) =E= 0

; (LHS = 0)

NonlinearTechCost01(3).. - 1E-5\*CF\_AnnualCost(3) + NonlinearTechCost(3,1) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost02 =E=

NonlinearTechCost02(1).. - 1E-5\*GAC\_TotalCost(1) + NonlinearTechCost(1,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(2).. - 1E-5\*GAC\_TotalCost(2) + NonlinearTechCost(2,2) =E= 0

; (LHS = 0)

NonlinearTechCost02(3).. - 1E-5\*GAC\_TotalCost(3) + NonlinearTechCost(3,2) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- NonlinearTechCost03 =E=

NonlinearTechCost03(1).. - 1E-5\*IX\_TotalCost(1) + NonlinearTechCost(1,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(2).. - 1E-5\*IX\_TotalCost(2) + NonlinearTechCost(2,3) =E= 0

; (LHS = 0)

NonlinearTechCost03(3).. - 1E-5\*IX\_TotalCost(3) + NonlinearTechCost(3,3) =E= 0

; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE TechProblem Using NLP From line 868

---- CF\_NoOfModules Number of modules

CF\_NoOfModules(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(1)

-90 CF08(1)

-370000 CF10(1)

-70000 CF12(1)

CF\_NoOfModules(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(2)

-90 CF08(2)

-370000 CF10(2)

-70000 CF12(2)

CF\_NoOfModules(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(3)

-90 CF08(3)

-370000 CF10(3)

-70000 CF12(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackwashFlow Backwash flow

CF\_BackwashFlow(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(1)

CF\_BackwashFlow(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(2)

CF\_BackwashFlow(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpHP Feed pump horsepower

CF\_FeedPumpHP(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(1)

-6534.96 CF06(1)

-43.508 CF07(1)

CF\_FeedPumpHP(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(2)

-6534.96 CF06(2)

-43.508 CF07(2)

CF\_FeedPumpHP(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(3)

-6534.96 CF06(3)

-43.508 CF07(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpPower Feed pump power requirement in kWh

CF\_FeedPumpPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(1)

-0.0925 CF23(1)

CF\_FeedPumpPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(2)

-0.0925 CF23(2)

CF\_FeedPumpPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(3)

-0.0925 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackflushPower Backflush power requirement in kWh

CF\_BackflushPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(1)

-0.0925 CF23(1)

CF\_BackflushPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(2)

-0.0925 CF23(2)

CF\_BackflushPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(3)

-0.0925 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MFF Microfiltration feed flow in liters per sec

CF\_MFF(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(1)

-1 CF04(1)

-0.3468 CF05(1)

CF\_MFF(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(2)

-1 CF04(2)

-0.3468 CF05(2)

CF\_MFF(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(3)

-1 CF04(3)

-0.3468 CF05(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_NoOfMembranes Number of membranes used

CF\_NoOfMembranes(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(1)

-131.9213 CF26(1)

CF\_NoOfMembranes(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(2)

-131.9213 CF26(2)

CF\_NoOfMembranes(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(3)

-131.9213 CF26(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingArea Building area for the process implementation

CF\_BuildingArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(1)

-1076 CF11(1)

CF\_BuildingArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(2)

-1076 CF11(2)

CF\_BuildingArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(3)

-1076 CF11(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneModuleCost Membrane module cost

CF\_MembraneModuleCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(1)

-0.05 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MembraneModuleCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(2)

-0.05 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MembraneModuleCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(3)

-0.05 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingCost Building cost - based on the building area

CF\_BuildingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(1)

-1 CF16(1)

CF\_BuildingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(2)

-1 CF16(2)

CF\_BuildingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_InstallationCost Installation cost for the process

CF\_InstallationCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(1)

-1 CF16(1)

CF\_InstallationCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(2)

-1 CF16(2)

CF\_InstallationCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MiscCost Miscellaneous cost (taken as 5% of the module cost)

CF\_MiscCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MiscCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MiscCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_PlantPipingCost Plant piping cost (taken as 5% of the module and misc c

ost)

CF\_PlantPipingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(1)

-1 CF16(1)

CF\_PlantPipingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(2)

-1 CF16(2)

CF\_PlantPipingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_EngineeringCost Engineering cost (taken as 10% of the module and misc c

ost)

CF\_EngineeringCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(1)

-1 CF16(1)

CF\_EngineeringCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(2)

-1 CF16(2)

CF\_EngineeringCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_DirectCapitalCost Total direct capital cost

CF\_DirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(1)

-0.06 CF17(1)

-0.2 CF18(1)

-0.1 CF19(1)

-0.04 CF20(1)

-1 CF22(1)

-0.02 CF28(1)

CF\_DirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(2)

-0.06 CF17(2)

-0.2 CF18(2)

-0.1 CF19(2)

-0.04 CF20(2)

-1 CF22(2)

-0.02 CF28(2)

CF\_DirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(3)

-0.06 CF17(3)

-0.2 CF18(3)

-0.1 CF19(3)

-0.04 CF20(3)

-1 CF22(3)

-0.02 CF28(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ConstructionInterest Expense on interest during construction (taken as

6% of total direct capital cost)

CF\_ConstructionInterest(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(1)

-1 CF21(1)

CF\_ConstructionInterest(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(2)

-1 CF21(2)

CF\_ConstructionInterest(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Contingencies Contingencies (taken as 20% of total direct capital cost)

CF\_Contingencies(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(1)

-1 CF21(1)

CF\_Contingencies(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(2)

-1 CF21(2)

CF\_Contingencies(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ProjectManagement Fees and project management (taken as 10% of total di

rect capital cost)

CF\_ProjectManagement(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(1)

-1 CF21(1)

CF\_ProjectManagement(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(2)

-1 CF21(2)

CF\_ProjectManagement(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_WorkingCapital Working capital (taken as 4% of total direct capital cos

t)

CF\_WorkingCapital(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(1)

-1 CF21(1)

CF\_WorkingCapital(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(2)

-1 CF21(2)

CF\_WorkingCapital(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_IndirectCapitalCost Total indirect capital cost

CF\_IndirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(1)

-1 CF22(1)

CF\_IndirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(2)

-1 CF22(2)

CF\_IndirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(3)

-1 CF22(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalConstructionCost Total (direct and indirect) construction cost

CF\_TotalConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(1)

-0.1019 CF30(1)

CF\_TotalConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(2)

-0.1019 CF30(2)

CF\_TotalConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(3)

-0.1019 CF30(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ElectricityCost Electricity cost for the implementation of the process

CF\_ElectricityCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(1)

-1 CF29(1)

CF\_ElectricityCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(2)

-1 CF29(2)

CF\_ElectricityCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_LaborCost Labor cost for the implementation of the process

CF\_LaborCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(1)

-1 CF29(1)

CF\_LaborCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(2)

-1 CF29(2)

CF\_LaborCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ChemicalCost Chemical cost for the process

CF\_ChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(1)

-1 CF29(1)

CF\_ChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(2)

-1 CF29(2)

CF\_ChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneReplacementCost Membrane replacement cost for the process

CF\_MembraneReplacementCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(1)

-1 CF29(1)

CF\_MembraneReplacementCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(2)

-1 CF29(2)

CF\_MembraneReplacementCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CleaningChemicalCost Cleaning chemical (NaOCl) cost

CF\_CleaningChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(1)

-1 CF29(1)

CF\_CleaningChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(2)

-1 CF29(2)

CF\_CleaningChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Repairs Repairs replacement and misc cost (taken as 2% of the direct ca

pital cost)

CF\_Repairs(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(1)

-1 CF29(1)

CF\_Repairs(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(2)

-1 CF29(2)

CF\_Repairs(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalOMCost Total operating and maintenance cost

CF\_TotalOMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(1)

-2 CF31(1)

CF\_TotalOMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(2)

-2 CF31(2)

CF\_TotalOMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CapitalRecovery Capital recovery - calculate from the total captical co

st

CF\_CapitalRecovery(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(1)

-2 CF31(1)

CF\_CapitalRecovery(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(2)

-2 CF31(2)

CF\_CapitalRecovery(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_AnnualCost Annual cost depending on the Capital recovery and OM cost

CF\_AnnualCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(1)

-1.000000E-5 NonlinearTechCost01(1)

CF\_AnnualCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(2)

-1.000000E-5 NonlinearTechCost01(2)

CF\_AnnualCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(3)

-1.000000E-5 NonlinearTechCost01(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_CapitalCost Capital cost for the activated carbon process

GAC\_CapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(1)

-1 GAC03(1)

GAC\_CapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(2)

-1 GAC03(2)

GAC\_CapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_OMCost Operational and maintenance cost for the activated carbon proce

ss

GAC\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(1)

-1 GAC03(1)

GAC\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(2)

-1 GAC03(2)

GAC\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_TotalCost Total cost for the activated carbon process implementation

GAC\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(1)

-1.000000E-5 NonlinearTechCost02(1)

GAC\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(2)

-1.000000E-5 NonlinearTechCost02(2)

GAC\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(3)

-1.000000E-5 NonlinearTechCost02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinResinVolume Minimum volume of the medium in m3

IX\_MinResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(1)

IX\_MinResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(2)

IX\_MinResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinVolExhaustionTime Minimum volume exhaustion time in days

IX\_MinVolExhaustionTime(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(1)

IX\_MinVolExhaustionTime(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(2)

IX\_MinVolExhaustionTime(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ExhaustionTimeResinVolume Resin volume in m3 for the minimum exhaustion

time

IX\_ExhaustionTimeResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(1)

-2 IX05(1)

-1516.1815 IX06(1)

-150 IX08(1)

IX\_ExhaustionTimeResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(2)

-2 IX05(2)

-1516.1815 IX06(2)

-150 IX08(2)

IX\_ExhaustionTimeResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(3)

-2 IX05(3)

-1516.1815 IX06(3)

-150 IX08(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_VesselVolume Total vessel volume in m3

IX\_VesselVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(1)

(-5.350122E+6) IX07(1)

(-2.500000E+9) IX12(1)

IX\_VesselVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(2)

(-5.350122E+6) IX07(2)

(-2.500000E+9) IX12(2)

IX\_VesselVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(3)

(-5.350122E+6) IX07(3)

(-2.500000E+9) IX12(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ResinCost Total resin cost (in $ per day -- need to check)

IX\_ResinCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(1)

-24 IX15(1)

IX\_ResinCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(2)

-24 IX15(2)

IX\_ResinCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(3)

-24 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_BedArea Bed area for the vessel in m2

IX\_BedArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(1)

(-1254.21) IX13(1)

(-7.33000E+11) IX14(1)

IX\_BedArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(2)

(-1254.21) IX13(2)

(-7.33000E+11) IX14(2)

IX\_BedArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(3)

(-1254.21) IX13(3)

(-7.33000E+11) IX14(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TankTotalCost Total Tank cost in $

IX\_TankTotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(1)

-1 IX15(1)

IX\_TankTotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(2)

-1 IX15(2)

IX\_TankTotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_NaClReq NaCl requirement in Kg per day

IX\_NaClReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(1)

-0.01 IX09(1)

-3.65 IX10(1)

IX\_NaClReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(2)

-0.01 IX09(2)

-3.65 IX10(2)

IX\_NaClReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(3)

-0.01 IX09(3)

-3.65 IX10(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalChemCost Total chemical cost per year

IX\_TotalChemCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(1)

-1 IX15(1)

IX\_TotalChemCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(2)

-1 IX15(2)

IX\_TotalChemCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_RegFluidReq Regeneration fluid requirement

IX\_RegFluidReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(1)

-250 IX11(1)

IX\_RegFluidReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(2)

-250 IX11(2)

IX\_RegFluidReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(3)

-250 IX11(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_StorageTankCost Storage tank cost

IX\_StorageTankCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(1)

-1 IX15(1)

IX\_StorageTankCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(2)

-1 IX15(2)

IX\_StorageTankCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ConstructionCost Construction cost

IX\_ConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(1)

-1 IX15(1)

IX\_ConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(2)

-1 IX15(2)

IX\_ConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_OMCost Operating and maintenance cost

IX\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(1)

-1 IX15(1)

IX\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(2)

-1 IX15(2)

IX\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalCost Total cost for the implementation of ion exchange process for

each industry

IX\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(1)

-1.000000E-5 NonlinearTechCost03(1)

IX\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(2)

-1.000000E-5 NonlinearTechCost03(2)

IX\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(3)

-1.000000E-5 NonlinearTechCost03(3)

REMAINING 26 ENTRIES SKIPPED

---- Tobj Objective function for the technoogy only problem

Tobj

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 Tobjective

---- Volume volume of waste treated by each industry using each technology (def

ined over i and j)

Volume(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0028 Tc2(1)

-43.8021 DFREq(1,1)

-1.1574 CF01(1)

Volume(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0041 Tc2(1)

-43.8021 DFREq(1,2)

(-7.37701E+16) GAC01(1)

(-8.53308E+15) GAC02(1)

Volume(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Tc1(1)

0.0014 Tc2(1)

-43.8021 DFREq(1,3)

REMAINING 84 ENTRIES SKIPPED

---- DFR Desired flow rate for the industry in liters per sec

DFR(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,1)

-1.0067 CF03(1)

1 CF04(1)

-1.0603 CF09(1)

-45.2295 CF25(1)

-9.0459 CF27(1)

DFR(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,2)

DFR(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,3)

-0.18 IX01(1)

-0.0156 IX04(1)

REMAINING 84 ENTRIES SKIPPED

---- NonlinearTechCost

NonlinearTechCost(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost01(1)

NonlinearTechCost(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost02(1)

NonlinearTechCost(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

-1 Tobjective

1 NonlinearTechCost03(1)

REMAINING 84 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE TechProblem Using NLP From line 868

LOOPS FOR/WHILE 1

FOR/WHILE 10

MODEL STATISTICS

BLOCKS OF EQUATIONS 54 SINGLE EQUATIONS 1,596

BLOCKS OF VARIABLES 51 SINGLE VARIABLES 1,625

NON ZERO ELEMENTS 4,003 NON LINEAR N-Z 174

DERIVATIVE POOL 10 CONSTANT POOL 31

CODE LENGTH 1,508

GENERATION TIME = 0.000 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.000 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 10

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE TechProblem Using NLP From line 868

S O L V E S U M M A R Y

MODEL TechProblem OBJECTIVE Tobj

TYPE NLP DIRECTION MINIMIZE

SOLVER CONOPT FROM LINE 868

\*\*\*\* SOLVER STATUS 7 Licensing Problems

\*\*\*\* MODEL STATUS 11 Licensing Problem

\*\*\*\* OBJECTIVE VALUE NA

RESOURCE USAGE, LIMIT 0.000 1000.000

ITERATION COUNT, LIMIT 0 2000000000

EVALUATION ERRORS 0 0

CONOPT 3 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

\*\*\* No license found

\*\*\* To update your license, please contact your distributor.

\*\*\* Too many equations for demo mode

\*\*\* Number of equations : 1596

\*\*\* Maximum allowed : 300

\*\*\* Too many variables for demo mode

\*\*\* Number of variables : 1625

\*\*\* Maximum allowed : 300

\*\*\* Too many nonzero elements for demo mode

\*\*\* Number of nonzeros : 4003

\*\*\* Maximum allowed : 2000

No solution returned

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

E x e c u t i o n

---- 883 VARIABLE Tobj.L = 0.00000 Objective function fo

r the technoogy only

problem

---- 883 VARIABLE Volume.L volume of waste treated by each industry using ea

ch technology (defined over i and j)

( ALL 0.00000 )

---- 883 VARIABLE NonlinearTechCost.L

( ALL 0.00000 )

---- 883 PARAMETER CostTechSolution cost incurred by each industry for each

technology due to waste treatment setup

( ALL 0.00000 )

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE MasterProblem Using NLP From line 893

---- Mobj =E= Objective function for the master problem

Mobj.. - Theta + MasterObjective =E= 0 ; (LHS = -10, INFES = 10 \*\*\*\*)

---- Mc1 =L= Limitation on the number of technologies per industry

Mc1(1).. Volume(1,1) + Volume(1,2) + Volume(1,3) =L= 46.1 ; (LHS = 0)

Mc1(2).. Volume(2,1) + Volume(2,2) + Volume(2,3) =L= 1.5 ; (LHS = 0)

Mc1(3).. Volume(3,1) + Volume(3,2) + Volume(3,3) =L= 4.6 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- Mc2 =E= No trading within the industry

Mc2(1).. t(1,1) =E= 0 ; (LHS = 0)

Mc2(2).. t(2,2) =E= 0 ; (LHS = 0)

Mc2(3).. t(3,3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- Mc3 =G= Constrain on the objective based on linear approximation

NONE

---- Mc4 =G= Constraint to satisfy the minimum reduction requirement

Mc4(1).. - 0.1\*t(1,1) + t(1,2) + t(1,3) + t(1,4) + t(1,5) + t(1,6) + t(1,7)

+ t(1,8) + t(1,9) + t(1,10) + t(1,11) + t(1,12) + t(1,13) + t(1,14)

+ t(1,15) + t(1,16) + t(1,17) + t(1,18) + t(1,19) + t(1,20) + t(1,21)

+ t(1,22) + t(1,23) + t(1,24) + t(1,25) + t(1,26) + t(1,27) + t(1,28)

+ t(1,29) - 1.1\*t(2,1) - 1.1\*t(3,1) - 1.1\*t(4,1) - 1.1\*t(5,1) - 1.1\*t(6,1)

- 1.1\*t(7,1) - 1.1\*t(8,1) - 1.1\*t(9,1) - 1.1\*t(10,1) - 1.1\*t(11,1)

- 1.1\*t(12,1) - 1.1\*t(13,1) - 1.1\*t(14,1) - 1.1\*t(15,1) - 1.1\*t(16,1)

- 1.1\*t(17,1) - 1.1\*t(18,1) - 1.1\*t(19,1) - 1.1\*t(20,1) - 1.1\*t(21,1)

- 1.1\*t(22,1) - 1.1\*t(23,1) - 1.1\*t(24,1) - 1.1\*t(25,1) - 1.1\*t(26,1)

- 1.1\*t(27,1) - 1.1\*t(28,1) - 1.1\*t(29,1) + 0.002762685\*Volume(1,1)

+ 0.00414402749999999\*Volume(1,2) + 0.0013813425\*Volume(1,3) =G=

0.122832874808418 ; (LHS = 0, INFES = 0.122832874808418 \*\*\*\*)

Mc4(2).. - 1.1\*t(1,2) + t(2,1) - 0.1\*t(2,2) + t(2,3) + t(2,4) + t(2,5) + t(2,6)

+ t(2,7) + t(2,8) + t(2,9) + t(2,10) + t(2,11) + t(2,12) + t(2,13)

+ t(2,14) + t(2,15) + t(2,16) + t(2,17) + t(2,18) + t(2,19) + t(2,20)

+ t(2,21) + t(2,22) + t(2,23) + t(2,24) + t(2,25) + t(2,26) + t(2,27)

+ t(2,28) + t(2,29) - 1.1\*t(3,2) - 1.1\*t(4,2) - 1.1\*t(5,2) - 1.1\*t(6,2)

- 1.1\*t(7,2) - 1.1\*t(8,2) - 1.1\*t(9,2) - 1.1\*t(10,2) - 1.1\*t(11,2)

- 1.1\*t(12,2) - 1.1\*t(13,2) - 1.1\*t(14,2) - 1.1\*t(15,2) - 1.1\*t(16,2)

- 1.1\*t(17,2) - 1.1\*t(18,2) - 1.1\*t(19,2) - 1.1\*t(20,2) - 1.1\*t(21,2)

- 1.1\*t(22,2) - 1.1\*t(23,2) - 1.1\*t(24,2) - 1.1\*t(25,2) - 1.1\*t(26,2)

- 1.1\*t(27,2) - 1.1\*t(28,2) - 1.1\*t(29,2) + 0.002762685\*Volume(2,1)

+ 0.00414402749999999\*Volume(2,2) + 0.0013813425\*Volume(2,3) =G=

0.00202831822193877 ; (LHS = 0, INFES = 0.00202831822193877 \*\*\*\*)

Mc4(3).. - 1.1\*t(1,3) - 1.1\*t(2,3) + t(3,1) + t(3,2) - 0.1\*t(3,3) + t(3,4)

+ t(3,5) + t(3,6) + t(3,7) + t(3,8) + t(3,9) + t(3,10) + t(3,11) + t(3,12)

+ t(3,13) + t(3,14) + t(3,15) + t(3,16) + t(3,17) + t(3,18) + t(3,19)

+ t(3,20) + t(3,21) + t(3,22) + t(3,23) + t(3,24) + t(3,25) + t(3,26)

+ t(3,27) + t(3,28) + t(3,29) - 1.1\*t(4,3) - 1.1\*t(5,3) - 1.1\*t(6,3)

- 1.1\*t(7,3) - 1.1\*t(8,3) - 1.1\*t(9,3) - 1.1\*t(10,3) - 1.1\*t(11,3)

- 1.1\*t(12,3) - 1.1\*t(13,3) - 1.1\*t(14,3) - 1.1\*t(15,3) - 1.1\*t(16,3)

- 1.1\*t(17,3) - 1.1\*t(18,3) - 1.1\*t(19,3) - 1.1\*t(20,3) - 1.1\*t(21,3)

- 1.1\*t(22,3) - 1.1\*t(23,3) - 1.1\*t(24,3) - 1.1\*t(25,3) - 1.1\*t(26,3)

- 1.1\*t(27,3) - 1.1\*t(28,3) - 1.1\*t(29,3) + 0.002762685\*Volume(3,1)

+ 0.00414402749999999\*Volume(3,2) + 0.0013813425\*Volume(3,3) =G=

0.0100326811806122 ; (LHS = 0, INFES = 0.0100326811806122 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- Mc5 =G= Constraint not to exceed the Tech only reduction cost

Mc5(1).. - 1500\*t(1,2) - 1500\*t(1,3) - 1500\*t(1,4) - 1500\*t(1,5) - 1500\*t(1,6)

- 1500\*t(1,7) - 1500\*t(1,8) - 1500\*t(1,9) - 1500\*t(1,10) - 1500\*t(1,11)

- 1500\*t(1,12) - 1500\*t(1,13) - 1500\*t(1,14) - 1500\*t(1,15) - 1500\*t(1,16)

- 1500\*t(1,17) - 1500\*t(1,18) - 1500\*t(1,19) - 1500\*t(1,20) - 1500\*t(1,21)

- 1500\*t(1,22) - 1500\*t(1,23) - 1500\*t(1,24) - 1500\*t(1,25) - 1500\*t(1,26)

- 1500\*t(1,27) - 1500\*t(1,28) - 1500\*t(1,29) + 1500\*t(2,1) + 1500\*t(3,1)

+ 1500\*t(4,1) + 1500\*t(5,1) + 1500\*t(6,1) + 1500\*t(7,1) + 1500\*t(8,1)

+ 1500\*t(9,1) + 1500\*t(10,1) + 1500\*t(11,1) + 1500\*t(12,1) + 1500\*t(13,1)

+ 1500\*t(14,1) + 1500\*t(15,1) + 1500\*t(16,1) + 1500\*t(17,1) + 1500\*t(18,1)

+ 1500\*t(19,1) + 1500\*t(20,1) + 1500\*t(21,1) + 1500\*t(22,1) + 1500\*t(23,1)

+ 1500\*t(24,1) + 1500\*t(25,1) + 1500\*t(26,1) + 1500\*t(27,1) + 1500\*t(28,1)

+ 1500\*t(29,1) - 3.47845\*Volume(1,1) - 4.8691\*Volume(1,2)

- 3.2193\*Volume(1,3) =G= 0 ; (LHS = 0)

Mc5(2).. 1500\*t(1,2) - 1500\*t(2,1) - 1500\*t(2,3) - 1500\*t(2,4) - 1500\*t(2,5)

- 1500\*t(2,6) - 1500\*t(2,7) - 1500\*t(2,8) - 1500\*t(2,9) - 1500\*t(2,10)

- 1500\*t(2,11) - 1500\*t(2,12) - 1500\*t(2,13) - 1500\*t(2,14) - 1500\*t(2,15)

- 1500\*t(2,16) - 1500\*t(2,17) - 1500\*t(2,18) - 1500\*t(2,19) - 1500\*t(2,20)

- 1500\*t(2,21) - 1500\*t(2,22) - 1500\*t(2,23) - 1500\*t(2,24) - 1500\*t(2,25)

- 1500\*t(2,26) - 1500\*t(2,27) - 1500\*t(2,28) - 1500\*t(2,29) + 1500\*t(3,2)

+ 1500\*t(4,2) + 1500\*t(5,2) + 1500\*t(6,2) + 1500\*t(7,2) + 1500\*t(8,2)

+ 1500\*t(9,2) + 1500\*t(10,2) + 1500\*t(11,2) + 1500\*t(12,2) + 1500\*t(13,2)

+ 1500\*t(14,2) + 1500\*t(15,2) + 1500\*t(16,2) + 1500\*t(17,2) + 1500\*t(18,2)

+ 1500\*t(19,2) + 1500\*t(20,2) + 1500\*t(21,2) + 1500\*t(22,2) + 1500\*t(23,2)

+ 1500\*t(24,2) + 1500\*t(25,2) + 1500\*t(26,2) + 1500\*t(27,2) + 1500\*t(28,2)

+ 1500\*t(29,2) - 3.47845\*Volume(2,1) - 4.8691\*Volume(2,2)

- 3.2193\*Volume(2,3) =G= 0 ; (LHS = 0)

Mc5(3).. 1500\*t(1,3) + 1500\*t(2,3) - 1500\*t(3,1) - 1500\*t(3,2) - 1500\*t(3,4)

- 1500\*t(3,5) - 1500\*t(3,6) - 1500\*t(3,7) - 1500\*t(3,8) - 1500\*t(3,9)

- 1500\*t(3,10) - 1500\*t(3,11) - 1500\*t(3,12) - 1500\*t(3,13) - 1500\*t(3,14)

- 1500\*t(3,15) - 1500\*t(3,16) - 1500\*t(3,17) - 1500\*t(3,18) - 1500\*t(3,19)

- 1500\*t(3,20) - 1500\*t(3,21) - 1500\*t(3,22) - 1500\*t(3,23) - 1500\*t(3,24)

- 1500\*t(3,25) - 1500\*t(3,26) - 1500\*t(3,27) - 1500\*t(3,28) - 1500\*t(3,29)

+ 1500\*t(4,3) + 1500\*t(5,3) + 1500\*t(6,3) + 1500\*t(7,3) + 1500\*t(8,3)

+ 1500\*t(9,3) + 1500\*t(10,3) + 1500\*t(11,3) + 1500\*t(12,3) + 1500\*t(13,3)

+ 1500\*t(14,3) + 1500\*t(15,3) + 1500\*t(16,3) + 1500\*t(17,3) + 1500\*t(18,3)

+ 1500\*t(19,3) + 1500\*t(20,3) + 1500\*t(21,3) + 1500\*t(22,3) + 1500\*t(23,3)

+ 1500\*t(24,3) + 1500\*t(25,3) + 1500\*t(26,3) + 1500\*t(27,3) + 1500\*t(28,3)

+ 1500\*t(29,3) - 3.47845\*Volume(3,1) - 4.8691\*Volume(3,2)

- 3.2193\*Volume(3,3) =G= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- Mc6 =G= Lower bound on the reduction

Mc6(1).. - 0.1\*t(1,1) + t(1,2) + t(1,3) + t(1,4) + t(1,5) + t(1,6) + t(1,7)

+ t(1,8) + t(1,9) + t(1,10) + t(1,11) + t(1,12) + t(1,13) + t(1,14)

+ t(1,15) + t(1,16) + t(1,17) + t(1,18) + t(1,19) + t(1,20) + t(1,21)

+ t(1,22) + t(1,23) + t(1,24) + t(1,25) + t(1,26) + t(1,27) + t(1,28)

+ t(1,29) - 1.1\*t(2,1) - 1.1\*t(3,1) - 1.1\*t(4,1) - 1.1\*t(5,1) - 1.1\*t(6,1)

- 1.1\*t(7,1) - 1.1\*t(8,1) - 1.1\*t(9,1) - 1.1\*t(10,1) - 1.1\*t(11,1)

- 1.1\*t(12,1) - 1.1\*t(13,1) - 1.1\*t(14,1) - 1.1\*t(15,1) - 1.1\*t(16,1)

- 1.1\*t(17,1) - 1.1\*t(18,1) - 1.1\*t(19,1) - 1.1\*t(20,1) - 1.1\*t(21,1)

- 1.1\*t(22,1) - 1.1\*t(23,1) - 1.1\*t(24,1) - 1.1\*t(25,1) - 1.1\*t(26,1)

- 1.1\*t(27,1) - 1.1\*t(28,1) - 1.1\*t(29,1) + 0.002762685\*Volume(1,1)

+ 0.00414402749999999\*Volume(1,2) + 0.0013813425\*Volume(1,3) =G= 0 ;

(LHS = 0)

Mc6(2).. - 1.1\*t(1,2) + t(2,1) - 0.1\*t(2,2) + t(2,3) + t(2,4) + t(2,5) + t(2,6)

+ t(2,7) + t(2,8) + t(2,9) + t(2,10) + t(2,11) + t(2,12) + t(2,13)

+ t(2,14) + t(2,15) + t(2,16) + t(2,17) + t(2,18) + t(2,19) + t(2,20)

+ t(2,21) + t(2,22) + t(2,23) + t(2,24) + t(2,25) + t(2,26) + t(2,27)

+ t(2,28) + t(2,29) - 1.1\*t(3,2) - 1.1\*t(4,2) - 1.1\*t(5,2) - 1.1\*t(6,2)

- 1.1\*t(7,2) - 1.1\*t(8,2) - 1.1\*t(9,2) - 1.1\*t(10,2) - 1.1\*t(11,2)

- 1.1\*t(12,2) - 1.1\*t(13,2) - 1.1\*t(14,2) - 1.1\*t(15,2) - 1.1\*t(16,2)

- 1.1\*t(17,2) - 1.1\*t(18,2) - 1.1\*t(19,2) - 1.1\*t(20,2) - 1.1\*t(21,2)

- 1.1\*t(22,2) - 1.1\*t(23,2) - 1.1\*t(24,2) - 1.1\*t(25,2) - 1.1\*t(26,2)

- 1.1\*t(27,2) - 1.1\*t(28,2) - 1.1\*t(29,2) + 0.002762685\*Volume(2,1)

+ 0.00414402749999999\*Volume(2,2) + 0.0013813425\*Volume(2,3) =G= 0 ;

(LHS = 0)

Mc6(3).. - 1.1\*t(1,3) - 1.1\*t(2,3) + t(3,1) + t(3,2) - 0.1\*t(3,3) + t(3,4)

+ t(3,5) + t(3,6) + t(3,7) + t(3,8) + t(3,9) + t(3,10) + t(3,11) + t(3,12)

+ t(3,13) + t(3,14) + t(3,15) + t(3,16) + t(3,17) + t(3,18) + t(3,19)

+ t(3,20) + t(3,21) + t(3,22) + t(3,23) + t(3,24) + t(3,25) + t(3,26)

+ t(3,27) + t(3,28) + t(3,29) - 1.1\*t(4,3) - 1.1\*t(5,3) - 1.1\*t(6,3)

- 1.1\*t(7,3) - 1.1\*t(8,3) - 1.1\*t(9,3) - 1.1\*t(10,3) - 1.1\*t(11,3)

- 1.1\*t(12,3) - 1.1\*t(13,3) - 1.1\*t(14,3) - 1.1\*t(15,3) - 1.1\*t(16,3)

- 1.1\*t(17,3) - 1.1\*t(18,3) - 1.1\*t(19,3) - 1.1\*t(20,3) - 1.1\*t(21,3)

- 1.1\*t(22,3) - 1.1\*t(23,3) - 1.1\*t(24,3) - 1.1\*t(25,3) - 1.1\*t(26,3)

- 1.1\*t(27,3) - 1.1\*t(28,3) - 1.1\*t(29,3) + 0.002762685\*Volume(3,1)

+ 0.00414402749999999\*Volume(3,2) + 0.0013813425\*Volume(3,3) =G= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- Mc7 =E= Constraint for the first master problem solution

Mc7.. Theta =E= -9999999 ; (LHS = 10, INFES = 10000009 \*\*\*\*)

---- Mc8 =G= Optimality cut for the first stage problem

NONE

---- DFREq =E=

DFREq(1,1).. - 43.8020833333334\*Volume(1,1) + DFR(1,1) =E= 0 ; (LHS = 0)

DFREq(1,2).. - 43.8020833333334\*Volume(1,2) + DFR(1,2) =E= 0 ; (LHS = 0)

DFREq(1,3).. - 43.8020833333334\*Volume(1,3) + DFR(1,3) =E= 0 ; (LHS = 0)

REMAINING 84 ENTRIES SKIPPED

---- CF01 =E=

CF01(1).. CF\_NoOfModules(1) - 1.15740740740741\*Volume(1,1) =E= 0 ; (LHS = 0)

CF01(2).. CF\_NoOfModules(2) - 1.15740740740741\*Volume(2,1) =E= 0 ; (LHS = 0)

CF01(3).. CF\_NoOfModules(3) - 1.15740740740741\*Volume(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF03 =E=

CF03(1).. CF\_MFF(1) - 1.00671140939597\*DFR(1,1) =E= 0 ; (LHS = 0)

CF03(2).. CF\_MFF(2) - 1.00671140939597\*DFR(2,1) =E= 0 ; (LHS = 0)

CF03(3).. CF\_MFF(3) - 1.00671140939597\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF04 =E=

CF04(1).. CF\_BackwashFlow(1) - CF\_MFF(1) + DFR(1,1) =E= 0 ; (LHS = 0)

CF04(2).. CF\_BackwashFlow(2) - CF\_MFF(2) + DFR(2,1) =E= 0 ; (LHS = 0)

CF04(3).. CF\_BackwashFlow(3) - CF\_MFF(3) + DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF05 =E=

CF05(1).. CF\_FeedPumpHP(1) - 0.346809353943718\*CF\_MFF(1) =E= 0 ; (LHS = 0)

CF05(2).. CF\_FeedPumpHP(2) - 0.346809353943718\*CF\_MFF(2) =E= 0 ; (LHS = 0)

CF05(3).. CF\_FeedPumpHP(3) - 0.346809353943718\*CF\_MFF(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF06 =E=

CF06(1).. - 6534.96\*CF\_FeedPumpHP(1) + CF\_FeedPumpPower(1) =E= 0 ; (LHS = 0)

CF06(2).. - 6534.96\*CF\_FeedPumpHP(2) + CF\_FeedPumpPower(2) =E= 0 ; (LHS = 0)

CF06(3).. - 6534.96\*CF\_FeedPumpHP(3) + CF\_FeedPumpPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF07 =E=

CF07(1).. - 43.508\*CF\_FeedPumpHP(1) + CF\_BackflushPower(1) =E= 0 ; (LHS = 0)

CF07(2).. - 43.508\*CF\_FeedPumpHP(2) + CF\_BackflushPower(2) =E= 0 ; (LHS = 0)

CF07(3).. - 43.508\*CF\_FeedPumpHP(3) + CF\_BackflushPower(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF08 =E=

CF08(1).. - 90\*CF\_NoOfModules(1) + CF\_NoOfMembranes(1) =E= 0 ; (LHS = 0)

CF08(2).. - 90\*CF\_NoOfModules(2) + CF\_NoOfMembranes(2) =E= 0 ; (LHS = 0)

CF08(3).. - 90\*CF\_NoOfModules(3) + CF\_NoOfMembranes(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF09 =E=

CF09(1).. CF\_BuildingArea(1) - 1.060338816\*DFR(1,1) =E= 0 ; (LHS = 0)

CF09(2).. CF\_BuildingArea(2) - 1.060338816\*DFR(2,1) =E= 0 ; (LHS = 0)

CF09(3).. CF\_BuildingArea(3) - 1.060338816\*DFR(3,1) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF10 =E=

CF10(1).. - 370000\*CF\_NoOfModules(1) + CF\_MembraneModuleCost(1) =E= 0 ;

(LHS = 0)

CF10(2).. - 370000\*CF\_NoOfModules(2) + CF\_MembraneModuleCost(2) =E= 0 ;

(LHS = 0)

CF10(3).. - 370000\*CF\_NoOfModules(3) + CF\_MembraneModuleCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF11 =E=

CF11(1).. - 1076\*CF\_BuildingArea(1) + CF\_BuildingCost(1) =E= 0 ; (LHS = 0)

CF11(2).. - 1076\*CF\_BuildingArea(2) + CF\_BuildingCost(2) =E= 0 ; (LHS = 0)

CF11(3).. - 1076\*CF\_BuildingArea(3) + CF\_BuildingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF12 =E=

CF12(1).. - 70000\*CF\_NoOfModules(1) + CF\_InstallationCost(1) =E= 0 ; (LHS = 0)

CF12(2).. - 70000\*CF\_NoOfModules(2) + CF\_InstallationCost(2) =E= 0 ; (LHS = 0)

CF12(3).. - 70000\*CF\_NoOfModules(3) + CF\_InstallationCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF13 =E=

CF13(1).. - 0.05\*CF\_MembraneModuleCost(1) + CF\_MiscCost(1) =E= 0 ; (LHS = 0)

CF13(2).. - 0.05\*CF\_MembraneModuleCost(2) + CF\_MiscCost(2) =E= 0 ; (LHS = 0)

CF13(3).. - 0.05\*CF\_MembraneModuleCost(3) + CF\_MiscCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF14 =E=

CF14(1).. - 0.05\*CF\_MembraneModuleCost(1) - 0.05\*CF\_MiscCost(1)

+ CF\_PlantPipingCost(1) =E= 0 ; (LHS = 0)

CF14(2).. - 0.05\*CF\_MembraneModuleCost(2) - 0.05\*CF\_MiscCost(2)

+ CF\_PlantPipingCost(2) =E= 0 ; (LHS = 0)

CF14(3).. - 0.05\*CF\_MembraneModuleCost(3) - 0.05\*CF\_MiscCost(3)

+ CF\_PlantPipingCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF15 =E=

CF15(1).. - 0.1\*CF\_MembraneModuleCost(1) - 0.1\*CF\_MiscCost(1)

+ CF\_EngineeringCost(1) =E= 0 ; (LHS = 0)

CF15(2).. - 0.1\*CF\_MembraneModuleCost(2) - 0.1\*CF\_MiscCost(2)

+ CF\_EngineeringCost(2) =E= 0 ; (LHS = 0)

CF15(3).. - 0.1\*CF\_MembraneModuleCost(3) - 0.1\*CF\_MiscCost(3)

+ CF\_EngineeringCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF16 =E=

CF16(1).. - CF\_MembraneModuleCost(1) - CF\_BuildingCost(1)

- CF\_InstallationCost(1) - CF\_MiscCost(1) - CF\_PlantPipingCost(1)

- CF\_EngineeringCost(1) + CF\_DirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF16(2).. - CF\_MembraneModuleCost(2) - CF\_BuildingCost(2)

- CF\_InstallationCost(2) - CF\_MiscCost(2) - CF\_PlantPipingCost(2)

- CF\_EngineeringCost(2) + CF\_DirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF16(3).. - CF\_MembraneModuleCost(3) - CF\_BuildingCost(3)

- CF\_InstallationCost(3) - CF\_MiscCost(3) - CF\_PlantPipingCost(3)

- CF\_EngineeringCost(3) + CF\_DirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF17 =E=

CF17(1).. - 0.06\*CF\_DirectCapitalCost(1) + CF\_ConstructionInterest(1) =E= 0 ;

(LHS = 0)

CF17(2).. - 0.06\*CF\_DirectCapitalCost(2) + CF\_ConstructionInterest(2) =E= 0 ;

(LHS = 0)

CF17(3).. - 0.06\*CF\_DirectCapitalCost(3) + CF\_ConstructionInterest(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF18 =E=

CF18(1).. - 0.2\*CF\_DirectCapitalCost(1) + CF\_Contingencies(1) =E= 0 ; (LHS = 0)

CF18(2).. - 0.2\*CF\_DirectCapitalCost(2) + CF\_Contingencies(2) =E= 0 ; (LHS = 0)

CF18(3).. - 0.2\*CF\_DirectCapitalCost(3) + CF\_Contingencies(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF19 =E=

CF19(1).. - 0.1\*CF\_DirectCapitalCost(1) + CF\_ProjectManagement(1) =E= 0 ;

(LHS = 0)

CF19(2).. - 0.1\*CF\_DirectCapitalCost(2) + CF\_ProjectManagement(2) =E= 0 ;

(LHS = 0)

CF19(3).. - 0.1\*CF\_DirectCapitalCost(3) + CF\_ProjectManagement(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF20 =E=

CF20(1).. - 0.04\*CF\_DirectCapitalCost(1) + CF\_WorkingCapital(1) =E= 0 ;

(LHS = 0)

CF20(2).. - 0.04\*CF\_DirectCapitalCost(2) + CF\_WorkingCapital(2) =E= 0 ;

(LHS = 0)

CF20(3).. - 0.04\*CF\_DirectCapitalCost(3) + CF\_WorkingCapital(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF21 =E=

CF21(1).. - CF\_ConstructionInterest(1) - CF\_Contingencies(1)

- CF\_ProjectManagement(1) - CF\_WorkingCapital(1)

+ CF\_IndirectCapitalCost(1) =E= 0 ; (LHS = 0)

CF21(2).. - CF\_ConstructionInterest(2) - CF\_Contingencies(2)

- CF\_ProjectManagement(2) - CF\_WorkingCapital(2)

+ CF\_IndirectCapitalCost(2) =E= 0 ; (LHS = 0)

CF21(3).. - CF\_ConstructionInterest(3) - CF\_Contingencies(3)

- CF\_ProjectManagement(3) - CF\_WorkingCapital(3)

+ CF\_IndirectCapitalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF22 =E=

CF22(1).. - CF\_DirectCapitalCost(1) - CF\_IndirectCapitalCost(1)

+ CF\_TotalConstructionCost(1) =E= 0 ; (LHS = 0)

CF22(2).. - CF\_DirectCapitalCost(2) - CF\_IndirectCapitalCost(2)

+ CF\_TotalConstructionCost(2) =E= 0 ; (LHS = 0)

CF22(3).. - CF\_DirectCapitalCost(3) - CF\_IndirectCapitalCost(3)

+ CF\_TotalConstructionCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF23 =E=

CF23(1).. - 0.092543542478\*CF\_FeedPumpPower(1)

- 0.092543542478\*CF\_BackflushPower(1) + CF\_ElectricityCost(1) =E= 0 ;

(LHS = 0)

CF23(2).. - 0.092543542478\*CF\_FeedPumpPower(2)

- 0.092543542478\*CF\_BackflushPower(2) + CF\_ElectricityCost(2) =E= 0 ;

(LHS = 0)

CF23(3).. - 0.092543542478\*CF\_FeedPumpPower(3)

- 0.092543542478\*CF\_BackflushPower(3) + CF\_ElectricityCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF24 =E=

CF24(1).. CF\_LaborCost(1) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(2).. CF\_LaborCost(2) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

CF24(3).. CF\_LaborCost(3) =E= 528520 ; (LHS = 0, INFES = 528520 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF25 =E=

CF25(1).. CF\_ChemicalCost(1) - 45.2294991346302\*DFR(1,1) =E= -264.152574543161

; (LHS = 0, INFES = 264.152574543161 \*\*\*\*)

CF25(2).. CF\_ChemicalCost(2) - 45.2294991346302\*DFR(2,1) =E= -264.152574543161

; (LHS = 0, INFES = 264.152574543161 \*\*\*\*)

CF25(3).. CF\_ChemicalCost(3) - 45.2294991346302\*DFR(3,1) =E= -264.152574543161

; (LHS = 0, INFES = 264.152574543161 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF26 =E=

CF26(1).. - 131.921287694597\*CF\_NoOfMembranes(1)

+ CF\_MembraneReplacementCost(1) =E= 0 ; (LHS = 0)

CF26(2).. - 131.921287694597\*CF\_NoOfMembranes(2)

+ CF\_MembraneReplacementCost(2) =E= 0 ; (LHS = 0)

CF26(3).. - 131.921287694597\*CF\_NoOfMembranes(3)

+ CF\_MembraneReplacementCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF27 =E=

CF27(1).. CF\_CleaningChemicalCost(1) - 9.04589982692604\*DFR(1,1) =E=

52.8308318920387 ; (LHS = 0, INFES = 52.8308318920387 \*\*\*\*)

CF27(2).. CF\_CleaningChemicalCost(2) - 9.04589982692604\*DFR(2,1) =E=

52.8308318920387 ; (LHS = 0, INFES = 52.8308318920387 \*\*\*\*)

CF27(3).. CF\_CleaningChemicalCost(3) - 9.04589982692604\*DFR(3,1) =E=

52.8308318920387 ; (LHS = 0, INFES = 52.8308318920387 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- CF28 =E=

CF28(1).. - 0.02\*CF\_DirectCapitalCost(1) + CF\_Repairs(1) =E= 0 ; (LHS = 0)

CF28(2).. - 0.02\*CF\_DirectCapitalCost(2) + CF\_Repairs(2) =E= 0 ; (LHS = 0)

CF28(3).. - 0.02\*CF\_DirectCapitalCost(3) + CF\_Repairs(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF29 =E=

CF29(1).. - CF\_ElectricityCost(1) - CF\_LaborCost(1) - CF\_ChemicalCost(1)

- CF\_MembraneReplacementCost(1) - CF\_CleaningChemicalCost(1)

- CF\_Repairs(1) + CF\_TotalOMCost(1) =E= 0 ; (LHS = 0)

CF29(2).. - CF\_ElectricityCost(2) - CF\_LaborCost(2) - CF\_ChemicalCost(2)

- CF\_MembraneReplacementCost(2) - CF\_CleaningChemicalCost(2)

- CF\_Repairs(2) + CF\_TotalOMCost(2) =E= 0 ; (LHS = 0)

CF29(3).. - CF\_ElectricityCost(3) - CF\_LaborCost(3) - CF\_ChemicalCost(3)

- CF\_MembraneReplacementCost(3) - CF\_CleaningChemicalCost(3)

- CF\_Repairs(3) + CF\_TotalOMCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF30 =E=

CF30(1).. - 0.101852208823151\*CF\_TotalConstructionCost(1)

+ CF\_CapitalRecovery(1) =E= 0 ; (LHS = 0)

CF30(2).. - 0.101852208823151\*CF\_TotalConstructionCost(2)

+ CF\_CapitalRecovery(2) =E= 0 ; (LHS = 0)

CF30(3).. - 0.101852208823151\*CF\_TotalConstructionCost(3)

+ CF\_CapitalRecovery(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- CF31 =E=

CF31(1).. - 2\*CF\_TotalOMCost(1) - 2\*CF\_CapitalRecovery(1) + CF\_AnnualCost(1)

=E= 0 ; (LHS = 0)

CF31(2).. - 2\*CF\_TotalOMCost(2) - 2\*CF\_CapitalRecovery(2) + CF\_AnnualCost(2)

=E= 0 ; (LHS = 0)

CF31(3).. - 2\*CF\_TotalOMCost(3) - 2\*CF\_CapitalRecovery(3) + CF\_AnnualCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC01 =E=

GAC01(1).. GAC\_CapitalCost(1) - (7.37701051584E16)\*Volume(1,2) =E= 0 ;

(LHS = 0)

GAC01(2).. GAC\_CapitalCost(2) - (7.37701051584E16)\*Volume(2,2) =E= 0 ;

(LHS = 0)

GAC01(3).. GAC\_CapitalCost(3) - (7.37701051584E16)\*Volume(3,2) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC02 =E=

GAC02(1).. GAC\_OMCost(1) - (8.53307527956E15)\*Volume(1,2) =E= 0 ; (LHS = 0)

GAC02(2).. GAC\_OMCost(2) - (8.53307527956E15)\*Volume(2,2) =E= 0 ; (LHS = 0)

GAC02(3).. GAC\_OMCost(3) - (8.53307527956E15)\*Volume(3,2) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- GAC03 =E=

GAC03(1).. - GAC\_CapitalCost(1) - GAC\_OMCost(1) + GAC\_TotalCost(1) =E= 0 ;

(LHS = 0)

GAC03(2).. - GAC\_CapitalCost(2) - GAC\_OMCost(2) + GAC\_TotalCost(2) =E= 0 ;

(LHS = 0)

GAC03(3).. - GAC\_CapitalCost(3) - GAC\_OMCost(3) + GAC\_TotalCost(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX01 =E=

IX01(1).. IX\_MinResinVolume(1) - 0.18\*DFR(1,3) =E= 0 ; (LHS = 0)

IX01(2).. IX\_MinResinVolume(2) - 0.18\*DFR(2,3) =E= 0 ; (LHS = 0)

IX01(3).. IX\_MinResinVolume(3) - 0.18\*DFR(3,3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX02 =E=

IX02(1).. IX\_MinVolExhaustionTime(1) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(2).. IX\_MinVolExhaustionTime(2) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

IX02(3).. IX\_MinVolExhaustionTime(3) =E= 11.5101289134438 ;

(LHS = 0, INFES = 11.5101289134438 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX04 =E=

IX04(1).. IX\_ExhaustionTimeResinVolume(1) - 0.0156384\*DFR(1,3) =E= 0 ;

(LHS = 0)

IX04(2).. IX\_ExhaustionTimeResinVolume(2) - 0.0156384\*DFR(2,3) =E= 0 ;

(LHS = 0)

IX04(3).. IX\_ExhaustionTimeResinVolume(3) - 0.0156384\*DFR(3,3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX05 =E=

IX05(1).. - 2\*IX\_ExhaustionTimeResinVolume(1) + IX\_VesselVolume(1) =E= 0 ;

(LHS = 0)

IX05(2).. - 2\*IX\_ExhaustionTimeResinVolume(2) + IX\_VesselVolume(2) =E= 0 ;

(LHS = 0)

IX05(3).. - 2\*IX\_ExhaustionTimeResinVolume(3) + IX\_VesselVolume(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX06 =E=

IX06(1).. - 1516.1814575484\*IX\_ExhaustionTimeResinVolume(1) + IX\_ResinCost(1)

=E= 0 ; (LHS = 0)

IX06(2).. - 1516.1814575484\*IX\_ExhaustionTimeResinVolume(2) + IX\_ResinCost(2)

=E= 0 ; (LHS = 0)

IX06(3).. - 1516.1814575484\*IX\_ExhaustionTimeResinVolume(3) + IX\_ResinCost(3)

=E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX07 =E=

IX07(1).. - (5350122.17055354)\*IX\_VesselVolume(1) + IX\_TankTotalCost(1) =E= 0 ;

(LHS = -115.015960136027, INFES = 115.015960136027 \*\*\*\*)

IX07(2).. - (5350122.17055354)\*IX\_VesselVolume(2) + IX\_TankTotalCost(2) =E= 0 ;

(LHS = -115.015960136027, INFES = 115.015960136027 \*\*\*\*)

IX07(3).. - (5350122.17055354)\*IX\_VesselVolume(3) + IX\_TankTotalCost(3) =E= 0 ;

(LHS = -115.015960136027, INFES = 115.015960136027 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX08 =E=

IX08(1).. - 150\*IX\_ExhaustionTimeResinVolume(1) + IX\_NaClReq(1) =E= 0 ;

(LHS = 0)

IX08(2).. - 150\*IX\_ExhaustionTimeResinVolume(2) + IX\_NaClReq(2) =E= 0 ;

(LHS = 0)

IX08(3).. - 150\*IX\_ExhaustionTimeResinVolume(3) + IX\_NaClReq(3) =E= 0 ;

(LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX09 =E=

IX09(1).. - 0.01\*IX\_NaClReq(1) + IX\_RegFluidReq(1) =E= 0 ; (LHS = 0)

IX09(2).. - 0.01\*IX\_NaClReq(2) + IX\_RegFluidReq(2) =E= 0 ; (LHS = 0)

IX09(3).. - 0.01\*IX\_NaClReq(3) + IX\_RegFluidReq(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX10 =E=

IX10(1).. - 3.65\*IX\_NaClReq(1) + IX\_TotalChemCost(1) =E= 0 ; (LHS = 0)

IX10(2).. - 3.65\*IX\_NaClReq(2) + IX\_TotalChemCost(2) =E= 0 ; (LHS = 0)

IX10(3).. - 3.65\*IX\_NaClReq(3) + IX\_TotalChemCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX11 =E=

IX11(1).. - 250\*IX\_RegFluidReq(1) + IX\_StorageTankCost(1) =E= 0 ; (LHS = 0)

IX11(2).. - 250\*IX\_RegFluidReq(2) + IX\_StorageTankCost(2) =E= 0 ; (LHS = 0)

IX11(3).. - 250\*IX\_RegFluidReq(3) + IX\_StorageTankCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX12 =E=

IX12(1).. - (2500000000)\*IX\_VesselVolume(1) + IX\_BedArea(1) =E= 0 ; (LHS = 0)

IX12(2).. - (2500000000)\*IX\_VesselVolume(2) + IX\_BedArea(2) =E= 0 ; (LHS = 0)

IX12(3).. - (2500000000)\*IX\_VesselVolume(3) + IX\_BedArea(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

---- IX13 =E=

IX13(1).. - (1254.21)\*IX\_BedArea(1) + IX\_ConstructionCost(1) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(2).. - (1254.21)\*IX\_BedArea(2) + IX\_ConstructionCost(2) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

IX13(3).. - (1254.21)\*IX\_BedArea(3) + IX\_ConstructionCost(3) =E= 36000 ;

(LHS = 0, INFES = 36000 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX14 =E=

IX14(1).. - (733000000000)\*IX\_BedArea(1) + IX\_OMCost(1) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(2).. - (733000000000)\*IX\_BedArea(2) + IX\_OMCost(2) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

IX14(3).. - (733000000000)\*IX\_BedArea(3) + IX\_OMCost(3) =E= 2200 ;

(LHS = 0, INFES = 2200 \*\*\*\*)

REMAINING 26 ENTRIES SKIPPED

---- IX15 =E=

IX15(1).. - 24\*IX\_ResinCost(1) - IX\_TankTotalCost(1) - IX\_TotalChemCost(1)

- IX\_StorageTankCost(1) - IX\_ConstructionCost(1) - IX\_OMCost(1)

+ IX\_TotalCost(1) =E= 0 ; (LHS = 0)

IX15(2).. - 24\*IX\_ResinCost(2) - IX\_TankTotalCost(2) - IX\_TotalChemCost(2)

- IX\_StorageTankCost(2) - IX\_ConstructionCost(2) - IX\_OMCost(2)

+ IX\_TotalCost(2) =E= 0 ; (LHS = 0)

IX15(3).. - 24\*IX\_ResinCost(3) - IX\_TankTotalCost(3) - IX\_TotalChemCost(3)

- IX\_StorageTankCost(3) - IX\_ConstructionCost(3) - IX\_OMCost(3)

+ IX\_TotalCost(3) =E= 0 ; (LHS = 0)

REMAINING 26 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE MasterProblem Using NLP From line 893

---- CF\_NoOfModules Number of modules

CF\_NoOfModules(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(1)

-90 CF08(1)

-370000 CF10(1)

-70000 CF12(1)

CF\_NoOfModules(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(2)

-90 CF08(2)

-370000 CF10(2)

-70000 CF12(2)

CF\_NoOfModules(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF01(3)

-90 CF08(3)

-370000 CF10(3)

-70000 CF12(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackwashFlow Backwash flow

CF\_BackwashFlow(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(1)

CF\_BackwashFlow(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(2)

CF\_BackwashFlow(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF04(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpHP Feed pump horsepower

CF\_FeedPumpHP(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(1)

-6534.96 CF06(1)

-43.508 CF07(1)

CF\_FeedPumpHP(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(2)

-6534.96 CF06(2)

-43.508 CF07(2)

CF\_FeedPumpHP(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF05(3)

-6534.96 CF06(3)

-43.508 CF07(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_FeedPumpPower Feed pump power requirement in kWh

CF\_FeedPumpPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(1)

-0.0925 CF23(1)

CF\_FeedPumpPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(2)

-0.0925 CF23(2)

CF\_FeedPumpPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF06(3)

-0.0925 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BackflushPower Backflush power requirement in kWh

CF\_BackflushPower(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(1)

-0.0925 CF23(1)

CF\_BackflushPower(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(2)

-0.0925 CF23(2)

CF\_BackflushPower(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF07(3)

-0.0925 CF23(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MFF Microfiltration feed flow in liters per sec

CF\_MFF(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(1)

-1 CF04(1)

-0.3468 CF05(1)

CF\_MFF(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(2)

-1 CF04(2)

-0.3468 CF05(2)

CF\_MFF(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF03(3)

-1 CF04(3)

-0.3468 CF05(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_NoOfMembranes Number of membranes used

CF\_NoOfMembranes(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(1)

-131.9213 CF26(1)

CF\_NoOfMembranes(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(2)

-131.9213 CF26(2)

CF\_NoOfMembranes(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF08(3)

-131.9213 CF26(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingArea Building area for the process implementation

CF\_BuildingArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(1)

-1076 CF11(1)

CF\_BuildingArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(2)

-1076 CF11(2)

CF\_BuildingArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF09(3)

-1076 CF11(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneModuleCost Membrane module cost

CF\_MembraneModuleCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(1)

-0.05 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MembraneModuleCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(2)

-0.05 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MembraneModuleCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF10(3)

-0.05 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_BuildingCost Building cost - based on the building area

CF\_BuildingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(1)

-1 CF16(1)

CF\_BuildingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(2)

-1 CF16(2)

CF\_BuildingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF11(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_InstallationCost Installation cost for the process

CF\_InstallationCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(1)

-1 CF16(1)

CF\_InstallationCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(2)

-1 CF16(2)

CF\_InstallationCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF12(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MiscCost Miscellaneous cost (taken as 5% of the module cost)

CF\_MiscCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(1)

-0.05 CF14(1)

-0.1 CF15(1)

-1 CF16(1)

CF\_MiscCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(2)

-0.05 CF14(2)

-0.1 CF15(2)

-1 CF16(2)

CF\_MiscCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF13(3)

-0.05 CF14(3)

-0.1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_PlantPipingCost Plant piping cost (taken as 5% of the module and misc c

ost)

CF\_PlantPipingCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(1)

-1 CF16(1)

CF\_PlantPipingCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(2)

-1 CF16(2)

CF\_PlantPipingCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF14(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_EngineeringCost Engineering cost (taken as 10% of the module and misc c

ost)

CF\_EngineeringCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(1)

-1 CF16(1)

CF\_EngineeringCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(2)

-1 CF16(2)

CF\_EngineeringCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF15(3)

-1 CF16(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_DirectCapitalCost Total direct capital cost

CF\_DirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(1)

-0.06 CF17(1)

-0.2 CF18(1)

-0.1 CF19(1)

-0.04 CF20(1)

-1 CF22(1)

-0.02 CF28(1)

CF\_DirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(2)

-0.06 CF17(2)

-0.2 CF18(2)

-0.1 CF19(2)

-0.04 CF20(2)

-1 CF22(2)

-0.02 CF28(2)

CF\_DirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF16(3)

-0.06 CF17(3)

-0.2 CF18(3)

-0.1 CF19(3)

-0.04 CF20(3)

-1 CF22(3)

-0.02 CF28(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ConstructionInterest Expense on interest during construction (taken as

6% of total direct capital cost)

CF\_ConstructionInterest(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(1)

-1 CF21(1)

CF\_ConstructionInterest(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(2)

-1 CF21(2)

CF\_ConstructionInterest(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF17(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Contingencies Contingencies (taken as 20% of total direct capital cost)

CF\_Contingencies(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(1)

-1 CF21(1)

CF\_Contingencies(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(2)

-1 CF21(2)

CF\_Contingencies(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF18(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ProjectManagement Fees and project management (taken as 10% of total di

rect capital cost)

CF\_ProjectManagement(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(1)

-1 CF21(1)

CF\_ProjectManagement(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(2)

-1 CF21(2)

CF\_ProjectManagement(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF19(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_WorkingCapital Working capital (taken as 4% of total direct capital cos

t)

CF\_WorkingCapital(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(1)

-1 CF21(1)

CF\_WorkingCapital(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(2)

-1 CF21(2)

CF\_WorkingCapital(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF20(3)

-1 CF21(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_IndirectCapitalCost Total indirect capital cost

CF\_IndirectCapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(1)

-1 CF22(1)

CF\_IndirectCapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(2)

-1 CF22(2)

CF\_IndirectCapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF21(3)

-1 CF22(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalConstructionCost Total (direct and indirect) construction cost

CF\_TotalConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(1)

-0.1019 CF30(1)

CF\_TotalConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(2)

-0.1019 CF30(2)

CF\_TotalConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF22(3)

-0.1019 CF30(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ElectricityCost Electricity cost for the implementation of the process

CF\_ElectricityCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(1)

-1 CF29(1)

CF\_ElectricityCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(2)

-1 CF29(2)

CF\_ElectricityCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF23(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_LaborCost Labor cost for the implementation of the process

CF\_LaborCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(1)

-1 CF29(1)

CF\_LaborCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(2)

-1 CF29(2)

CF\_LaborCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF24(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_ChemicalCost Chemical cost for the process

CF\_ChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(1)

-1 CF29(1)

CF\_ChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(2)

-1 CF29(2)

CF\_ChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF25(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_MembraneReplacementCost Membrane replacement cost for the process

CF\_MembraneReplacementCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(1)

-1 CF29(1)

CF\_MembraneReplacementCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(2)

-1 CF29(2)

CF\_MembraneReplacementCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF26(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CleaningChemicalCost Cleaning chemical (NaOCl) cost

CF\_CleaningChemicalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(1)

-1 CF29(1)

CF\_CleaningChemicalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(2)

-1 CF29(2)

CF\_CleaningChemicalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF27(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_Repairs Repairs replacement and misc cost (taken as 2% of the direct ca

pital cost)

CF\_Repairs(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(1)

-1 CF29(1)

CF\_Repairs(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(2)

-1 CF29(2)

CF\_Repairs(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF28(3)

-1 CF29(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_TotalOMCost Total operating and maintenance cost

CF\_TotalOMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(1)

-2 CF31(1)

CF\_TotalOMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(2)

-2 CF31(2)

CF\_TotalOMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF29(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_CapitalRecovery Capital recovery - calculate from the total captical co

st

CF\_CapitalRecovery(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(1)

-2 CF31(1)

CF\_CapitalRecovery(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(2)

-2 CF31(2)

CF\_CapitalRecovery(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF30(3)

-2 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- CF\_AnnualCost Annual cost depending on the Capital recovery and OM cost

CF\_AnnualCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(1)

CF\_AnnualCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(2)

CF\_AnnualCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 CF31(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_CapitalCost Capital cost for the activated carbon process

GAC\_CapitalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(1)

-1 GAC03(1)

GAC\_CapitalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(2)

-1 GAC03(2)

GAC\_CapitalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC01(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_OMCost Operational and maintenance cost for the activated carbon proce

ss

GAC\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(1)

-1 GAC03(1)

GAC\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(2)

-1 GAC03(2)

GAC\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC02(3)

-1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- GAC\_TotalCost Total cost for the activated carbon process implementation

GAC\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(1)

GAC\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(2)

GAC\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 GAC03(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinResinVolume Minimum volume of the medium in m3

IX\_MinResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(1)

IX\_MinResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(2)

IX\_MinResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX01(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_MinVolExhaustionTime Minimum volume exhaustion time in days

IX\_MinVolExhaustionTime(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(1)

IX\_MinVolExhaustionTime(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(2)

IX\_MinVolExhaustionTime(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX02(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ExhaustionTimeResinVolume Resin volume in m3 for the minimum exhaustion

time

IX\_ExhaustionTimeResinVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(1)

-2 IX05(1)

-1516.1815 IX06(1)

-150 IX08(1)

IX\_ExhaustionTimeResinVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(2)

-2 IX05(2)

-1516.1815 IX06(2)

-150 IX08(2)

IX\_ExhaustionTimeResinVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX04(3)

-2 IX05(3)

-1516.1815 IX06(3)

-150 IX08(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_VesselVolume Total vessel volume in m3

IX\_VesselVolume(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(1)

(-5.350122E+6) IX07(1)

(-2.500000E+9) IX12(1)

IX\_VesselVolume(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(2)

(-5.350122E+6) IX07(2)

(-2.500000E+9) IX12(2)

IX\_VesselVolume(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX05(3)

(-5.350122E+6) IX07(3)

(-2.500000E+9) IX12(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ResinCost Total resin cost (in $ per day -- need to check)

IX\_ResinCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(1)

-24 IX15(1)

IX\_ResinCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(2)

-24 IX15(2)

IX\_ResinCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX06(3)

-24 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_BedArea Bed area for the vessel in m2

IX\_BedArea(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(1)

(-1254.21) IX13(1)

(-7.33000E+11) IX14(1)

IX\_BedArea(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(2)

(-1254.21) IX13(2)

(-7.33000E+11) IX14(2)

IX\_BedArea(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX12(3)

(-1254.21) IX13(3)

(-7.33000E+11) IX14(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TankTotalCost Total Tank cost in $

IX\_TankTotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(1)

-1 IX15(1)

IX\_TankTotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(2)

-1 IX15(2)

IX\_TankTotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX07(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_NaClReq NaCl requirement in Kg per day

IX\_NaClReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(1)

-0.01 IX09(1)

-3.65 IX10(1)

IX\_NaClReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(2)

-0.01 IX09(2)

-3.65 IX10(2)

IX\_NaClReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX08(3)

-0.01 IX09(3)

-3.65 IX10(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalChemCost Total chemical cost per year

IX\_TotalChemCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(1)

-1 IX15(1)

IX\_TotalChemCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(2)

-1 IX15(2)

IX\_TotalChemCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX10(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_RegFluidReq Regeneration fluid requirement

IX\_RegFluidReq(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(1)

-250 IX11(1)

IX\_RegFluidReq(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(2)

-250 IX11(2)

IX\_RegFluidReq(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX09(3)

-250 IX11(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_StorageTankCost Storage tank cost

IX\_StorageTankCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(1)

-1 IX15(1)

IX\_StorageTankCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(2)

-1 IX15(2)

IX\_StorageTankCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX11(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_ConstructionCost Construction cost

IX\_ConstructionCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(1)

-1 IX15(1)

IX\_ConstructionCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(2)

-1 IX15(2)

IX\_ConstructionCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX13(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_OMCost Operating and maintenance cost

IX\_OMCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(1)

-1 IX15(1)

IX\_OMCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(2)

-1 IX15(2)

IX\_OMCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX14(3)

-1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- IX\_TotalCost Total cost for the implementation of ion exchange process for

each industry

IX\_TotalCost(1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(1)

IX\_TotalCost(2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(2)

IX\_TotalCost(3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 IX15(3)

REMAINING 26 ENTRIES SKIPPED

---- t Variable deciding the amount of mercury traded between various industrie

s

t(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Mc2(1)

-0.1 Mc4(1)

-0.1 Mc6(1)

t(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Mc4(1)

-1.1 Mc4(2)

-1500 Mc5(1)

1500 Mc5(2)

1 Mc6(1)

-1.1 Mc6(2)

t(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Mc4(1)

-1.1 Mc4(3)

-1500 Mc5(1)

1500 Mc5(3)

1 Mc6(1)

-1.1 Mc6(3)

REMAINING 838 ENTRIES SKIPPED

---- Theta Linear approximation of the recourse function

Theta

(.LO, .L, .UP, .M = -INF, 10, +INF, 0)

-1 Mobj

1 Mc7

---- MasterObjective Objective function of the master problem

MasterObjective

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 Mobj

---- Volume volume of waste treated by each industry using each technology (def

ined over i and j)

Volume(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Mc1(1)

0.0028 Mc4(1)

-3.4784 Mc5(1)

0.0028 Mc6(1)

-43.8021 DFREq(1,1)

-1.1574 CF01(1)

Volume(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Mc1(1)

0.0041 Mc4(1)

-4.8691 Mc5(1)

0.0041 Mc6(1)

-43.8021 DFREq(1,2)

(-7.37701E+16) GAC01(1)

(-8.53308E+15) GAC02(1)

Volume(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Mc1(1)

0.0014 Mc4(1)

-3.2193 Mc5(1)

0.0014 Mc6(1)

-43.8021 DFREq(1,3)

REMAINING 84 ENTRIES SKIPPED

---- DFR Desired flow rate for the industry in liters per sec

DFR(1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,1)

-1.0067 CF03(1)

1 CF04(1)

-1.0603 CF09(1)

-45.2295 CF25(1)

-9.0459 CF27(1)

DFR(1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,2)

DFR(1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 DFREq(1,3)

-0.18 IX01(1)

-0.0156 IX04(1)

REMAINING 84 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE MasterProblem Using NLP From line 893

LOOPS FOR/WHILE 1

MODEL STATISTICS

BLOCKS OF EQUATIONS 57 SINGLE EQUATIONS 1,597

BLOCKS OF VARIABLES 52 SINGLE VARIABLES 2,380

NON ZERO ELEMENTS 8,877 NON LINEAR N-Z 174

DERIVATIVE POOL 10 CONSTANT POOL 31

CODE LENGTH 1,508

GENERATION TIME = 0.015 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.015 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE MasterProblem Using NLP From line 893

S O L V E S U M M A R Y

MODEL MasterProblem OBJECTIVE MasterObjective

TYPE NLP DIRECTION MINIMIZE

SOLVER CONOPT FROM LINE 893

\*\*\*\* SOLVER STATUS 7 Licensing Problems

\*\*\*\* MODEL STATUS 11 Licensing Problem

\*\*\*\* OBJECTIVE VALUE NA

RESOURCE USAGE, LIMIT 0.000 1000.000

ITERATION COUNT, LIMIT 0 2000000000

EVALUATION ERRORS 0 0

CONOPT 3 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

\*\*\* No license found

\*\*\* To update your license, please contact your distributor.

\*\*\* Too many equations for demo mode

\*\*\* Number of equations : 1597

\*\*\* Maximum allowed : 300

\*\*\* Too many variables for demo mode

\*\*\* Number of variables : 2380

\*\*\* Maximum allowed : 300

\*\*\* Too many nonzero elements for demo mode

\*\*\* Number of nonzeros : 8877

\*\*\* Maximum allowed : 2000

No solution returned

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

E x e c u t i o n

---- 894 VARIABLE MasterObjective.L = 0.00000 Objective function of

the master problem

---- 912 PARAMETER a Temporary storage parameter of the first stage decision

values

( ALL 0.00000 )

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE Optimality Using LP From line 936

---- OptObj =E= Objective function for the optimality problem

OptObj.. OptObjective =E= 0 ; (LHS = 0)

---- Optconst1 =L= Constraint for the optimality problem

Optconst1(1,1,1).. pi(1,1,1) =L= 1 ; (LHS = 0)

Optconst1(1,1,2).. pi(1,1,2) =L= 1 ; (LHS = 0)

Optconst1(1,1,3).. pi(1,1,3) =L= 1 ; (LHS = 0)

REMAINING 838 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE Optimality Using LP From line 936

---- pi simplex variable (one in number)

pi(1,1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Optconst1(1,1,1)

pi(1,1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Optconst1(1,1,2)

pi(1,1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, 0)

1 Optconst1(1,1,3)

REMAINING 838 ENTRIES SKIPPED

---- OptObjective Objective function for the Optimality problem

OptObjective

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 OptObj

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE Optimality Using LP From line 936

LOOPS FOR/WHILE 1

FOR/WHILE 1

MODEL STATISTICS

BLOCKS OF EQUATIONS 2 SINGLE EQUATIONS 842

BLOCKS OF VARIABLES 2 SINGLE VARIABLES 842

NON ZERO ELEMENTS 842

GENERATION TIME = 0.016 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.031 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 1

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE Optimality Using LP From line 936

S O L V E S U M M A R Y

MODEL Optimality OBJECTIVE OptObjective

TYPE LP DIRECTION MAXIMIZE

SOLVER CPLEX FROM LINE 936

\*\*\*\* SOLVER STATUS 1 Normal Completion

\*\*\*\* MODEL STATUS 1 Optimal

\*\*\*\* OBJECTIVE VALUE 0.0000

RESOURCE USAGE, LIMIT 0.015 1000.000

ITERATION COUNT, LIMIT 0 2000000000

IBM ILOG CPLEX 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

--- GAMS/Cplex licensed for continuous and discrete problems.

Cplex 12.5.1.0

LP status(1): optimal

Cplex Time: 0.00sec (det. 0.46 ticks)

Optimal solution found.

Objective : 0.000000

LOWER LEVEL UPPER MARGINAL

---- EQU OptObj . . . 1.000

OptObj Objective function for the optimality problem

---- EQU Optconst1 Constraint for the optimality problem

LOWER LEVEL UPPER MARGINAL

1 .1.1 -INF . 1.000 .

1 .1.2 -INF . 1.000 .

1 .1.3 -INF . 1.000 .

1 .1.4 -INF . 1.000 .

1 .1.5 -INF . 1.000 .

1 .1.6 -INF . 1.000 .

1 .1.7 -INF . 1.000 .

1 .1.8 -INF . 1.000 .

1 .1.9 -INF . 1.000 .

1 .1.10 -INF . 1.000 .

1 .1.11 -INF . 1.000 .

1 .1.12 -INF . 1.000 .

1 .1.13 -INF . 1.000 .

1 .1.14 -INF . 1.000 .

1 .1.15 -INF . 1.000 .

1 .1.16 -INF . 1.000 .

1 .1.17 -INF . 1.000 .

1 .1.18 -INF . 1.000 .

1 .1.19 -INF . 1.000 .

1 .1.20 -INF . 1.000 .

1 .1.21 -INF . 1.000 .

1 .1.22 -INF . 1.000 .

1 .1.23 -INF . 1.000 .

1 .1.24 -INF . 1.000 .

1 .1.25 -INF . 1.000 .

1 .1.26 -INF . 1.000 .

1 .1.27 -INF . 1.000 .

1 .1.28 -INF . 1.000 .

1 .1.29 -INF . 1.000 .

2 .1.1 -INF . 1.000 .

2 .1.2 -INF . 1.000 .

2 .1.3 -INF . 1.000 .

2 .1.4 -INF . 1.000 .

2 .1.5 -INF . 1.000 .

2 .1.6 -INF . 1.000 .

2 .1.7 -INF . 1.000 .

2 .1.8 -INF . 1.000 .

2 .1.9 -INF . 1.000 .

2 .1.10 -INF . 1.000 .

2 .1.11 -INF . 1.000 .

2 .1.12 -INF . 1.000 .

2 .1.13 -INF . 1.000 .

2 .1.14 -INF . 1.000 .

2 .1.15 -INF . 1.000 .

2 .1.16 -INF . 1.000 .

2 .1.17 -INF . 1.000 .

2 .1.18 -INF . 1.000 .

2 .1.19 -INF . 1.000 .

2 .1.20 -INF . 1.000 .

2 .1.21 -INF . 1.000 .

2 .1.22 -INF . 1.000 .

2 .1.23 -INF . 1.000 .

2 .1.24 -INF . 1.000 .

2 .1.25 -INF . 1.000 .

2 .1.26 -INF . 1.000 .

2 .1.27 -INF . 1.000 .

2 .1.28 -INF . 1.000 .

2 .1.29 -INF . 1.000 .

3 .1.1 -INF . 1.000 .

3 .1.2 -INF . 1.000 .

3 .1.3 -INF . 1.000 .

3 .1.4 -INF . 1.000 .

3 .1.5 -INF . 1.000 .

3 .1.6 -INF . 1.000 .

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LOWER LEVEL UPPER MARGINAL

---- VAR OptObject~ -INF . +INF .

OptObjective Objective function for the Optimality problem

\*\*\*\* REPORT SUMMARY : 0 NONOPT

0 INFEASIBLE

0 UNBOUNDED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE Optimality Using LP From line 936

---- OptObj =E= Objective function for the optimality problem

OptObj.. OptObjective =E= 0 ; (LHS = 0)

---- Optconst1 =L= Constraint for the optimality problem

Optconst1(1,1,1).. pi(1,1,1) =L= 1 ; (LHS = 0)

Optconst1(1,1,2).. pi(1,1,2) =L= 1 ; (LHS = 0)

Optconst1(1,1,3).. pi(1,1,3) =L= 1 ; (LHS = 0)

REMAINING 838 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE Optimality Using LP From line 936

---- pi simplex variable (one in number)

pi(1,1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,1)

pi(1,1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,2)

pi(1,1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,3)

REMAINING 838 ENTRIES SKIPPED

---- OptObjective Objective function for the Optimality problem

OptObjective

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 OptObj

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE Optimality Using LP From line 936

LOOPS FOR/WHILE 1

FOR/WHILE 2

MODEL STATISTICS

BLOCKS OF EQUATIONS 2 SINGLE EQUATIONS 842

BLOCKS OF VARIABLES 2 SINGLE VARIABLES 842

NON ZERO ELEMENTS 842

GENERATION TIME = 0.016 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.016 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 2

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE Optimality Using LP From line 936

S O L V E S U M M A R Y

MODEL Optimality OBJECTIVE OptObjective

TYPE LP DIRECTION MAXIMIZE

SOLVER CPLEX FROM LINE 936

\*\*\*\* SOLVER STATUS 1 Normal Completion

\*\*\*\* MODEL STATUS 1 Optimal

\*\*\*\* OBJECTIVE VALUE 0.0000

RESOURCE USAGE, LIMIT 0.000 1000.000

ITERATION COUNT, LIMIT 0 2000000000

IBM ILOG CPLEX 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

--- GAMS/Cplex licensed for continuous and discrete problems.

Cplex 12.5.1.0

LP status(1): optimal

Cplex Time: 0.00sec (det. 0.46 ticks)

Optimal solution found.

Objective : 0.000000

LOWER LEVEL UPPER MARGINAL

---- EQU OptObj . . . 1.000

OptObj Objective function for the optimality problem

---- EQU Optconst1 Constraint for the optimality problem

LOWER LEVEL UPPER MARGINAL

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LOWER LEVEL UPPER MARGINAL

---- VAR OptObject~ -INF . +INF .

OptObjective Objective function for the Optimality problem

\*\*\*\* REPORT SUMMARY : 0 NONOPT

0 INFEASIBLE

0 UNBOUNDED

GAMS 24.1.3 r41464 Released Jul 26, 2013 WEX-WEI x86\_64/MS Windows 01/19/16 16:16:30 Page 56

G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE Optimality Using LP From line 936

---- OptObj =E= Objective function for the optimality problem

OptObj.. OptObjective =E= 0 ; (LHS = 0)

---- Optconst1 =L= Constraint for the optimality problem

Optconst1(1,1,1).. pi(1,1,1) =L= 1 ; (LHS = 0)

Optconst1(1,1,2).. pi(1,1,2) =L= 1 ; (LHS = 0)

Optconst1(1,1,3).. pi(1,1,3) =L= 1 ; (LHS = 0)

REMAINING 838 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE Optimality Using LP From line 936

---- pi simplex variable (one in number)

pi(1,1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,1)

pi(1,1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,2)

pi(1,1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,3)

REMAINING 838 ENTRIES SKIPPED

---- OptObjective Objective function for the Optimality problem

OptObjective

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 OptObj

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE Optimality Using LP From line 936

LOOPS FOR/WHILE 1

FOR/WHILE 3

MODEL STATISTICS

BLOCKS OF EQUATIONS 2 SINGLE EQUATIONS 842

BLOCKS OF VARIABLES 2 SINGLE VARIABLES 842

NON ZERO ELEMENTS 842

GENERATION TIME = 0.016 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.031 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 3

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE Optimality Using LP From line 936

S O L V E S U M M A R Y

MODEL Optimality OBJECTIVE OptObjective

TYPE LP DIRECTION MAXIMIZE

SOLVER CPLEX FROM LINE 936

\*\*\*\* SOLVER STATUS 1 Normal Completion

\*\*\*\* MODEL STATUS 1 Optimal

\*\*\*\* OBJECTIVE VALUE 0.0000

RESOURCE USAGE, LIMIT 0.031 1000.000

ITERATION COUNT, LIMIT 0 2000000000

IBM ILOG CPLEX 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

--- GAMS/Cplex licensed for continuous and discrete problems.

Cplex 12.5.1.0

LP status(1): optimal

Cplex Time: 0.00sec (det. 0.46 ticks)

Optimal solution found.

Objective : 0.000000

LOWER LEVEL UPPER MARGINAL

---- EQU OptObj . . . 1.000

OptObj Objective function for the optimality problem

---- EQU Optconst1 Constraint for the optimality problem

LOWER LEVEL UPPER MARGINAL

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---- VAR pi simplex variable (one in number)

LOWER LEVEL UPPER MARGINAL

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LOWER LEVEL UPPER MARGINAL

---- VAR OptObject~ -INF . +INF .

OptObjective Objective function for the Optimality problem

\*\*\*\* REPORT SUMMARY : 0 NONOPT

0 INFEASIBLE

0 UNBOUNDED

GAMS 24.1.3 r41464 Released Jul 26, 2013 WEX-WEI x86\_64/MS Windows 01/19/16 16:16:30 Page 60

G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE Optimality Using LP From line 936

---- OptObj =E= Objective function for the optimality problem

OptObj.. OptObjective =E= 0 ; (LHS = 0)

---- Optconst1 =L= Constraint for the optimality problem

Optconst1(1,1,1).. pi(1,1,1) =L= 1 ; (LHS = 0)

Optconst1(1,1,2).. pi(1,1,2) =L= 1 ; (LHS = 0)

Optconst1(1,1,3).. pi(1,1,3) =L= 1 ; (LHS = 0)

REMAINING 838 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE Optimality Using LP From line 936

---- pi simplex variable (one in number)

pi(1,1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,1)

pi(1,1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,2)

pi(1,1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,3)

REMAINING 838 ENTRIES SKIPPED

---- OptObjective Objective function for the Optimality problem

OptObjective

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 OptObj

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE Optimality Using LP From line 936

LOOPS FOR/WHILE 1

FOR/WHILE 4

MODEL STATISTICS

BLOCKS OF EQUATIONS 2 SINGLE EQUATIONS 842

BLOCKS OF VARIABLES 2 SINGLE VARIABLES 842

NON ZERO ELEMENTS 842

GENERATION TIME = 0.015 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.015 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 4

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE Optimality Using LP From line 936

S O L V E S U M M A R Y

MODEL Optimality OBJECTIVE OptObjective

TYPE LP DIRECTION MAXIMIZE

SOLVER CPLEX FROM LINE 936

\*\*\*\* SOLVER STATUS 1 Normal Completion

\*\*\*\* MODEL STATUS 1 Optimal

\*\*\*\* OBJECTIVE VALUE 0.0000

RESOURCE USAGE, LIMIT 0.000 1000.000

ITERATION COUNT, LIMIT 0 2000000000

IBM ILOG CPLEX 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

--- GAMS/Cplex licensed for continuous and discrete problems.

Cplex 12.5.1.0

LP status(1): optimal

Cplex Time: 0.00sec (det. 0.46 ticks)

Optimal solution found.

Objective : 0.000000

LOWER LEVEL UPPER MARGINAL

---- EQU OptObj . . . 1.000

OptObj Objective function for the optimality problem

---- EQU Optconst1 Constraint for the optimality problem

LOWER LEVEL UPPER MARGINAL

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29.1.29 . . +INF EPS

LOWER LEVEL UPPER MARGINAL

---- VAR OptObject~ -INF . +INF .

OptObjective Objective function for the Optimality problem

\*\*\*\* REPORT SUMMARY : 0 NONOPT

0 INFEASIBLE

0 UNBOUNDED

GAMS 24.1.3 r41464 Released Jul 26, 2013 WEX-WEI x86\_64/MS Windows 01/19/16 16:16:30 Page 64

G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE Optimality Using LP From line 936

---- OptObj =E= Objective function for the optimality problem

OptObj.. OptObjective =E= 0 ; (LHS = 0)

---- Optconst1 =L= Constraint for the optimality problem

Optconst1(1,1,1).. pi(1,1,1) =L= 1 ; (LHS = 0)

Optconst1(1,1,2).. pi(1,1,2) =L= 1 ; (LHS = 0)

Optconst1(1,1,3).. pi(1,1,3) =L= 1 ; (LHS = 0)

REMAINING 838 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE Optimality Using LP From line 936

---- pi simplex variable (one in number)

pi(1,1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,1)

pi(1,1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,2)

pi(1,1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,3)

REMAINING 838 ENTRIES SKIPPED

---- OptObjective Objective function for the Optimality problem

OptObjective

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 OptObj

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE Optimality Using LP From line 936

LOOPS FOR/WHILE 1

FOR/WHILE 5

MODEL STATISTICS

BLOCKS OF EQUATIONS 2 SINGLE EQUATIONS 842

BLOCKS OF VARIABLES 2 SINGLE VARIABLES 842

NON ZERO ELEMENTS 842

GENERATION TIME = 0.016 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.016 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 5

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE Optimality Using LP From line 936

S O L V E S U M M A R Y

MODEL Optimality OBJECTIVE OptObjective

TYPE LP DIRECTION MAXIMIZE

SOLVER CPLEX FROM LINE 936

\*\*\*\* SOLVER STATUS 1 Normal Completion

\*\*\*\* MODEL STATUS 1 Optimal

\*\*\*\* OBJECTIVE VALUE 0.0000

RESOURCE USAGE, LIMIT 0.015 1000.000

ITERATION COUNT, LIMIT 0 2000000000

IBM ILOG CPLEX 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

--- GAMS/Cplex licensed for continuous and discrete problems.

Cplex 12.5.1.0

LP status(1): optimal

Cplex Time: 0.01sec (det. 0.46 ticks)

Optimal solution found.

Objective : 0.000000

LOWER LEVEL UPPER MARGINAL

---- EQU OptObj . . . 1.000

OptObj Objective function for the optimality problem

---- EQU Optconst1 Constraint for the optimality problem

LOWER LEVEL UPPER MARGINAL

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LOWER LEVEL UPPER MARGINAL

---- VAR OptObject~ -INF . +INF .

OptObjective Objective function for the Optimality problem

\*\*\*\* REPORT SUMMARY : 0 NONOPT

0 INFEASIBLE

0 UNBOUNDED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE Optimality Using LP From line 936

---- OptObj =E= Objective function for the optimality problem

OptObj.. OptObjective =E= 0 ; (LHS = 0)

---- Optconst1 =L= Constraint for the optimality problem

Optconst1(1,1,1).. pi(1,1,1) =L= 1 ; (LHS = 0)

Optconst1(1,1,2).. pi(1,1,2) =L= 1 ; (LHS = 0)

Optconst1(1,1,3).. pi(1,1,3) =L= 1 ; (LHS = 0)

REMAINING 838 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE Optimality Using LP From line 936

---- pi simplex variable (one in number)

pi(1,1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,1)

pi(1,1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,2)

pi(1,1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,3)

REMAINING 838 ENTRIES SKIPPED

---- OptObjective Objective function for the Optimality problem

OptObjective

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 OptObj

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE Optimality Using LP From line 936

LOOPS FOR/WHILE 1

FOR/WHILE 6

MODEL STATISTICS

BLOCKS OF EQUATIONS 2 SINGLE EQUATIONS 842

BLOCKS OF VARIABLES 2 SINGLE VARIABLES 842

NON ZERO ELEMENTS 842

GENERATION TIME = 0.015 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.031 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 6

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE Optimality Using LP From line 936

S O L V E S U M M A R Y

MODEL Optimality OBJECTIVE OptObjective

TYPE LP DIRECTION MAXIMIZE

SOLVER CPLEX FROM LINE 936

\*\*\*\* SOLVER STATUS 1 Normal Completion

\*\*\*\* MODEL STATUS 1 Optimal

\*\*\*\* OBJECTIVE VALUE 0.0000

RESOURCE USAGE, LIMIT 0.016 1000.000

ITERATION COUNT, LIMIT 0 2000000000

IBM ILOG CPLEX 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

--- GAMS/Cplex licensed for continuous and discrete problems.

Cplex 12.5.1.0

LP status(1): optimal

Cplex Time: 0.00sec (det. 0.46 ticks)

Optimal solution found.

Objective : 0.000000

LOWER LEVEL UPPER MARGINAL

---- EQU OptObj . . . 1.000

OptObj Objective function for the optimality problem

---- EQU Optconst1 Constraint for the optimality problem

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LOWER LEVEL UPPER MARGINAL

---- VAR OptObject~ -INF . +INF .

OptObjective Objective function for the Optimality problem

\*\*\*\* REPORT SUMMARY : 0 NONOPT

0 INFEASIBLE

0 UNBOUNDED

GAMS 24.1.3 r41464 Released Jul 26, 2013 WEX-WEI x86\_64/MS Windows 01/19/16 16:16:30 Page 72

G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE Optimality Using LP From line 936

---- OptObj =E= Objective function for the optimality problem

OptObj.. OptObjective =E= 0 ; (LHS = 0)

---- Optconst1 =L= Constraint for the optimality problem

Optconst1(1,1,1).. pi(1,1,1) =L= 1 ; (LHS = 0)

Optconst1(1,1,2).. pi(1,1,2) =L= 1 ; (LHS = 0)

Optconst1(1,1,3).. pi(1,1,3) =L= 1 ; (LHS = 0)

REMAINING 838 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE Optimality Using LP From line 936

---- pi simplex variable (one in number)

pi(1,1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,1)

pi(1,1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,2)

pi(1,1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,3)

REMAINING 838 ENTRIES SKIPPED

---- OptObjective Objective function for the Optimality problem

OptObjective

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 OptObj

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE Optimality Using LP From line 936

LOOPS FOR/WHILE 1

FOR/WHILE 7

MODEL STATISTICS

BLOCKS OF EQUATIONS 2 SINGLE EQUATIONS 842

BLOCKS OF VARIABLES 2 SINGLE VARIABLES 842

NON ZERO ELEMENTS 842

GENERATION TIME = 0.032 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.047 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 7

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE Optimality Using LP From line 936

S O L V E S U M M A R Y

MODEL Optimality OBJECTIVE OptObjective

TYPE LP DIRECTION MAXIMIZE

SOLVER CPLEX FROM LINE 936

\*\*\*\* SOLVER STATUS 1 Normal Completion

\*\*\*\* MODEL STATUS 1 Optimal

\*\*\*\* OBJECTIVE VALUE 0.0000

RESOURCE USAGE, LIMIT 0.016 1000.000

ITERATION COUNT, LIMIT 0 2000000000

IBM ILOG CPLEX 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

--- GAMS/Cplex licensed for continuous and discrete problems.

Cplex 12.5.1.0

LP status(1): optimal

Cplex Time: 0.00sec (det. 0.46 ticks)

Optimal solution found.

Objective : 0.000000

LOWER LEVEL UPPER MARGINAL

---- EQU OptObj . . . 1.000

OptObj Objective function for the optimality problem

---- EQU Optconst1 Constraint for the optimality problem

LOWER LEVEL UPPER MARGINAL

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LOWER LEVEL UPPER MARGINAL

---- VAR OptObject~ -INF . +INF .

OptObjective Objective function for the Optimality problem

\*\*\*\* REPORT SUMMARY : 0 NONOPT

0 INFEASIBLE

0 UNBOUNDED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE Optimality Using LP From line 936

---- OptObj =E= Objective function for the optimality problem

OptObj.. OptObjective =E= 0 ; (LHS = 0)

---- Optconst1 =L= Constraint for the optimality problem

Optconst1(1,1,1).. pi(1,1,1) =L= 1 ; (LHS = 0)

Optconst1(1,1,2).. pi(1,1,2) =L= 1 ; (LHS = 0)

Optconst1(1,1,3).. pi(1,1,3) =L= 1 ; (LHS = 0)

REMAINING 838 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE Optimality Using LP From line 936

---- pi simplex variable (one in number)

pi(1,1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,1)

pi(1,1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,2)

pi(1,1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,3)

REMAINING 838 ENTRIES SKIPPED

---- OptObjective Objective function for the Optimality problem

OptObjective

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 OptObj

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE Optimality Using LP From line 936

LOOPS FOR/WHILE 1

FOR/WHILE 8

MODEL STATISTICS

BLOCKS OF EQUATIONS 2 SINGLE EQUATIONS 842

BLOCKS OF VARIABLES 2 SINGLE VARIABLES 842

NON ZERO ELEMENTS 842

GENERATION TIME = 0.015 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.015 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 8

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE Optimality Using LP From line 936

S O L V E S U M M A R Y

MODEL Optimality OBJECTIVE OptObjective

TYPE LP DIRECTION MAXIMIZE

SOLVER CPLEX FROM LINE 936

\*\*\*\* SOLVER STATUS 1 Normal Completion

\*\*\*\* MODEL STATUS 1 Optimal

\*\*\*\* OBJECTIVE VALUE 0.0000

RESOURCE USAGE, LIMIT 0.015 1000.000

ITERATION COUNT, LIMIT 0 2000000000

IBM ILOG CPLEX 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

--- GAMS/Cplex licensed for continuous and discrete problems.

Cplex 12.5.1.0

LP status(1): optimal

Cplex Time: 0.00sec (det. 0.46 ticks)

Optimal solution found.

Objective : 0.000000

LOWER LEVEL UPPER MARGINAL

---- EQU OptObj . . . 1.000

OptObj Objective function for the optimality problem

---- EQU Optconst1 Constraint for the optimality problem

LOWER LEVEL UPPER MARGINAL

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28.1.1 -INF . 1.000 .

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LOWER LEVEL UPPER MARGINAL

---- VAR OptObject~ -INF . +INF .

OptObjective Objective function for the Optimality problem

\*\*\*\* REPORT SUMMARY : 0 NONOPT

0 INFEASIBLE

0 UNBOUNDED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE Optimality Using LP From line 936

---- OptObj =E= Objective function for the optimality problem

OptObj.. OptObjective =E= 0 ; (LHS = 0)

---- Optconst1 =L= Constraint for the optimality problem

Optconst1(1,1,1).. pi(1,1,1) =L= 1 ; (LHS = 0)

Optconst1(1,1,2).. pi(1,1,2) =L= 1 ; (LHS = 0)

Optconst1(1,1,3).. pi(1,1,3) =L= 1 ; (LHS = 0)

REMAINING 838 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE Optimality Using LP From line 936

---- pi simplex variable (one in number)

pi(1,1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,1)

pi(1,1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,2)

pi(1,1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,3)

REMAINING 838 ENTRIES SKIPPED

---- OptObjective Objective function for the Optimality problem

OptObjective

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 OptObj

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE Optimality Using LP From line 936

LOOPS FOR/WHILE 1

FOR/WHILE 9

MODEL STATISTICS

BLOCKS OF EQUATIONS 2 SINGLE EQUATIONS 842

BLOCKS OF VARIABLES 2 SINGLE VARIABLES 842

NON ZERO ELEMENTS 842

GENERATION TIME = 0.015 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.015 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 9

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE Optimality Using LP From line 936

S O L V E S U M M A R Y

MODEL Optimality OBJECTIVE OptObjective

TYPE LP DIRECTION MAXIMIZE

SOLVER CPLEX FROM LINE 936

\*\*\*\* SOLVER STATUS 1 Normal Completion

\*\*\*\* MODEL STATUS 1 Optimal

\*\*\*\* OBJECTIVE VALUE 0.0000

RESOURCE USAGE, LIMIT 0.031 1000.000

ITERATION COUNT, LIMIT 0 2000000000

IBM ILOG CPLEX 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

--- GAMS/Cplex licensed for continuous and discrete problems.

Cplex 12.5.1.0

LP status(1): optimal

Cplex Time: 0.00sec (det. 0.46 ticks)

Optimal solution found.

Objective : 0.000000

LOWER LEVEL UPPER MARGINAL

---- EQU OptObj . . . 1.000

OptObj Objective function for the optimality problem

---- EQU Optconst1 Constraint for the optimality problem

LOWER LEVEL UPPER MARGINAL

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LOWER LEVEL UPPER MARGINAL

---- VAR OptObject~ -INF . +INF .

OptObjective Objective function for the Optimality problem

\*\*\*\* REPORT SUMMARY : 0 NONOPT

0 INFEASIBLE

0 UNBOUNDED

GAMS 24.1.3 r41464 Released Jul 26, 2013 WEX-WEI x86\_64/MS Windows 01/19/16 16:16:30 Page 84

G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Equation Listing SOLVE Optimality Using LP From line 936

---- OptObj =E= Objective function for the optimality problem

OptObj.. OptObjective =E= 0 ; (LHS = 0)

---- Optconst1 =L= Constraint for the optimality problem

Optconst1(1,1,1).. pi(1,1,1) =L= 1 ; (LHS = 0)

Optconst1(1,1,2).. pi(1,1,2) =L= 1 ; (LHS = 0)

Optconst1(1,1,3).. pi(1,1,3) =L= 1 ; (LHS = 0)

REMAINING 838 ENTRIES SKIPPED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Column Listing SOLVE Optimality Using LP From line 936

---- pi simplex variable (one in number)

pi(1,1,1)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,1)

pi(1,1,2)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,2)

pi(1,1,3)

(.LO, .L, .UP, .M = 0, 0, +INF, EPS)

1 Optconst1(1,1,3)

REMAINING 838 ENTRIES SKIPPED

---- OptObjective Objective function for the Optimality problem

OptObjective

(.LO, .L, .UP, .M = -INF, 0, +INF, 0)

1 OptObj

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Model Statistics SOLVE Optimality Using LP From line 936

LOOPS FOR/WHILE 1

FOR/WHILE 10

MODEL STATISTICS

BLOCKS OF EQUATIONS 2 SINGLE EQUATIONS 842

BLOCKS OF VARIABLES 2 SINGLE VARIABLES 842

NON ZERO ELEMENTS 842

GENERATION TIME = 0.015 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

EXECUTION TIME = 0.015 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

L O O P S FOR/WHILE 1

FOR/WHILE 10

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

Solution Report SOLVE Optimality Using LP From line 936

S O L V E S U M M A R Y

MODEL Optimality OBJECTIVE OptObjective

TYPE LP DIRECTION MAXIMIZE

SOLVER CPLEX FROM LINE 936

\*\*\*\* SOLVER STATUS 1 Normal Completion

\*\*\*\* MODEL STATUS 1 Optimal

\*\*\*\* OBJECTIVE VALUE 0.0000

RESOURCE USAGE, LIMIT 0.016 1000.000

ITERATION COUNT, LIMIT 0 2000000000

IBM ILOG CPLEX 24.1.3 r41464 Released Jul 26, 2013 WEI x86\_64/MS Windows

--- GAMS/Cplex licensed for continuous and discrete problems.

Cplex 12.5.1.0

LP status(1): optimal

Cplex Time: 0.00sec (det. 0.46 ticks)

Optimal solution found.

Objective : 0.000000

LOWER LEVEL UPPER MARGINAL

---- EQU OptObj . . . 1.000

OptObj Objective function for the optimality problem

---- EQU Optconst1 Constraint for the optimality problem

LOWER LEVEL UPPER MARGINAL

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29.1.2 . . +INF EPS

29.1.3 . . +INF EPS

29.1.4 . . +INF EPS

29.1.5 . . +INF EPS

29.1.6 . . +INF EPS

29.1.7 . . +INF EPS

29.1.8 . . +INF EPS

29.1.9 . . +INF EPS

29.1.10 . . +INF EPS

29.1.11 . . +INF EPS

29.1.12 . . +INF EPS

29.1.13 . . +INF EPS

29.1.14 . . +INF EPS

29.1.15 . . +INF EPS

29.1.16 . . +INF EPS

29.1.17 . . +INF EPS

29.1.18 . . +INF EPS

29.1.19 . . +INF EPS

29.1.20 . . +INF EPS

29.1.21 . . +INF EPS

29.1.22 . . +INF EPS

29.1.23 . . +INF EPS

29.1.24 . . +INF EPS

29.1.25 . . +INF EPS

29.1.26 . . +INF EPS

29.1.27 . . +INF EPS

29.1.28 . . +INF EPS

29.1.29 . . +INF EPS

LOWER LEVEL UPPER MARGINAL

---- VAR OptObject~ -INF . +INF .

OptObjective Objective function for the Optimality problem

\*\*\*\* REPORT SUMMARY : 0 NONOPT

0 INFEASIBLE

0 UNBOUNDED

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G e n e r a l A l g e b r a i c M o d e l i n g S y s t e m

E x e c u t i o n

---- 989 PARAMETER ReductionTarget Desired reduction in grams per year for t

he individual industries

1 0.12283, 2 0.00203, 3 0.01003, 4 0.00141

5 0.00320, 6 0.00303, 7 0.00195, 8 0.07865

9 0.00795, 10 0.00052, 11 0.00047, 12 0.00069

13 0.00163, 14 0.01081, 15 0.04000, 16 0.02366

17 0.17395, 18 0.05715, 19 0.00371, 20 0.00071

21 0.27732, 22 0.01603, 23 0.06553, 24 0.00313

25 0.00134, 26 0.00085, 27 4.139517E-6, 28 0.00237

29 0.00005

---- 989 PARAMETER ReductionFinal Final reduction in the discharge achieved

by each industry after optimization

( ALL 0.00000 )

---- 989 PARAMETER ReductionTargetTotal = 0.91101 The total targetted r

eduction from all the

industries

PARAMETER ReductionFinalTotal = 0.00000 The final combined re

duction achieved by a

ll the industries

---- 989 PARAMETER ReductionTechnology The final reduction achieved by each

industry due to technology implementa

tion only

( ALL 0.00000 )

---- 991 VARIABLE MasterObjective.L = 0.00000 Objective function of

the master problem

PARAMETER iter = 2.00000 iteration count

---- 991 VARIABLE Volume.L volume of waste treated by each industry using ea

ch technology (defined over i and j)

( ALL 0.00000 )

---- 991 VARIABLE t.L Variable deciding the amount of mercury traded between

various industries

( ALL 0.00000 )

---- 991 PARAMETER Results Summary of cost related values

( ALL 0.00000 )

---- 991 PARAMETER CostTechSolutionMax The maximum value for the nonlinear t

echnology implementation costs for ea

ch industry from all samples

( ALL 0.00000 )

---- 991 VARIABLE NonlinearTechCost.L

( ALL 0.00000 )

---- 991 PARAMETER b binary parameter specifying the process selection based

on first stage decision variables

( ALL 0. )

EXECUTION TIME = 0.000 SECONDS 3 MB 24.1.3 r41464 WEX-WEI

USER: Jeff Polasek G130903:1641AS-WIN

Texas A&M University, Artie McFerrin Department of ChemicaDC10525

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\*\*\*\* FILE SUMMARY

Input C:\Users\debalinasengupta\Desktop\TwoStageLP.gms

Output C:\Users\debalinasengupta\Documents\gamsdir\projdir\TwoStageLP.lst