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"Modelova uloha - absorpcni obeh kombinovane vyroby elektriny a chladu"

Q_24=100 "hodnota pozadovaneho tepelneho toku v desorberu mezi mediem MM a smesi LiBr-H2O"
"na zakl. teto hodnoty je vypocteny hmotnostni tok MM"

"VYPARNIK = evaporator"

"Urcujici parametry na vystupu:"
T[42]=8 "chladici voda na vystupu"
DELTAT_eva=3

T[10]=T[42]-DELTAT_eva   "teplota, na ktere se musi voda vyparovat"
T[11]=T[10] "vyparovani H2O = isotermicky dej"
p[10]=Pressure(Steam_IAPWS;T=T[10];x=0)  "tlak, na kterem se zacina voda vyparovat"
p[10]=p[11] "vyparovani = isobaricky dej"

m[11]=m[10]

Q_1011=m[10]*(h[11]-h[10]) "mnozstvi tepla odebraneho z CHLAZENE vody/vzduchu"
h[11]=enthalpy(Steam_iapws;T=T[11];x=1) "entalpie pary na konci vyparovani"
"h[10] = urceno kondenzatorem (skrceni - isoentalpicky dej)"

T[41]=13 "teplota na vstupu"
h_41H2O=Enthalpy(Water;T=T[41];P=1) "entalpie chlazene vody na vstupu do vyparniku"
h[41]=h_41H2O
h_42H2O=Enthalpy(Water;T=T[42];P=1)
h[42]=h_42H2O
Q_1011=m[41]*(h[41]-h[42]) "teplo prijate chlazenou vodou/vzduchem" "=> Urceni hmot. toku m[41]"
m[42]=m[41]

s[41]=Entropy(Water;T=T[41];P=1)
s[42]=Entropy(Water;T=T[42];P=1)

"SLUCOVANI"
m[12]=m[11]+m[7] "hmotnostni bilance"
m[12]*h[12]=m[11]*h[11]+m[7]*h[7] "energeticka bilance"
p[12]=p[11]
m[6]=m[7]

T[12]=Temperature(Steam_IAPWS;P=p[12];h=h[12]) "teplota ve stavu 12"

"ABSORBER"
"mixing"
p[16]=p[12]
m[16]=m[15]+m[12] "hmotnostni bilance smesi"

m[16]*xi[16]=m[12]+m[15]*xi[15] "hmotnostni bilance H2O"
xi[15]=0,38 "volena koncentrace VODY s silnem roztoku LiBr-H2O"

m[16]*h[16]=m[12]*h[12]+m[15]*h[15] "energeticka bilance - odsud a z hmot. bilanci zjistime m[15] a m[16]"

"samotna absorpce/kondenzace"
CALL t_phxi_WaLi_EES(p[16];h[16];xi[16]:T[16]) "vypocet teploty na zacatku absorbce"

CALL xil_psts_WaLi_EES(p[17];T[17]:xi[17])  "vypocet hmot. koncentrace na konci vystupu absorberu (slaby roztok) z tlaku a
 teplotu"
xi[17]=xi[16]
p[17]=p[16]
T[17]=35  "pozadovana teplota vystupni"

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CALL hl_pstsxil_WaLi_EES(p[17];T[17];-1:h[17]) "vypocet vystupni entalpie h[17] za absorberem"
CALL sl_pstsxil_WaLi_EES(p[17];T[17];-1:s[17]) "vypocet vystupni entropie s[17] za absorberem"

Q_1617=m[16]*(h[16]-h[17]) "teplo odevzdane chladici vode"
Q_1617=m[31]*(h[32]-h[31]) "teplo prijate chladici vodou"

DELTAT_absorb=min(DELTA_T[start_cond..end_cond])
DELTAT_absorb=10

h[31]=Enthalpy(Water;T=T[31];P=1) "entalpie privadene chladici vody na vstupu pri atmosfer. tlaku"
T[32]=Temperature(Water;P=1;h=h[32]) "teplota chladici vody na vystupu z abs. (h[32] urceno z mnostvi tepla; p je atmosfericky)"
m[31]=m[32]
T[31]=25 "teplota chladici vody na vstupu do absorberu"

s[31]=Entropy(Water;T=T[31];P=1)
s[32]=Entropy(Water;T=T[32];P=1)


"CERPADLO"
eta_p=0,7 "ucinnost cerpadla (pump)"
m[17]=m[16]
m[1]=m[17]

s_ideal[1]=s[17]
CALL t_psxi_WaLi_EES(p[1];s_ideal[1];xi[1]:T_ideal[1]) "isoentropicka teplota - v knihovne neni prima funkce pro zjisteni entalpie"
CALL h_ptxi_WaLi_EES(p[1];T_ideal[1];xi[1]:h_ideal[1]) "entalpie po idealni isoentropicke zmene"
h[1]-h[17]=(h_ideal[1]-h[17])/eta_p "vypocet skutecne entalpie h[1] za cerpadlem"
xi[1]=xi[17]
CALL t_phxi_WaLi_EES(p[1];h[1];xi[1]:T[1]) "Vypocet teploty za cerpadlem"

W_117=m[17]*(h[1]-h[17]) "potrebna prace cerpadla"

"REKUPERATOR"
dT_rec=10
Q_12=m[1]*(h[2]-h[1]) "Energeticka bilance v rekuperatoru"
Q_12=m[13]*(h[13]-h[14])
CALL h_ptxi_WaLi_EES(p[14];T[14];xi[14]:h[14]) "vypocet entalpie silne smesi po regeneraci"
p[14]=p[13]
xi[14]=xi[13]
T[14]=T[1]+dT_rec
m[14]=m[13]

p[2]=p[1]

"skrceni"
h[15]=h[14] "isoentalpicky dej"

p[15]=p[16]
CALL t_phxi_WaLi_EES(p[15];h[15];xi[15]:T[15]) "urceni teploty silne smesi ve stavu 15"

"DESORBER"
DELTAT_desorb=10 "podminka pitch point platna pro stav 34-22"
T[22]=T_sat(MM;P=p[22]) "teplota externiho media MM na vstupu do desorberu v C"
T[23]=T[22]
p[21]=0,75 "tlak media MM na vstupu do desorberu v bar"
p[22]=p[21]
p[23]=p[22]
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T[34]=T[22]-DELTAT_desorb "teplota smesi na konci isobarickeho ohrati" "predpoklad pitch pointu mezi 34-22"

"predehrati"
CALL t_phxi_WaLi_EES(p[2];h[2];xi[2]:T[2]) "Teplota T[2] na vstupu do desorberu"
xi[2]=xi[1] ".!!!"

Q_23=m[2]*(h[3]-h[2]) "teplo potrebne dodat slabe smesi do stavu nasyceni"
m[2]=m[1]
CALL hl_pstsxil_WaLi_EES(p[3];T[3];-1:h[3]) "vypocet entalpie ve stavu nasyceni = dolni mezni krivka"
p[3]=p[2]

Q_2223=m[22]*(h[22]-h[23]) "teplo odevzdane mediem MM behem predhrivani smesi"
h[23]=Enthalpy(MM;x=0;P=p[23])
h[22]=Enthalpy(MM;P=p[22];x=1) "entalpie media MM na vstupu do desorberu o teplote 90C"
s[22]=Entropy(MM;x=1;P=p[22])

m[22]=m[21]
m[23]=m[22]

"var"
CALL ps_tsxil_WaLi_EES(T[3];xi[3]:p[3]) "vypocet tlaku na dolni mezni krivce (var-isobara)"
xi[3]=xi[2]
p[4]=p[3]

Q_34=m[5]*h[5]+m[13]*h[13]-m[3]*h[3] "mnozstvi tepla prijateho behem varu"
m[3]=m[2]
CALL ts_psxil_WaLi_EES(p[4];xi[13]:T[4]) "Urceni teploty na konci varu"
xi[13]=xi[15]
h[5]=Enthalpy(Steam_IAPWS;T=T[4];P=p[4])
CALL hl_pstsxil_WaLi_EES(-1;T[4];xi[13]:h[13])

Q_3_34=Q_34-Q_2122 "Hledani stavu 34 mezi stavy 3 a 4 pro Pinch point"
Q_3_34=m[3]*(h[34]-h[3])
CALL t_phxi_WaLi_EES(p[3];h[34];xi[3]:T[34])
CALL s_ptxi_WaLi_EES(p[3];T[34];xi[3]:s[34])

Q_24=Q_23+Q_34 "celkove teplo prijate smesi v desorberu"

Q_2122=m[21]*(h[21]-h[22])
T[21]=150 "teplota se kterou opousti MM expander v ORC (vstup do desorberu)"
h[21]=Enthalpy(MM;T=T[21];P=p[21])

Q_24=Q_2122+Q_2223


"separace"
T[5]=T[4]
T[13]=T[4]
m[4]=m[5]+m[13] "hmotnostni bilance"
m_H2O=m[5]+xi[13]*m[13] "celkova hmotnost vody v jednotlivich slozkach"
m_H2O=xi[4]*m[4] "celkova hmotnost vody z zakl. smesi"
xi[4]=xi[3]
m[13]=m[15]
p[5]=p[4]
p[13]=p[4]

m_LiBr=m[1]-m_H2O

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"VETVENI"
m[5]=m[6]+m[8]
i_65=m[6]/m[5]
i_65=0,6 "<---------------------------- MENIT"
"i=0...neuvazujeme zatim vetev s turbinou; i=1... veskera para vyuzita k vyrobe elektriny"
T[8]=T[5]
p[8]=p[5]
p[6]=p[5]

"TURBINA"
eta_t=0,8 "ucinnost turbiny"

h[6]=h[5]
T[6]=T[5]
s[6]=Entropy(Steam_IAPWS;T=T[6];P=p[6]) "expanze pary v turbine je v idealnim pripade isoentropicky dej"
s_ideal[7]=s[6] "expanze pary v turbine je v idealnim pripade isoentropicky dej"
h_ideal[7]=Enthalpy(Steam_IAPWS;s=s_ideal[7];P=p[7])
p[7]=p[12] "pri slouceni vetvi konstantni tlak"
h[6]-h[7]=(h[6]-h_ideal[7])*eta_t "realni zmena entalpii je zmensena nasobkem o ucinnost turbiny" "=>h[7]"
W_67=m[6]*(h[6]-h[7]) "vypocet vykonane prace turbiny"
T[7]=Temperature(Steam_IAPWS;P=p[7];h=h[7]) "vypocet teploty na vystupu turbiny"
x_7=Quality(Steam_IAPWS;T=T[7];h=h[7])

"KONDENZATOR"
m[9]=m[8]
T[9]=Temperature(Steam_IAPWS;P=p[9];x=0)
p[9]=p[8] "isobaricky dej"

h[8]=Enthalpy(Steam_IAPWS;T=T[8];P=p[8]) "entalpie na vstupu do kondenzatoru"
h[9]=Enthalpy(Steam_IAPWS;x=0;T=T[9]) "entalpie na vystupu z kondenzatoru (x=0...dolni mezni krivka)"
Q_89=m[8]*(h[8]-h[9]) "Teplo potrebne k kondenzaci odevzdane chladici kapaline"
Q_89=m[27]*(h[28]-h[27]) "mnostvi tepla prijate chladici kapalinou (je privadena z vystupu absorberu)" "explicitni vyjadreni
 h[28]"
m[27]=m[28]
h[27]=Enthalpy(Water;T=T[27];P=1)
T[27]=25 "C"

T[28]=Temperature(Water;P=1;h=h[28]) "vypocet teploty chladici vody na vystupu ze systemu"
DELTAT_condenser=5
T[28]=T[9]-DELTAT_condenser "pinch point condition"

h_89=Enthalpy(Steam_IAPWS;T=T[9];x=1)
Q_8_89=m[8]*(h[8]-h_89)

s[27]=Entropy(Water;T=T[27];P=1)
s[28]=Entropy(Water;T=T[28];P=1)

"EXPANZNI VENTIL"
h[10]=h[9] "isoentalpicky dej"




"doplneni chybejicich stavu"
h[4]*m[4]=h[5]*m[5]+h[13]*m[13] "h[4]"
xi[5]=1
xi[6]=1
xi[7]=1
xi[8]=1
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xi[9]=1
xi[10]=1
xi[11]=1
xi[12]=1
xi[34]=xi[3]
p[34]=p[3]
m[34]=m[3]
p[27]=1
p[28]=1
p[31]=1
p[32]=1
p[41]=1
p[42]=1

"entropie:"
CALL s_ptxi_WaLi_EES(p[1];T[1];xi[1]:s[1])
CALL s_ptxi_WaLi_EES(p[2];T[2];xi[2]:s[2])
CALL sl_pstsxil_WaLi_EES(p[3];-1;xi[3]:s[3])
s[4]*m[4]=s[5]*m[5]+s[13]*m[13] "s[4]"
s[5]=Entropy(Steam_IAPWS;T=T[5];P=p[5])
s[7]=Entropy(Steam_IAPWS;x=1;P=p[7])
s[8]=Entropy(Steam_IAPWS;T=T[8];P=p[8])
s[9]=Entropy(Steam_IAPWS;x=0;P=p[9])
s[10]=Entropy(Steam_IAPWS;x=0;P=p[10])
s[11]=Entropy(Steam_IAPWS;x=1;P=p[11])
s[12]*m[12]=s[11]*m[11]+s[7]*m[7]
CALL s_ptxi_WaLi_EES(p[13];T[13];xi[13]:s[13])
CALL s_ptxi_WaLi_EES(p[14];T[14];xi[14]:s[14])
CALL s_ptxi_WaLi_EES(p[15];T[15];xi[15]:s[15])
s[16]*m[16]=s[12]*m[12]+s[15]*m[15] "s[16]"


"q-T distribuce"
n=50
start_cond=50
end_cond=50+n

T[start_cond]=T[16]
xi[start_cond]=xi[16]

Q_tot[start_cond]=0
h[start_cond]=h[16]
h_fluid[end_cond]=h[31]
T_hs[start_cond]=Temperature(Water;P=1;h=h[32])
DELTA_T[start_cond]=T[16]-T[32]

dh_cond=(h[16]-h[17])/n

duplicate i=start_cond+1;end_cond
    h[i]=h[i-1]-dh_cond
    CALL t_phxi_WaLi_EES(p[17];h[i];xi[17]:T[i])
    dQ_cond[i]=m[1]*dh_cond
    Q_tot[i]=Q_tot[i-1]+dQ_cond[i]
    h_fluid[i-1]-h_fluid[i]=dQ_cond[i]/m[31]
    h_fluid[i]=Enthalpy(Water;T=T_hs[i];P=1)
    DELTA_T[i]=T[i]-T_hs[i]

END

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293:
294: "UCINNOST"
295: "1st law efficiency"
296: W_net=W_67-W_117 "Celkovy ziskany mechanicky vykon obehu"
297: T_0=15+273,15 "referencni teplota okoli v Kelvinech"
298: DELTAEx_cold=m[41]*((h[42]-h[41])-T_0*(s[42]-s[41])) "exergie chlazene vody"
299: "eta_II_ref=0,3" "2nd law efficiency chladiciho cyklu (30% v pripade kompresniho cyklu)"
300: eta_I=(W_net+Q_1011)/Q_24 "efektivini 1st law efficiency"
301:
302: "Exergicka ucinnost"
303: eta_ex=(W_net+DELTAEx_cold)/DELTAEx_hs
304: DELTAEx_hs=m[21]*((h[21]-h[23])-T_0*(s[21]-s[23]))
305: s[21]=Entropy(MM;T=T[21];P=p[21])
306: s[23]=Entropy(MM;T=T[23];x=0)
307:
308: "COP v pripade i_65=0"
309: COP=Q_1011/Q_24
310:
311:
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