

Alumno: _____



Integración III

Recuperatorio 07/12/2023

Problema 1 (Psicrometría):

Una corriente de 1000 [kg/hr] de aire húmedo a 60 [°C] , 1 [atm] con una humedad relativa del 20 % se la satura con una corriente de 20 [kg/hr] de agua a 20 [°C] y 1 [atm]. Las corrientes de salida tienen una temperatura de 35 [°C]. Calcular:

- a) Cantidad de agua evaporada.
- b) Humedad absoluta de la corriente de salida.
- c) Flujos de salida
- d) Cantidad de calor a entregar o retirar.

Datos:

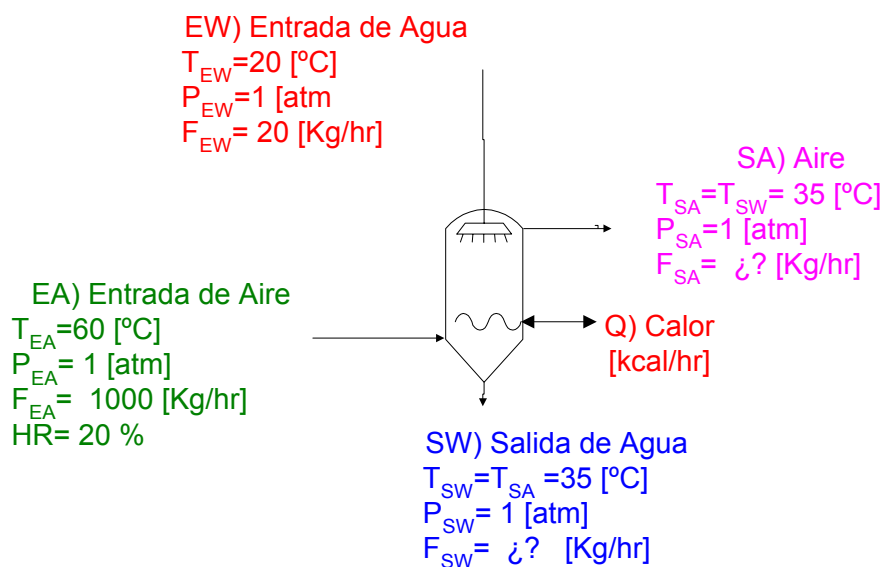
$$\log_{10}(P_s) = 8,07131 - \frac{1730,63}{233,426 + t} \quad \text{con } P_s \text{ en [mmHg] y } t \text{ en [°C]}$$

Entalpía del aire húmedo:

$$\overline{\Delta H} = 0,24 \times t + HA \times (595 + 0,46 \times t) \quad \text{En [kcal/Kg aire seco] y } t \text{ en [°C]}$$

Entalpía del agua líquida:

$$\overline{\Delta H} = 1 \times t \quad \text{En [kcal/Kg] y } t \text{ [°C]}$$



Flowsheet

Resolución:

Entrada EA:

$$P_{EA} = 760 \text{ [mmHg]}$$

$$HR_{EA} = 20 \%$$

$$T_{EA} = 60 \text{ [}^{\circ}\text{C]}$$

$$P_{sat}^{EA}(60) = 10^{\left(8,07131 - \frac{1730,63}{233,426 + t}\right)} = 10^{\left(8,07131 - \frac{1730,63}{233,426 + 60}\right)} = 149,04 \text{ [mmHg]}$$

$$P_{vap}^{EA} = \frac{HR \times P_{sat}}{100} = \frac{149,04 \times 100}{100} = 29,81 \text{ [mmHg]}$$

$$HAM_{EA} = \frac{P_{vap}^{EA}}{P_{EA} - P_{vap}^{EA}} = 0,04082 \left[\frac{\text{kmol Agua}}{\text{kmol Aire seco}} \right]$$

$$HA_{AE} = \frac{M_{Agua}}{M_{Aire}} \times HAM = \frac{18,05}{28,84} \times 0,04082 = 0,02555 \left[\frac{\text{kg Agua}}{\text{kg Aireseco}} \right]$$

$$F_{AE} = 1000 \text{ [kg/hr]}$$

$$x_{Agua}^{AE} = \frac{PAE_{vap}^{AE}}{P_{AE}} = \frac{29,81 \text{ [mmHg]}}{760 \text{ [mmHg]}} = 0,0392$$

$$x_{N2}^{AE} = 1 - 0,0392 = 0,9608$$

$$\overline{\Delta H}_{AE} = 0,24 \times t_{AE} + HA_{AE} \times (595 + 0,46 \times t_{AE}) = 0,24 \times 60 + 0,02555 \times (595 + 0,46 \times 60) = 30,31 \left[\frac{\text{kcal}}{\text{kg Aire seco}} \right]$$

$$F_{Aire seco}^{AE} = F_{AE} \times (1 - HA_{AE}) = 1000 \times (1 - 0,02555) = 974,5 \left[\frac{\text{kg Aireseco}}{\text{hr}} \right]$$

El flujo de energía:

$$FE_{AE} = 974,5 \times 30,31 = 2,954 \times 10^4 \left[\frac{\text{kCal}}{\text{hr}} \right]$$

Entrada EW:

$$F_{EW} = 20 \text{ [kg/hr]}$$

$$P_{EW} = 760 \text{ [mmHg]}$$

$$T_{EW} = 20 \text{ [}^{\circ}\text{C]}$$

$$\overline{\Delta H}_{EW} = Cp \times t = 1 \times 20 = 20 \left[\frac{\text{kcal}}{\text{kg Agua}} \right]$$

El flujo de energía:

$$FE_{AE} = 20 \times 20 = 400 \left[\frac{\text{kCal}}{\text{hr}} \right]$$

Salida G)

$$P_G = 760 \text{ [mmHg]}$$

$$HR_G = 100 \%$$

$$T_G = 35 \text{ [}^\circ\text{C]}$$

$$P_{\text{sat}}^G(35) = 10^{\left(8,07131 - \frac{1730,63}{233,426+t}\right)} = 10^{\left(8,07131 - \frac{1730,63}{233,426+35}\right)} = 42,07 \text{ [mmHg]}$$

$$P_{\text{vap}}^G = \frac{HR \times P_{\text{sat}}}{100} = \frac{42,07 \times 100}{100} = 42,07 \text{ [mmHg]}$$

$$HAM_G = \frac{P_{\text{vap}}^G}{P_G - P_{\text{vap}}^G} = 0,05860 \left[\frac{\text{kmol Agua}}{\text{kmol Aire seco}} \right]$$

$$HA_{AE} = \frac{M_{\text{Agua}}}{M_{\text{Aire}}} \times HAM = \frac{18,05}{28,84} \times 0,05860 = 0,03668 \left[\frac{\text{kg Agua}}{\text{kg Aireseco}} \right]$$

$$F_G = ? \text{ [kg/hr]}$$

$$x_{\text{Agua}}^G = \frac{PAE_{\text{vap}}^G}{P_{AE}} = \frac{42,07 \text{ [mmHg]}}{760 \text{ [mmHg]}} = 0,0554$$

$$x_{N_2}^G = 1 - 0,0554 = 0,9446$$

$$\overline{\Delta H}_G = 0,24 \times t_G + HA_G \times (595 + 0,46 \times t_G) = 0,24 \times 35 + 0,03668 \times (595 + 0,46 \times 35) = 30,81 \left[\frac{\text{kcal}}{\text{kg Aire seco}} \right]$$

$$F_{\text{Aire seco}}^G = 974,5 \left[\frac{\text{kg Aireseco}}{\text{hr}} \right]$$

El flujo de energía:

$$FE_G = 974,5 \times 30,81 = 3,002 \times 10^4 \left[\frac{\text{kCal}}{\text{hr}} \right]$$

Salida L:

$$F_L = ? \text{ [kg/hr]}$$

$$P_L = 760 \text{ [mmHg]}$$

$$T_L = 35 \text{ [}^\circ\text{C]}$$

$$\overline{\Delta H}_L = Cp \times t_L = 1 \times 35 = 35 \left[\frac{\text{kcal}}{\text{kg Agua}} \right]$$

El flujo de energía:

$$FE_{AE} = F_L \times 35$$

Balance de materia para el agua:

$$F_{Aire\ seco}^{AE} \times HA_{AE} + F_{EW} = F_{Aire\ seco}^G \times HA_G + F_L$$

$$F_L = F_{Aire\ seco}^{AE} \times HA_{AE} + F_{EW} - F_{Aire\ seco}^G \times HA_G$$

$$F_L = 974,5 \times 0,02555 + 20 - 974,5 \times 0,03668 = 9,154 \left[\frac{\text{kg}}{\text{hr}} \right]$$

Balance global

$$F_{AE} + F_{EW} = F_G + F_L$$

$$F_G = F_{AE} + F_{EW} - F_L = 1000 + 20 - 9,154 = 1011 \left[\frac{\text{kg}}{\text{hr}} \right]$$

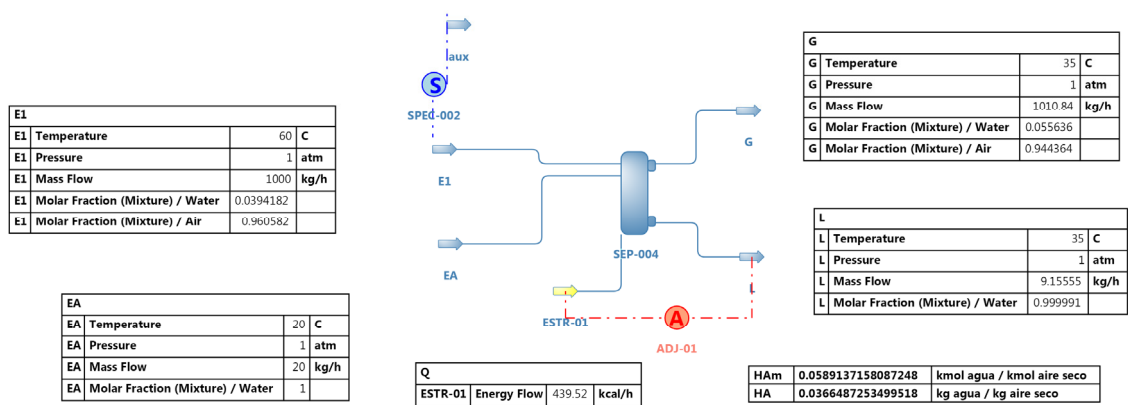
Balance de energía:

$$FE_{EA} + FE_{EW} + Q = FE_L + FE_G$$

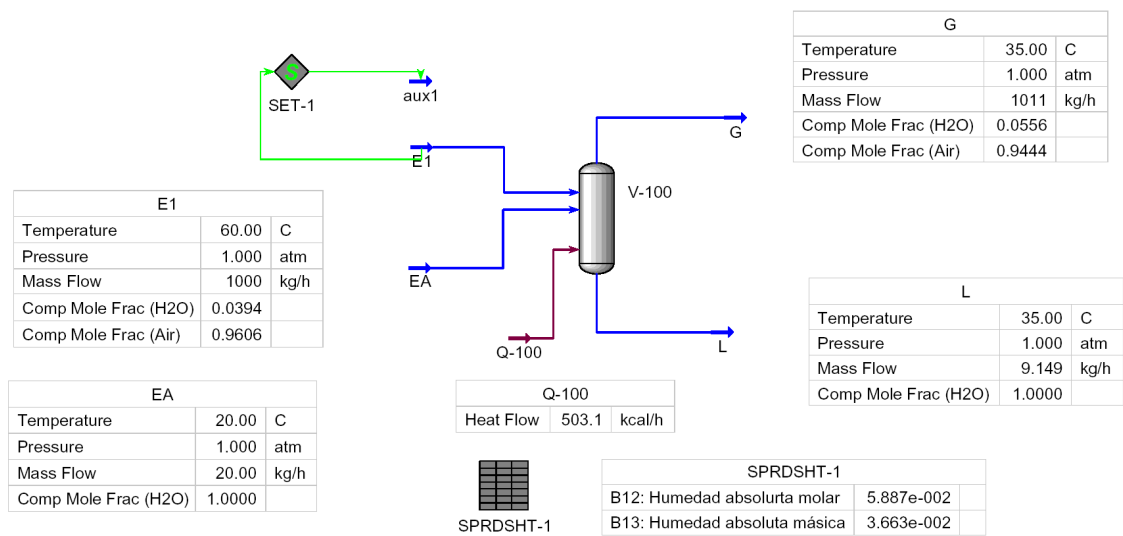
$$Q = FE_L + FE_G - FE_{EA} - FE_{EW}$$

$$Q = 9,154 \times 35 + 3,002 \times 10^4 - 2,954 \times 10^4 - 400 = 4,136 \times 10^2 \left[\frac{\text{kcal}}{\text{hr}} \right]$$

- a) La cantidad de agua evaporada: $20 - 9,145 = 10,85 \text{ [kg/hr]}$.
- b) La humedad absoluta a la salida es $0,0586 \text{ [kmol agua/kmol de aire seco]}$ o $0,03668 \text{ [kg agua/kg aire seco]}$.
- c) Salen $9,154 \text{ [kg/hr]}$ de agua en forma líquida y 1011 [kg/hr] de aire saturado a $35 \text{ [}^\circ\text{C]}$.
- d) Se deben entregar $413,6 \text{ [kcal/hr]}$.



dwsim



Hysys

GAMS

* Integración III recuperatorio

* Problema 1: psicrometria

PARAMETERS

A /8.07131/

B /1730.63/

C /233.426/

rel /0.6259/

PEA /760/

tEA /60/

HREA /20/

FEA /1000/

tEW /20/

Cp /1/

FEW /20/

HRSA /100/

tSA /35/

PSA /760/

POSITIVE VARIABLES

PSEA, PVEA , HAmEA, HAEA, FAS, DHEA, FEEA
DHEW, FEEW

PSSA, PVSA , HAmSA, HASA, DHSA, FESA, FSA
FSW, FEvap, tSW, DHSW, FESW

Q ;

EQUATIONS

R1,R2,R3,R4, R5, R6, R7

R8, R9

R10, R11, R12, R13, R14, R15, R16

R17, R18, R19, R20, R21

R22 ;

R1.. $\log_{10}(PSEA)=E= A-B/(tEA+C);$

R2.. $HREA =E= PVEA/PSEA*100;$

R3.. $HAmEA =E= PVEA/(PEA-PVEA);$

R4.. $HAEA =E= rel*HAmEA;$

R5.. $FAS =E= FEA*(1-HAEA);$

R6.. $DHEA =E= 0.24*tEA+HAEA*(595+0.46*tEA);$

R7.. $FEEA =E= FAS*DHEA;$

R8.. $DHEW =E= Cp*tEW;$

R9.. $FEEW =E= FEW*DHEW;$

R10.. $\log_{10}(PSSA)=E= A-B/(tSA+C);$

R11.. $HRSA =E= PVSA/PSSA*100;$

R12.. $HAmSA =E= PVSA/(PSA-PVSA);$

R13.. $HASA =E= rel*HAmSA;$

R14.. $DHSA =E= 0.24*tSA+HASA*(595+0.46*tSA);$

R15.. $FESA =E= FAS*DHSA;$

R16.. $FSA = E = FAS * (1 + HASA);$
 R17.. $FSW = e = FAS * (HAEA - HASA) + FEW;$
 R18.. $FEvap = E = FEW - FSW;$
 R19.. $tSW = E = tSA;$
 R20.. $DHSW = E = Cp * tSW;$
 R21.. $FESW = E = FSW * DHSW;$
 R22.. $FEEA + FEEW + Q = E = FESA + FESW;$

PSEA.I=30;

PSSA.I=30;

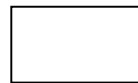
MODEL BM /ALL/;

SOLVE BM USING CNS;

Resultados:

VAR	LOWER	LEVEL	UPPER
PSEA	.	149.038	=+INF
PVEA	.	29.808	=+INF
HAmEA	.	0.041	=+INF
HAEA	.	0.026	=+INF
FAS	.	974.45	=+INF
DHEA	.	30.308	=+INF
FEEA	.	29533.245	=+INF
DHEW	.	20	=+INF
FEEW	.	400	=+INF
PSSA	.	42.071	=+INF
PVSA	.	42.071	=+INF
HAmSA	.	0.059	=+INF
HASA	.	0.037	=+INF
DHSA	.	30.814	=+INF
FESA	.	30026.701	=+INF
FSA	.	1010.191	=+INF
FSW	.	9.156	=+INF
FEvap	.	10.844	=+INF
tSW	.	35	=+INF
DHSW	.	35	=+INF
FESW	.	320.477	=+INF
Q	.	413.933	=+INF
Agua Evap		10.844	

Alumno: _____



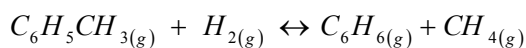
Integración III

Recuperatorio 06/12/2022

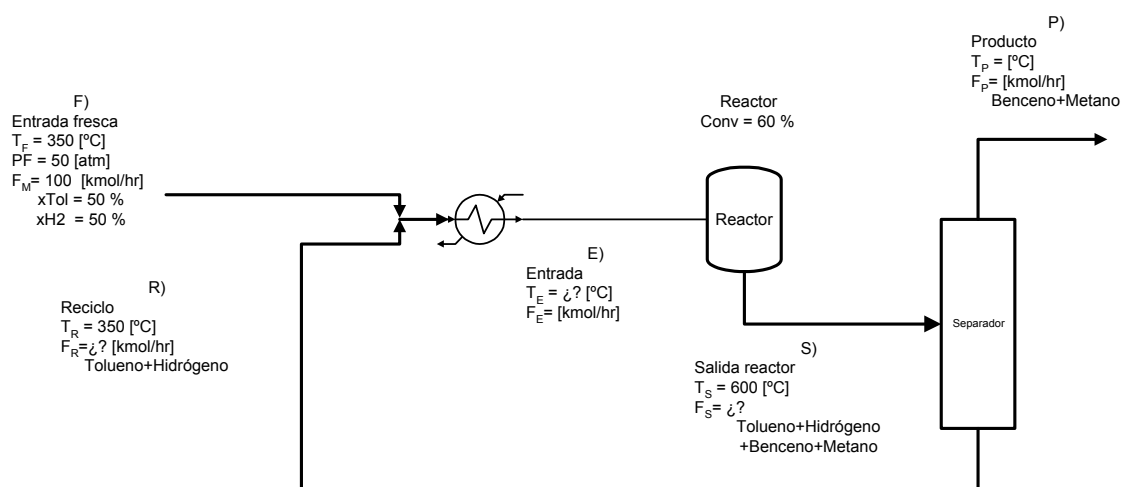
Problema 2: (Termoquímica):

Se obtiene benceno de la hidrogenación del tolueno. Para ello ingresa una corriente del 100 [kmol/hr] al 50 % en moles de tolueno e hidrógeno con una temperatura de 350 [°C] y 50 [atm] de presión. La conversión por paso es del 60 % y la global del 100 %. El reactor es adiabático. De los productos se separan el tolueno y el hidrógeno de los productos y se reciclan. Calcular

- Flujo de la recirculación.
- Temperatura a que hay que calentar los reactantes para que la salida del reactor tenga 600 [°C].

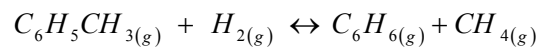


Comp	$\overline{\Delta H_i} \left[\frac{kcal}{kmol} \right], T [^{\circ}K]$	
	a x T	b
Tolueno	5,946E+01	-1,533E+04
Hidrogeno	7,102E+00	-2,178E+03
Benceno	4,637E+01	-7,630E+02
Metano	1,465E+01	-2,370E+04



Flowsheet

Resolución:



Corriente: F

$$F_F = 100 \text{ [kmol/hr]}$$

$$T_F = 350 \text{ [}^\circ\text{C]} = 623,15 \text{ [}^\circ\text{K]}$$

$$P_F = 50 \text{ [atm]}$$

$$x_{Tol}^F = 0,500$$

$$x_{H_2}^F = 0,500$$

$$x_{Ben}^F = 0,000$$

$$x_{Met}^F = 0,000$$

Corriente: R

Conversión por paso = 60 %

Conversión global = 100 %

De los 50 [kmoles/hr] que entran de la alimentación neta todos reaccionan y sólo sale del sistema el 50 % del reciclo (el otro 50 % es del H₂ sin reaccionar):

$$conv = \frac{Rx}{E} \times 100 = \frac{0,5 \times 100}{(100 + R) \times 0,5} \times 100 = 60$$

$$\frac{0,5 \times 100}{(100 + R) \times 0,5} = 0,60$$

$$\frac{0,5 \times 100}{0,60} = (100 + R) \times 0,5$$

$$83,3 = 50 + R \times 0,5$$

$$R = \frac{83,3 - 50}{0,5} = 66,6 \left[\frac{\text{kmol}}{\text{hr}} \right]$$

$$F_R = 66,66 \text{ [kmol/hr]}$$

$$T_R = 350 \text{ [}^\circ\text{C]} = 623,15 \text{ [}^\circ\text{K]}$$

$$P_R = 50 \text{ [atm]}$$

$$x^R_{Tol} = 0,500$$

$$x^R_{H_2} = 0,500$$

$$x^R_{Ben} = 0,000$$

$$x^R_{Met} = 0,000$$

Corriente: M

$$F_M = F_F + F_R = 100 + 66,66 = 166,66 \text{ [kmol/hr]}$$

$$T_M = 350 \text{ [}^\circ\text{C]} = 623,15 \text{ [}^\circ\text{K]}$$

$$P_M = 50 \text{ [atm]}$$

$$x^M_{Tol} = 0,500$$

$$x^M_{H_2} = 0,500$$

$$x^M_{Ben} = 0,000$$

$$x^M_{Met} = 0,000$$

Corriente: E

$$F_E = F_M = 166,66 \text{ [kmol/hr]}$$

$$T_M = \text{¿? [}^\circ\text{C]} = \text{¿? [}^\circ\text{K]}$$

$$P_M = 50 \text{ [atm]}$$

$$x^M_{Tol} = 0,500$$

$$x^M_{H_2} = 0,500$$

$$x^M_{Ben} = 0,000$$

$$x^M_{Met} = 0,000$$

$$\overline{\Delta H}_E = \sum_{i=1}^{NC} \overline{\Delta H}_i^E \times x_i^E = 0,500 \times (59,46 \times T_E - 1,533 \times 10^4) + 0,500 \times (7,102 \times T_E - 2,178 \times 10^3) + 0,000 \times (46,37 \times T_E - 7,630 \times 10^2) + 0,000 \times (14,65 \times T_E - 2,370 \times 10^4)$$

$$\overline{\Delta H}_E = \sum_{i=1}^{NC} \overline{\Delta H}_i^E \times x_i^E = 33,28 \times T_E - 8751,8$$

$$FE_E = FM_E \times \overline{\Delta H}_E = (33,28 \times T_E - 8751,8) \times \left[\frac{kCal}{kmol} \right] \times 166,66 \left[\frac{kmol}{hr} \right]$$

$$FE_E = (5,547 \times 10^3 \times T_E - 1,459 \times 10^6) \times \left[\frac{kCal}{hr} \right]$$

Reacción:

Comp	Entra	Rx	Sale
Tolueno	$0,5*(100+R)$	$-0,6*0,5*(R+100)$	$20+0,2*R$
Hidrogeno	$0,5*(100+R)$	$-0,6*0,5*(R+100)$	$20+0,2*R$
Benceno	0	$0,6*0,5*(R+100)$	$30+0,3*R$
Metano	0	$0,6*0,5*(R+100)$	$30+0,3*R$

	Entra	Rx	Sale	xi
Tolueno	83,33	-50,00	33,33	0,200
Hidrogeno	83,33	-50,00	33,33	0,200
Benceno	0,00	50,00	50,00	0,300
Metano	0,00	50,00	50,00	0,300
Total			166,67	1,000

$$\begin{aligned} \overline{\Delta H}_S &= \sum_{i=1}^{NC} \overline{\Delta H}_i^S \times x_i^S = 0,200 \times (59,46 \times T_S - 1,533 \times 10^4) + 0,200 \times (7,102 \times T_S - 2,178 \times 10^3) + \\ &\quad 0,300 \times (46,37 \times T_S - 7,630 \times 10^2) + 0,300 \times (14,65 \times T_S - 2,370 \times 10^4) \\ \overline{\Delta H}_S &= 0,200 \times (59,46 \times 873,15 - 1,533 \times 10^4) + 0,200 \times (7,102 \times 873,15 - 2,178 \times 10^3) + \\ &\quad 0,300 \times (46,37 \times 873,15 - 7,630 \times 10^2) + 0,300 \times (14,65 \times 873,15 - 2,370 \times 10^4) \\ \overline{\Delta H}_S &= 1,677 \times 10^4 \left[\frac{kcal}{kmol} \right] \end{aligned}$$

$$FE_S = FM_S \times \overline{\Delta H}_S = (1,677 \times 10^4) \times \left[\frac{kCal}{kmol} \right] \times 166,66 \left[\frac{kmol}{hr} \right] = 2,794 \times 10^6 \left[\frac{kcal}{hr} \right]$$

Corriente: S

$$F_S = 166,67 \text{ [kmol/hr]}$$

$$T_S = 600 \text{ [}^\circ\text{C]} = 873,15 \text{ [}^\circ\text{K]}$$

$$P_S = 50 \text{ [atm]}$$

Balance de energía:

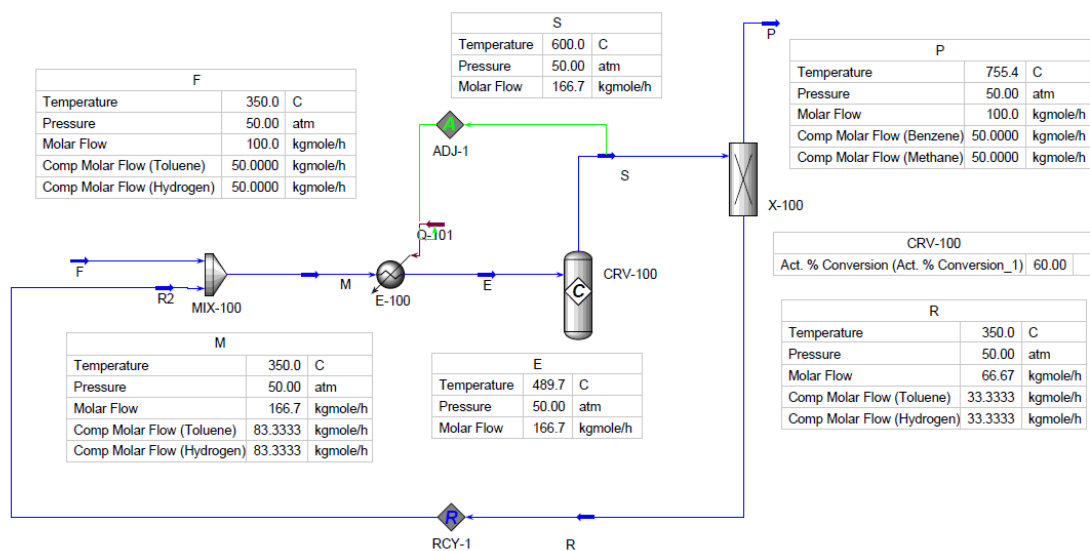
$$FE_E = FE_S$$

$$5,547 \times 10^3 \times T_E - 1,459 \times 10^6 = 2,794 \times 10^6$$

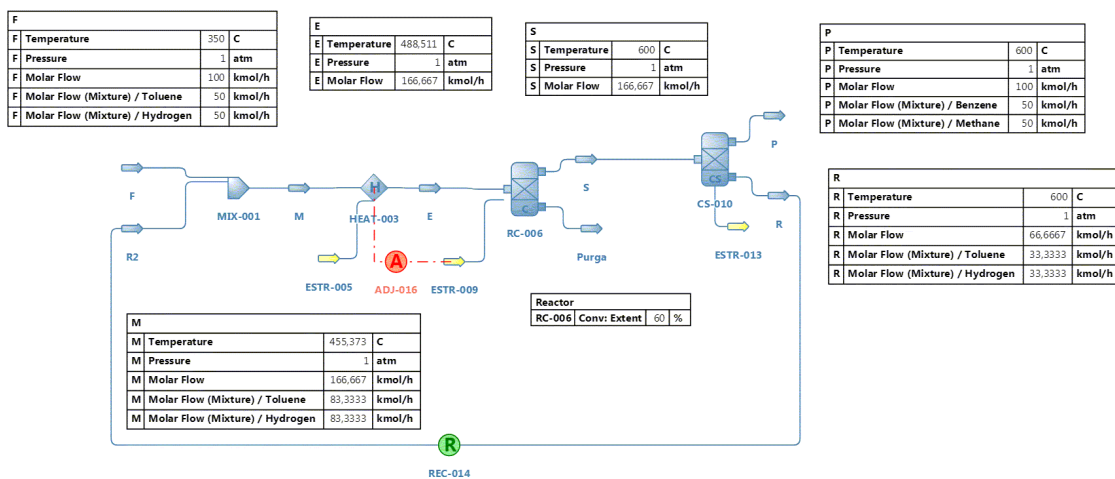
$$T_E = \frac{2,794 \times 10^6 + 1,459 \times 10^6}{5,547 \times 10^3} = 766,7 [^\circ K] = 493,6 [^\circ C]$$

Soluciones:

- El reciclo es de 66,66 [kmol/hr] de 50 % de tolueno y 50 % de Hidrógeno.
- La entrada del reactor tiene una temperatura de 766,7 [°K] o 493,6 [°C]



Hysys



dwsim

Código EMSO

Termoquímica **

```
using "types";
FlowSheet Prob2
PARAMETERS
    PP as Plugin(Brief="FQ",
                Type="PP",
                Components=["acetylene","water","acetaldehyde"],
                LiquidModel="IdealLiquid",
                VapourModel="Ideal" );

    rx(3) as Real;           # coefi esteq
    PE as pressure;          # Presión de entrada
    TE as temperature;       # Temperatura de entrada
    FE as flow_mass;         # Flujo masico entrada
    PS as pressure;          # Presión de salida
    TS as temperature;       # Temperatura salida

VARIABLES
    FmE as flow_mol;         # Flujo molar entrada
    HE as enth_mol;          # entalpía molar entrada
    xE(3) as fraction;        # fracc molar de entrada
    M(3) as molweight;        # pesos molares comp
    PME as molweight;         # peso molar entrada
    FmS as flow_mol;         # Flujo molar salida
    HS as enth_mol;          # entalpía molar salida
    xS(3) as fraction;        # fracc molar salida
    PMS as molweight;         # peso molar salida
    FS as flow_mass;         # Flujo masico salida
    conv as Real;            # conversion
    n as flow_mol;           # moles que reaccionan
    Q as heat_rate;          # calor extraído
    HF(3) as enth_mol;        # Calores de formación

EQUATIONS
    M=PP.MolecularWeight;
    xE(1)=0.5;
    xE(2)=0.5;
    sum(xE)=1;
    HE=PP.VapourEnthalpy(TE,PE,xE)+sum(xE*HF);
    FmE=FE/PME;
    PME=sum(xE*M);
    HS=PP.VapourEnthalpy(TS,PS,xS)+sum(xS*HF);
    FmS=FS/PMS;
    PMS=sum(xS*M);
```

```

FmE*xE+rx*n=FmS*xS;
conv=(FmE*xE(1)-FmS*xS(1))/(FmE*xE(1))*100;
FmE*HE=FmS*HS+Q;
sum(xS)=1;
HF=PP.IdealGasEnthalpyOfFormationAt25C;
Q=1163*'kW';

```

SET

```

TE=373.15;
FE=2000*'kg/h';
rx(1)=-1;
rx(2)=-1;
rx(3)=1;
PE=1*'atm';
PS=1*'atm';
TS=773.15;

```

INITIAL

GUESS

OPTIONS

```

TimeStart=373;
TimeEnd=390;
TimeStep=0.1;
TimeUnit='K';
DAESolver(File="dassl");
Dynamic=false;
end

```

Variable	Unidad	Valor	Unidad	Valor
rx(1)		-1,0000		
rx(2)		-1,0000		
rx(3)		1,0000		
PE	'atm'	1,0000		
TE	'K'	373,1500	'°C'	100
FE	'kg/h'	2000,0000		
PS	'atm'	1,0000		
TS	'K'	873,1500	'°C'	600
FmE	'kmol/h'	90,7997		
HE	'kJ/kmol'	-4,608E+03	'kcal/kmol'	-1,101E+03
xE(1)		0,5000		
xE(2)		0,5000		
xE(3)		0,0000		

Variable	Unidad	Valor	Unidad	Valor
M(1)	'kg/kmol'	26,0378		
M(2)	'kg/kmol'	18,0152		
M(3)	'kg/kmol'	44,0530		
PME	'kg/kmol'	22,0265		
FmS	'kmol/h'	52,2464		
HS	'kJ/kmol'	-8,815E+04	'kcal/kmol'	-2,105E+04
xS(1)		0,131043		
xS(2)		0,131043		
xS(3)		0,737913		
PMS	'kg/kmol'	38,2801		
FS	'kg/h'	2000		
conv	%	84,92		
n	'kmol/h'	38,5533		
Q	'kW'	1163	'kcal/hr'	1,000E+06
HF(1)	'kJ/kmol'	2,269E+05	'kcal/kmol'	5,419E+04
HF(2)	'kJ/kmol'	-2,420E+05	'kcal/kmol'	-5,780E+04
HF(3)	'kJ/kmol'	-1,644E+05	'kcal/kmol'	-3,927E+04

Alumno: _____



Integración III

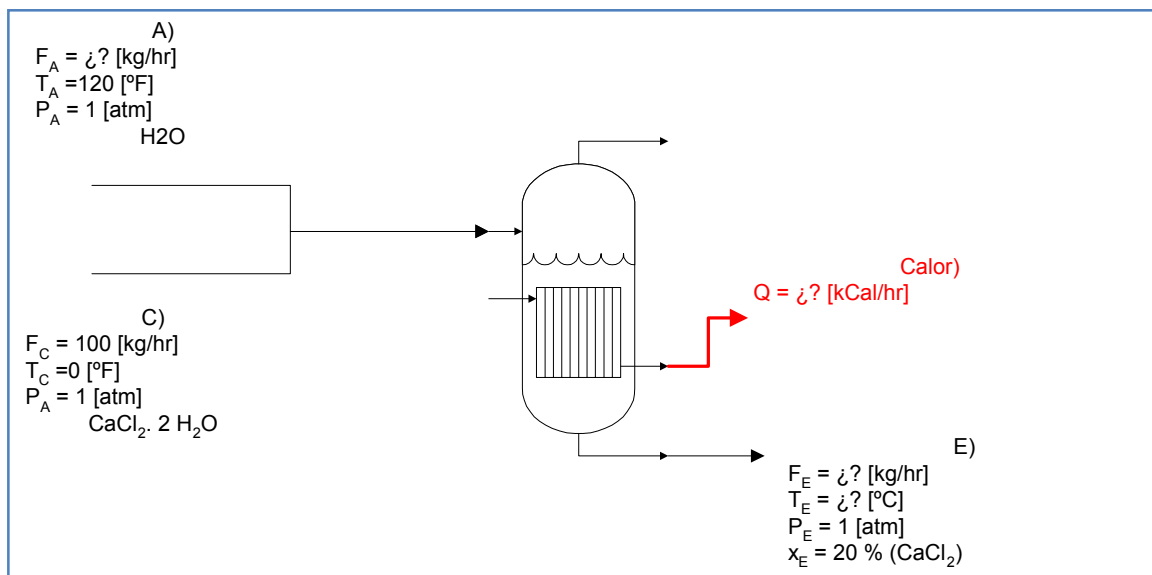
Recuperatorio 07/12/2020

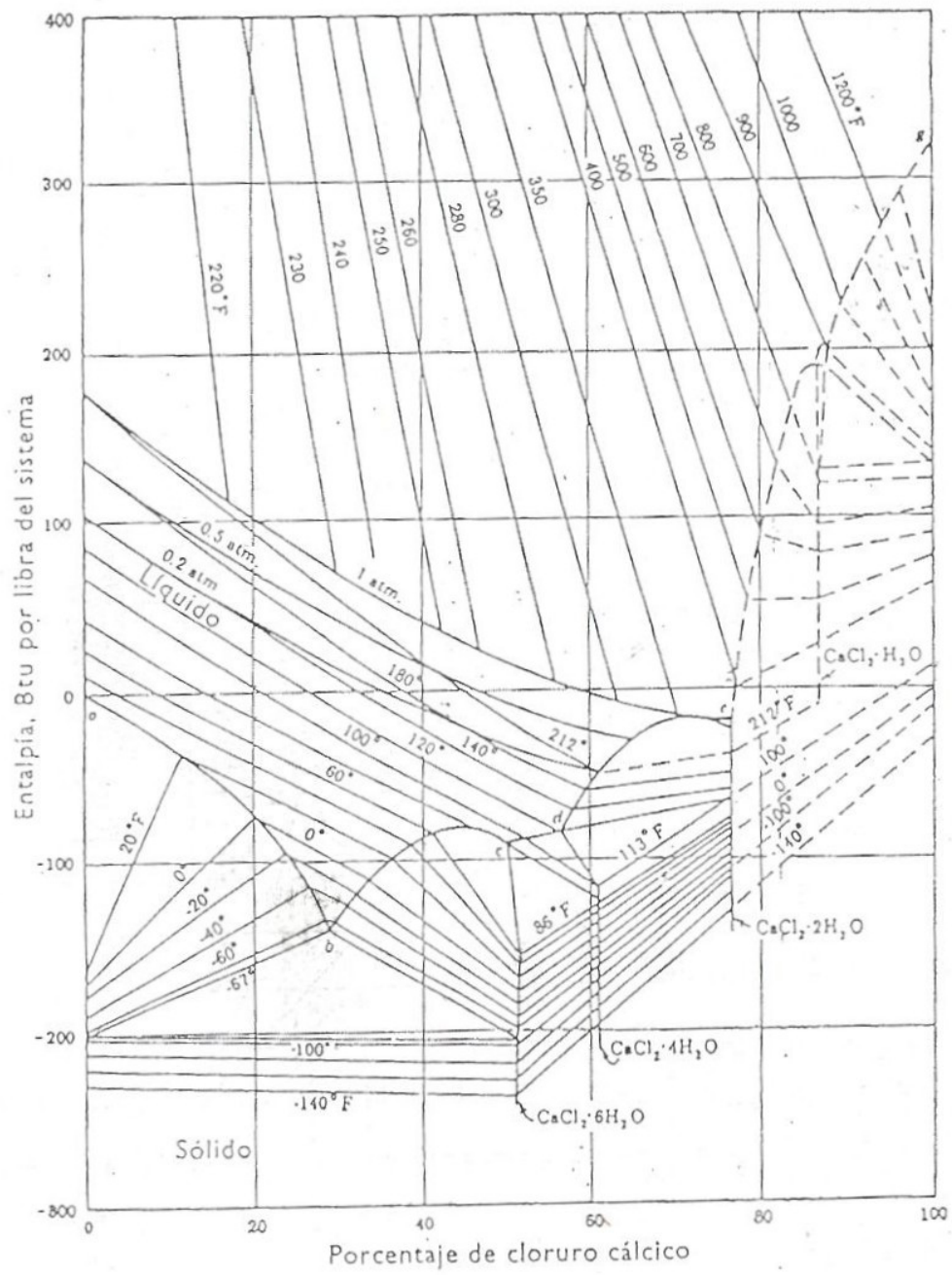
Problema 3 (Entalpía-composición):

Se disuelven 100 [kg] de cristales de $\text{CaCl}_2 \cdot 2 \text{H}_2\text{O}$ de 0 [°F] con agua pura a 120 [°F].

Calcular:

- La cantidad de agua necesaria para hacer una solución al 20 % p/p.
- Temperatura de la mezcla.
- Cantidad de calor a entregar para llevar a la mezcla a su punto normal de ebullición (temperatura aproximada del mismo).





Resolución:

Entrada C:

$$F_C = 100 \text{ [kg/hr]} = 220,5 \text{ [lb/hr]}$$

$$P_{AC} = 1 \text{ [atm]}$$

$$T_{AC} = -17,77 \text{ [}^\circ\text{C]} = 0 \text{ [}^\circ\text{F]}$$

$$x_C = \frac{M_{CaCl_2}}{M_{CaCl_2 \cdot 2H_2O}} = \frac{111}{147} = 0,755$$

$$\overline{\Delta H}_{AC} = -76,11 \left[\frac{BTU}{lb} \right] = -42,24 \left[\frac{kcal}{kg} \right]$$

Entrada A:

$$F_A = ? \text{ [kg/hr]}$$

$$P_A = 1 \text{ [atm]}$$

$$T_A = 48,89 \text{ [}^\circ\text{C]} = 120 \text{ [}^\circ\text{F]}$$

$$x_A = 0,00$$

$$\overline{\Delta H}_A = 87,61 \left[\frac{BTU}{lb} \right] = 48,62 \left[\frac{kcal}{kg} \right]$$

$$\text{BM global)} \quad F_C + F_A = F_M$$

$$\text{BM CaCl)} \quad F_C \times x_C + F_A \times x_A = F_M \times x_M$$

$$\text{BE adiab)} \quad F_C \times \overline{\Delta H}_C + F_A \times \overline{\Delta H}_A = F_M \times \overline{\Delta H}_M$$

$$\text{BE)} \quad F_C \times \overline{\Delta H}_C + F_A \times \overline{\Delta H}_A + Q = F_M \times \overline{\Delta H}_M$$

$$F_M = F_C + F_A$$

$$F_M = 100 + F_A$$

$$F_C \times x_C + F_A \times x_A = F_M \times x_M$$

$$F_C \times x_C + F_A \times x_A = (100 + F_A) \times x_M$$

$$F_C \times x_C + F_A \times x_A = 100 \times x_M + F_A \times x_M$$

$$F_C \times x_C - 100 \times x_M = F_A \times x_M - F_A \times x_A = F_A \times (x_M - x_A)$$

$$F_A = \frac{F_C \times x_C - 100 \times x_M}{(x_M - x_A)} = \frac{100 \times 0,755 - 100 \times 0,20}{0,20 - 0,00} = 277,5 \left[\frac{kg}{hr} \right]$$

$$F_M = 100 + 277,5 = 377,5 \left[\frac{kg}{hr} \right] = F_E$$

a) Se requieren 277,5 [kg/hr] de agua o 611,8 [lb/hr].

b) Según el diagrama la temperatura de la mezcla adiabática es de 140 [°F] = 60,0 [°C].

Salida E:

$$F_E = 377,58 \text{ [kg/hr]} = 832,2 \text{ [lb/hr]}$$

$$P_E = 1 \text{ [atm]}$$

$$T_E = 106,0 \text{ [°C]} = 223 \text{ [°F]} \text{ (interpolando del diagrama entre 220 y 230 °F)}$$

$$X_A = 0,755$$

$$\overline{\Delta H}_A = 105,3 \left[\frac{BTU}{lb} \right] = 58,45 \left[\frac{kcal}{kg} \right]$$

$$F_C \times \overline{\Delta H}_C + F_A \times \overline{\Delta H}_A + Q = F_E \times \overline{\Delta H}_E$$

$$Q = F_E \times \overline{\Delta H}_E - F_C \times \overline{\Delta H}_C - F_A \times \overline{\Delta H}_A$$

$$Q = 377,5 \times 58,45 - 100 \times (-42,24) - 277,5 \times 48,60 = 1,280 \times 10^4 \left[\frac{kcal}{hr} \right] = 5,360 \times 10^4 \left[\frac{BTU}{hr} \right]$$

Soluciones:

a) Se requieren 277,5 [kg/hr] de agua o 611,8 [lb/hr].

b) Según el diagrama la temperatura de la mezcla adiabática es de 140 [°F] = 60,0 [°C].

c) Se debe entregar 1,280x10⁴ [kcal/hr] o 5,360x10⁴ [BTU/hr] para llevar la solución al punto de ebullición (223 [°F] o 106,6 [°C]).

Código EMSO:

```
## Balance ##

using "types";

FlowSheet nombre

PARAMETERS

VARIABLES

    # Corriente de agua 0 % 48,89 C
    FA as Real;
    wA as Real;
    HA as Real;

    # Corriente cristales de CaCl2-2 H2O 75,5 % -17,77 C
    FC as Real;
    wC as Real;
    HC as Real;

    # Corriente salida 106,0 C
    FE as Real;
    wE as Real;
    HE as Real;

    # Corriente de calor
    Q as Real;

EQUATIONS
wA=0.0;
HA=48.62;
wC=0.755;
FC= 100;
HC= -42.24;
wE=0.20;
HE=58.45;
FE=FA+FC;
FE*wE=FA*wA+FC*wC;
FE*HE =FA*HA+FC*HC+Q;

SET
INITIAL
GUESS
OPTIONS
TimeStart=0;
TimeEnd=100;
TimeStep=1;
TimeUnit='h';
DAESolver(File="dassl");
Dynamic=false;
end
```

Resultados

Variable	Unidad	0
FA	kg/hr	277.5
wA		0
HA	kcal/kg	48.62
FC	kg/hr	100
wC		0.755
HC	kcal/kg	-42.24
FE	kg/hr	377.5
wE		0.2
HE	kcal/kg	58.45
Q	kcal/hr	1.280E+04

Código GAMS:

* Integración III
* Examen Recuperatorio nº 2 06/12/2022
* Problema 3

VARIABLES

FA, FE, Q;

PARAMETERS

wA /0.0/
wC /0.755/
wE /0.20/
FC /100/
HA /48.62/
HC /-42.24/
HE /58.45/

EQUATIONS

R1,R2, R3;

R1.. FA + FC =E= FE;
R2.. FA*wA+FC*wC =E= FE*wE;
R3.. FA*HA+FC*HC+Q =E= FE*HE;

MODEL BM /ALL/;

SOLVE BM USING CNS;

display FA.I, Q.I, FE.I;

Resultados:

VARIABLE	Unidades	Valor
FA.I	Kg/hr	277.5
Q.L	Kcal/hr	$1,280 \times 10^4$
FE.L	Kg/hr	377.5

