

Alumno: _____ Mail: _____



Balance de Masa y Energía (2025)

Parcial º 1: Psicrometría.

Tema B

Una corriente de aire a 30 [°C], 1 [atm] cuya humedad relativa es el 65 % ingresa a una torre de enfriamiento. El agua de enfriamiento ingresa a 50 [°C] y su flujo es de 1000 [kg/hr] mientras que el aire sale a 35 [°C]. Calcular:

- La cantidad de aire necesario.
- Cantidad de agua evaporada.
- Si el agua de reposición ingresa a 25 [°C] a qué temperatura saldría el agua de enfriamiento.
- El calor que se puede extraer del proceso.

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:

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

CP del agua líquida:

$$\overline{C_p} = 1 \quad \text{En [kcal/Kg °C]}$$

EW) Entrada de Agua
 $T_{EW} = 50 \text{ [°C]}$
 $P_{EW} = 1 \text{ [atm]}$
 $F_{EW} = 1000 \text{ [Kg/hr]}$

EA) Entrada de Aire
 $T_{EA} = 30 \text{ [°C]}$
 $P_{EA} = 1 \text{ [atm]}$
 $F_{EA} = ? \text{ [Kg/hr]}$
 $HR = 65 \%$

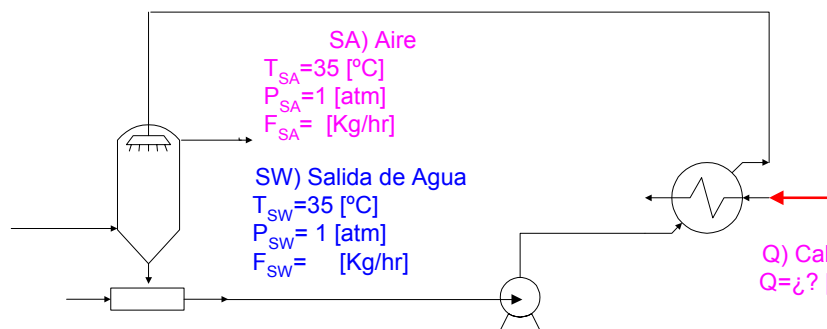
SA) Aire
 $T_{SA} = 35 \text{ [°C]}$
 $P_{SA} = 1 \text{ [atm]}$
 $F_{SA} = ? \text{ [Kg/hr]}$

SW) Salida de Agua
 $T_{SW} = 35 \text{ [°C]}$
 $P_{SW} = 1 \text{ [atm]}$
 $F_{SW} = ? \text{ [Kg/hr]}$

Q) Calor de proceso
 $Q = ? \text{ [kcal/hr]}$

AR) Agua de reposición
 $T_{AR} = 25 \text{ °C}$
 $P_{AR} = 1 \text{ atm}$
 $F_{AR} = ? \text{ [Kg/hr]}$

AE) Agua de enfriamiento
 T_{AE}
 P_{AE}
 F_{AE}



Flowsheet

Solución:

Entrada de aire: EA)

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

$$t_{EA} = 30 \text{ [}^{\circ}\text{C]}$$

$$P_{EA} = 1 \text{ [atm]} = 760 \text{ [mmHg]}$$

$$\log_{10}(P_s^{EA}) = 8,07131 - \frac{1730,63}{233,426 + 30}$$

$$P_s^{EA} = 31,74 \text{ [mmHg]} = 0,04176 \text{ [atm]}$$

$$HR_{EA} = 65 \%$$

$$P_V^{EA} = \frac{P_s^{EA} \times HR_{EA}}{100} = 20,63 \text{ [mmHg]} = 0,02714 \text{ [atm]}$$

$$x_{Agua}^{EA} = \frac{P_V^{EA}}{P_{EA}} = \frac{0,02714}{1} = 0,02714$$

$$x_{Aire}^{EA} = 1 - x_{Agua}^{EA} = 0,97286$$

$$Hm_{EA} = \frac{P_V^{EA}}{P_{EA} - P_V^{EA}} = \frac{0,02714}{1 - 0,02714} = 0,02790 \left[\frac{\text{kmol agua}}{\text{kmol aire seco}} \right]$$

$$HA_{EA} = \frac{PM_{Agua}}{PM_{Aire}} Hm_{EA} = 0,6241 \times 0,02790 = 0,01741 \left[\frac{\text{kg agua}}{\text{kg aire seco}} \right]$$

$$\overline{\Delta H}_{EA} = 0,24 \times 30 + 0,01741 \times (595 + 0,46 \times 30) = 17,80 \left[\frac{\text{kcal}}{\text{kg aire seco}} \right]$$

$$F_{Aireseco}^{EA} = \frac{F_{EA}}{(1 + HA_{EA})} = 0,9829 \times F_{EA} \left[\frac{\text{kg Aire seco}}{\text{hr}} \right]$$

$$FE_{EA} = F_{Aireseco}^{EA} \times \overline{\Delta H}_{EA} = 0,9829 \times F_{EA} \left[\frac{\text{kg aire seco}}{\text{hr}} \right] \times 17,80 \left[\frac{\text{kcal}}{\text{kg aire seco}} \right] = 17,50 \times F_{EA} \left[\frac{\text{kcal}}{\text{hr}} \right]$$

Entrada de agua: EW)

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

$$t_{EW} = 50 \text{ [}^{\circ}\text{C]}$$

$$\overline{\Delta H}_{EW} = 1 \left[\frac{\text{kcal}}{\text{kg }^{\circ}\text{C}} \right] \times 50 \text{ [}^{\circ}\text{C]} = 50 \left[\frac{\text{kcal}}{\text{kg}} \right]$$

$$FE_{EW} = F_{EW} \times \overline{\Delta H}_{EW} = 1000 \left[\frac{kg \text{ Agua}}{hr} \right] \times 50 \left[\frac{kcal}{kg \text{ Agua}} \right] = 5,000 \times 10^4 \left[\frac{kcal}{hr} \right]$$

Salida de aire: SA)

$$F_{SA} = [kg/hr]$$

$$T_{SA} = 35 [^{\circ}C]$$

$$P_{SA} = 1 [atm] = 760 [mmHg]$$

$$\log_{10}(P_S^{SA}) = 8,07131 - \frac{1730,63}{233,426 + 35}$$

$$P_S^{SA} = 42,07 [mmHg] = 0,05536 [atm]$$

$$HR_{SA} = 100 \%$$

$$P_V^{SA} = \frac{P_S^{SA} \times HR_{SA}}{100} = 42,07 [mmHg] = 0,05536 [atm]$$

$$x_{Agua}^{SA} = \frac{P_V^{EA}}{P_{EA}} = \frac{0,05536}{1} = 0,05536$$

$$x_{Aire}^{SA} = 1 - x_{Agua}^{EA} = 0,9446$$

$$Hm_{SA} = \frac{P_V^{EA}}{P_{EA} - P_V^{EA}} = \frac{0,05536}{1 - 0,05536} = 0,05860 \left[\frac{kmol \text{ agua}}{kmol \text{ aire seco}} \right]$$

$$HA_{SA} = \frac{PM_{Agua}}{PM_{Aire}} Hm_{EA} = 0,6241 \times 0,05860 = 0,03657 \left[\frac{kg \text{ agua}}{kg \text{ aire seco}} \right]$$

$$\overline{\Delta H}_{SA} = 0,24 \times 35 + 0,03657 \times (595 + 0,46 \times 35) = 30,75 \left[\frac{kcal}{kg \text{ aire seco}} \right]$$

$$F_{Aireseco}^{SA} = F_{Aireseco}^{EA} = 0,9829 \times F_{EA} \left[\frac{kg \text{ aire seco}}{hr} \right]$$

$$FE_{SA} = F_{Aireseco}^{SA} \times \overline{\Delta H}_{EA} = 0,9829 \times F_{EA} \left[\frac{kg \text{ aire seco}}{hr} \right] \times 30,75 \left[\frac{kcal}{kg \text{ aire seco}} \right] = 30,22 \times F_{EA} \left[\frac{kcal}{hr} \right]$$

Salida de agua: SW)

$$F_{SW} = ? [kg/hr]$$

$$T_{SW} = 35 [^{\circ}C]$$

$$\overline{\Delta H}_{SW} = 1 \left[\frac{kcal}{kg^{\circ}C} \right] \times 35 [^{\circ}C] = 35 \left[\frac{kcal}{kg} \right]$$

$$FE_{SW} = F_{SW} \times \overline{\Delta H}_{SW} = F_{SW} \times 35 \left[\frac{kcal}{hr} \right]$$

Balance de materia global:

$$F_{EA} + F_{EW} = F_{SA} + F_{SW}$$

Balance de materia por componente (aire):

$$F_{EA} \times (1 - HA_{EA}) = F_{SA} \times F_{SA} (1 - HA_{SA})$$

Balance de energía:

$$FE_{EA} + FE_{EW} = FE_{SA} + FE_{SW}$$

Vemos que tenemos 3 incógnitas: F_{EA} , F_{SA} y F_{SW} y como el sistema tiene 3 ecuaciones cierra los grados de libertad:

Del balance por componente despejamos una incógnita, ejemplo, F_{SA} :

$$\frac{F_{EA}}{(1 + 0,01741)} = \frac{F_{SA}}{(1 + 0,03657)}$$

$$F_{EA} \times (0,9829) = F_{SA} \times (0,9647)$$

$$F_{SA} = \frac{F_{EA} \times (0,9829)}{(0,9647)} = 1,019 \times F_{EA}$$

Del balance global:

$$F_{SW} = F_{EA} + F_{EW} - F_{SA}$$

$$F_{SW} = F_{EA} + F_{EW} - 1,019 \times F_{EA}$$

$$F_{SW} = F_{EW} - 0,01900 \times F_{EA}$$

El balance de energía queda:

$$17,50 \times F_{EA} + FE_{EW} = 30,22 \times F_{EA} + F_{SW} \times 35$$

Reemplazando:

$$17,50 \times F_{EA} + FE_{EW} = 30,22 \times F_{EA} + (F_{EW} - 0,01900 \times F_{EA}) \times 35$$

$$17,50 \times F_{EA} + FE_{EW} = 30,22 \times F_{EA} + 35 \times F_{EW} - 0,6650 \times F_{EA}$$

$$FE_{EW} - 35 \times F_{EW} = 30,22 \times F_{EA} - 0,6650 \times F_{EA} - 17,50 \times F_{EA}$$

$$FE_{EW} - 35 \times F_{EW} = 12,06 \times F_{EA}$$

$$F_{EA} = \frac{FE_{EW} - 35 \times F_{EW}}{12,06} = \frac{5,000 \times 10^4 - 35 \times 1000}{12,06} = \frac{1,5 \times 10^4}{12,06} = 1244 \left[\frac{kg}{hr} \right]$$

Reordenando:

$$F_{SA} = 1,01900 \times F_{EA} = 1,01900 \times 1244 = 1267 \left[\frac{kg}{h} \right]$$

$$F_{SW} = F_{EA} + F_{EW} - F_{SA} = 1244 + 1000 - 1267 = 977,0 \left[\frac{kg}{hr} \right]$$

Agua Evaporada: EV)

$$F_{Agua}^{Evap} = F_{EW} - F_{SW} = 1000 - 977,0 = 23,00 \left[\frac{kg}{hr} \right]$$

Pileta:

$$F_{Ar} = F_{Agua}^{Evap} = 23,00 \left[\frac{kg}{hr} \right]$$

$$\overline{\Delta H}_{AR} = 1 \left[\frac{kcal}{kg^{\circ}C} \right] \times 23 [^{\circ}C] = 23 \left[\frac{kcal}{kg} \right]$$

$$\overline{\Delta H}_{AR} = 23 \left[\frac{kcal}{hr} \right]$$

$$F_{AE} \times \overline{\Delta H}_{AE} = F_{SW} \times \overline{\Delta H}_{SW} + F_{AR} \times \overline{\Delta H}_{AR}$$

$$\overline{\Delta H}_{AE} = \frac{F_{SW} \times \overline{\Delta H}_{SW} + F_{AR} \times \overline{\Delta H}_{AR}}{F_{AE}} = \frac{977,0 \times 35 + 23,00 \times 25}{1000} = 34,77 \left[\frac{kcal}{hr} \right]$$

$$\overline{\Delta H}_{AE} = Cp \times t_{AE}$$

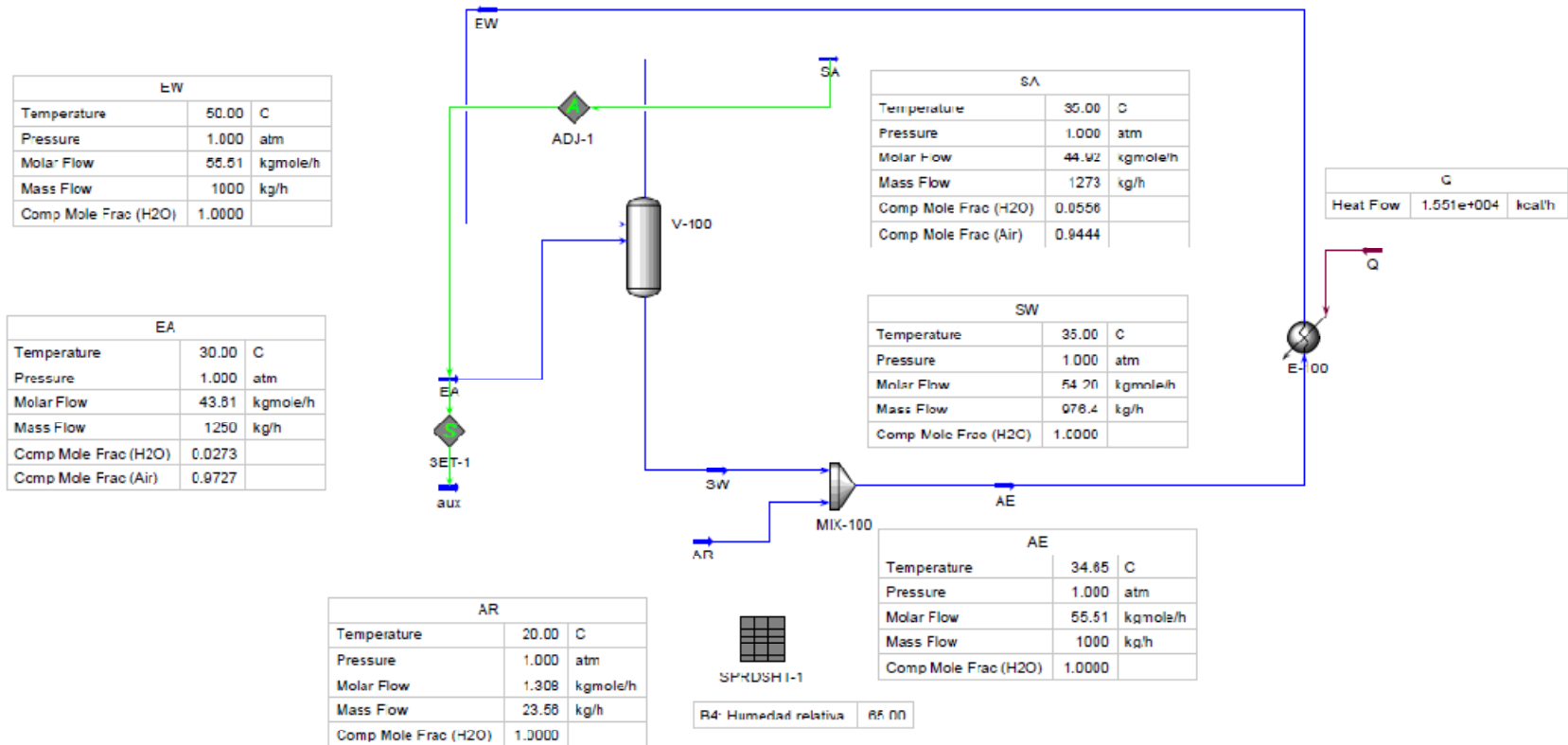
$$t_{AE} = \frac{\overline{\Delta H}_{AE}}{Cp} \frac{34,77 \left[\frac{kcal}{hr} \right]}{1 \left[\frac{kcal}{kg^{\circ}C} \right]} = 34,77 \text{ } [^{\circ}C]$$

Balance de energía del proceso:

$$Q = (\overline{\Delta H}_{EW} - \overline{\Delta H}_{AE}) \times F_{EW} = (50 - 34,75) \times 1000 = 1,525 \times 10^4 \left[\frac{kcal}{hr} \right]$$

Respuestas:

- a) Se requieren 1244 [kg/hr] de aire.**
- b) se evaporan 23,00 [kg(hr)] de agua.**
- c) El agua sale de la pileta a 34,77 [°C] o 307,92 [°K]**
- d) Puede extraerse hasta 1,525x10⁴ [kcal/hr] o 17,72 [kW]**



Hysys

Entrada de agua			
EW	Temperature	50	C
EW	Pressure	1	atm
EW	Mass Flow	1000	kg/h
EW	Molar Flow	55.5081	kmol/h
EW	Molar Fraction (Mixture) / Water	0.999991	

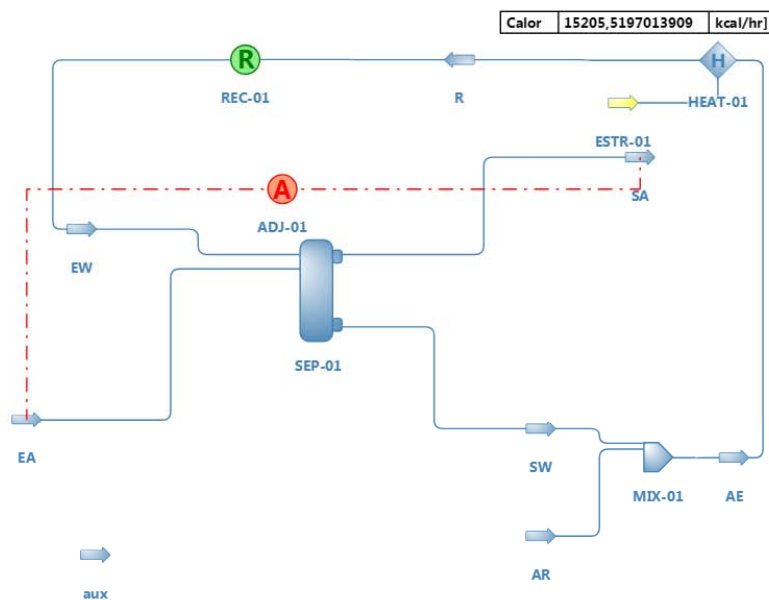
Entrada de aire			
EA	Temperature	30	C
EA	Pressure	1	atm
EA	Mass Flow	1236.09	kg/h
EA	Molar Flow	43.1273	kmol/h
EA	Molar Fraction (Mixture) / Water	0.0272815	
EA	Molar Fraction (Mixture) / Air	0.972718	

Salida de agua			
SW	Temperature	35	C
SW	Pressure	1	atm
SW	Mass Flow	976.671	kg/h
SW	Molar Flow	54.2132	kmol/h
SW	Molar Fraction (Mixture) / Water	0.999991	
SW	Molar Fraction (Mixture) / Air	9.29859E-06	

Agua de reposición			
AR	Temperature	25	C
AR	Pressure	1	atm
AR	Mass Flow	23.3288	kg/h
AR	Molar Flow	1.29494	kmol/h
AR	Molar Fraction (Mixture) / Water	1	

Salida de aire			
SA	Temperature	35	C
SA	Pressure	1	atm
SA	Mass Flow	1259.42	kg/h
SA	Molar Flow	44.4222	kmol/h
SA	Molar Fraction (Mixture) / Water	0.0556359	
SA	Molar Fraction (Mixture) / Air	0.944364	

Agua de enfriamiento			
AE	Temperature	34.7673	C
AE	Pressure	1	atm
AE	Mass Flow	1000	kg/h
AE	Molar Flow	55.5081	kmol/h
AE	Molar Fraction (Mixture) / Water	0.999991	



Dwsym

Código GAMS:

Sets

I /1,2/;

PARAMETERS

PVA /8.07131/
PVB /1730.63/
PVC /233.426/
M(i) /1 18,2 28.84/
EA_T /30/
EA_HR /65/
EA_PT /760/
EW_F /1000/
SA_T /35/
SA_HR /100/
SA_PT /760/
EW_T /50/
SW_T /35/
AR_T /25/;

POSITIVE VARIABLES

rel, EA_PS, EA_PV, EA_HAm, EA_HA, EA_y(i), EA_M, EA_Fm, EA_DH, EA_AS, EA_F
SA_PS, SA_PV, SA_HAm, SA_HA, SA_y(i), SA_M, SA_F, SA_Fm, SA_DH
EW_DH, SW_DH, SW_F, EV_F, AR_F, AR_DH, AE_F, AE_DH, AE_T, Q;

EQUATIONS

R0, R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R10b
R11, R12, R13, R14, R15, R16, R15, R16, R17, R18, R19
R20, R21, R22, R23, R24, R25, R26, R27, R28, R29;

R0.. rel =E= M('1')/M('2');
R1.. EA_PS =E= 10**((PVA-PVB)/(PVC+EA_T));
R2.. EA_HR =E= EA_PV/EA_PS*100;
R3.. EA_HAm =E= EA_PV/(EA_PT-EA_PV);
R4.. EA_HA =E= EA_HAm*rel;
R5.. EA_y('1') =E= EA_PV/EA_PT;
R6.. EA_y('2') =E= 1-EA_y('1');
R7.. EA_M =E= EA_y('1')*M('1')+EA_y('2')*M('2');
R8.. EA_Fm*EA_M =E= EA_F;
R9.. EA_AS =E= EA_F/(1+EA_HA);
R10.. EA_DH =E= 0.24*EA_T+EA_HA*(595+0.46*EA_T);
R11.. SA_PS =E= 10**((PVA-PVB)/(PVC+SA_T));
R12.. SA_HR =E= SA_PV/SA_PS*100;
R13.. SA_HAm =E= SA_PV/(SA_PT-SA_PV);
R14.. SA_HA =E= SA_HAm*rel;
R15.. SA_y('1') =E= SA_PV/SA_PT;

```

R16.. SA_y('2')=E= 1-SA_y('1');
R17.. SA_M =E= SA_y('1')*M('1')+SA_y('2')*M('2');
R18.. SA_F =E= EA_AS*(1+SA_HA);
R19.. SA_DH =E= 0.24*SA_T+SA_HA*(595+0.46*SA_T);
R20.. EW_DH =E= 1*EW_T;
R21.. SW_DH =E= 1*SW_T;
R10b.. EA_AS*EA_DH + EW_F*EW_DH =E= EA_AS*SA_DH + SW_F*SW_DH ;
R22.. EA_F + EW_F =E= SA_F + SW_F;
R23.. Ev_F =E= EW_F-SW_F;
R24.. AR_F =E= Ev_F;
R25.. AR_DH =E= 1*AR_T;
R26.. AE_F =E= SW_F+AR_F;
R27.. AE_DH*AE_F =E= SW_F*SW_DH+AR_F*AR_DH;
R28.. AE_DH =E= 1*AE_T;
R29.. Q =E=1*ae_F*(EW_T-AE_T);

EA_PS.I=100;
SA_PS.I=100;
AE_DH.I=30;
AE_F.I=1000;

MODEL BM /ALL/;
SOLVE BM USING CNS;

```

Resultados:

Variable	Unidad	Value		Unidad	Value
AE_DH	kcal/kg	34.77		kJ/kg	8.304
AE_F	kg/hr	1000			
AE_T	°C	34.77		°K	307.9
AR_DH	kcal/kg	25		kJ/kg	5.971
AR_F	kg/hr	23.41			
EA_AS	kg/hr	1221.7			
EA_DH	kcal/kg	17.80		kJ/kg	4.252
EA_F	kg/hr	1243.0			
EA_Fm	kmol/hr	43.54			
EA_HA	kg/kg AS	0.017416			
EA_HAm	kmol V/kmol AS	0.027904			
EA_M	kg/kmol	28.55			
EA_PS	mmHg	31.74		atm	0.04176
EA_PV	mmHg	20.63		atm	0.02715
EV_F	kg/hr	23.4			
EW_DH	kcal/kg	50.00		kJ/kg	11.942
Q	kcal/hr	1.523E+04		kW	17.71

Variable	Unidad	Value		Unidad	Value
rel	adim	0.624133148			
SA_DH	kcal/kg	30.75		kJ/kg	7.345
SA_F	kg/hr	1266.4			
SA_HA	kg/kg As	0.03657			
SA_HAm	kmol V/kmol AS	0.058600631			
SA_M	kg/kmol	28.23993344			
SA_PS	mmHg	42.07		atm	0.05536
SA_PV	mmHg	42.07		atm	0.05536
SW_DH	kcal/kg	35.00		kJ/kg	8.360
SW_F	kg/hr	976.6			

EA_y	
Agua	0.02715
Aire	0.97285

SA_y	
Agua	0.05536
Aire	0.94464

Código EMSO:

**** Integración III: Parcial 1 ****

using "types";

FlowSheet TemaA

PARAMETERS

```
PP as Plugin(Brief="FQ",
  Type="PP",
  Components=["water","nitrogen","oxygen"],
  LiquidModel="IdealLiquid",
  VapourModel="Ideal" );
```

Entrada de aire

```
T_EA as temperature;      # Temp
P_EA as pressure;         # Presion
HR_EA as positive;        # Humedad Relativa %
```

Salida de aire

```
T_SA as temperature;      # Temp
P_SA as pressure;         # Presion
HR_SA as positive;        # Humedad Relativa %
```

Entrada de agua

```
T_EW as temperature;      # Temp
```

x_EW(3) as fraction;	# comp molar
P_EW as pressure;	# Presion
# Agua de Reposicion	
T_AR as temperature;	# Temp
VARIABLES	
# Generales	
rel as positive;	# Relacion PM vapor/gas
M(3) as molweight;	# PM comp puros
# Cte EA	
M_EA as molweight;	# PM cte
PS_EA(3) as pressure;	# Presion sat comp puros
Ps_EA as pressure;	# Presion sat V
PV_EA as pressure;	# Presion p de V
HAm_EA as Real;	# Humedad absoluta molar
HA_EA as Real;	# Humedad absoluta masica
y_EA(3) as fraction;	# Comp fase gas
H_EA as enth_mol;	# Entalpia molar
F_EA as flow_mass;	# Flujo masico
Fm_EA as flow_mol;	# Flujo molar
FGS as flow_mass;	# flujo gas seco
# Cte SA	
M_SA as molweight;	# PM cte
PS_SA(3) as pressure;	# Presion sat comp puros
Ps_SA as pressure;	# Presion sat V
PV_SA as pressure;	# Presion p de V
HAm_SA as Real;	# Humedad absoluta molar
HA_SA as Real;	# Humedad absoluta masica
y_SA(3) as fraction;	# Comp fase gas
H_SA as enth_mol;	# Entalpia molar
F_SA as flow_mass;	# Flujo masico
Fm_SA as flow_mol;	# Flujo molar
# Entrada de agua	
M_EW as molweight;	# PM cte
H_EW as enth_mol;	# Entalpia molar
F_EW as flow_mass;	# Flujo masico
Fm_EW as flow_mol;	
# Salida de agua	
T_SW as temperature;	# Temp
P_SW as pressure;	# Presion
x_SW(3) as fraction;	# comp molar
H_SW as enth_mol;	# Entalpia molar
F_SW as flow_mass;	# Flujo masico
Fm_SW as flow_mol;	# Flujo molar
M_SW as molweight;	# Peso molecular
# agua evaporada	
F_Ev as flow_mass;	# Flujo masico
# Agua de reposicion y enfriamiento	
Fm_AR as flow_mol;	# Flujo molar
Fm_AE as flow_mol;	# Flujo molar

```

F_AR as flow_mass;      # Flujo masico
F_AE as flow_mass;      # Flujo masico
H_AR as enth_mol;       # Entalpia molar
H_AE as enth_mol;       # Entalpia molar
T_AE as temperature;    # Temp
                        # Proceso
Q as heat_rate;         # Calor extraido del Proceso

```

EQUATIONS

```

    # General
M=PP.MolecularWeight;
rel=M(1)/(0.79*M(2)+0.21*M(3));
    # Cte EA
M_EA=sum(y_EA*M);
F_EA=M_EA*Fm_EA;
PS_EA=PP.VapourPressure(T_EA);
Ps_EA=PS_EA(1);
HR_EA=Pv_EA/Ps_EA*100;
HAm_EA=Pv_EA/(P_EA-Pv_EA);
HA_EA=rel*HAm_EA;
y_EA(1)=Pv_EA/P_EA;
y_EA(2)=79*y_EA(3)/21;
sum(y_EA)=1;
H_EA=PP.VapourEnthalpy(T_EA,P_EA,y_EA);
    # Cte SA
M_SA=sum(y_SA*M);
F_SA=M_SA*Fm_SA;
PS_SA=PP.VapourPressure(T_SA);
Ps_SA=PS_SA(1);
HR_SA=Pv_SA/Ps_SA*100;
HAm_SA=Pv_SA/(P_SA-Pv_SA);
HA_SA=rel*HAm_SA;
y_SA(1)=Pv_SA/P_SA;
y_SA(2)=79*y_SA(3)/21;
sum(y_SA)=1;
H_SA=PP.VapourEnthalpy(T_SA,P_SA,y_SA);
    # Entrada de agua
M_EW=sum(x_EW*M);
H_EW=PP.LiquidEnthalpy(T_EW,P_EW,x_EW);
Fm_EW=F_EW/M_EW;
F_EW =1000*'kg/h';
    # Salida de agua
T_SW=T_SA;
P_SW=P_SA;
x_SW=x_EW;
H_SW=PP.LiquidEnthalpy(T_SW,P_SW,x_SW);
M_SW=sum(x_SW*M);
Fm_SW=F_SW/M_SW;
    # Balances
F_EW=F_SW+F_Ev;

```

```

Fm_EW*H_EW+Fm_EA*H_EA=Fm_SW*H_SW+Fm_SA*H_SA;
Fm_EW+Fm_EA=Fm_SW+Fm_SA;
Fm_EA*(1-y_EA(1))=Fm_SA*(1-y_SA(1));
FGS=F_EA/(1+HA_EA);
# Pileta
F_AR=F_Ev;
F_AE=F_EW;
Fm_AR=F_AR/M_EW;
Fm_AE=F_AE/M_EW;
H_AR=PP.LiquidEnthalpy(T_AR,P_SW,x_SW);
Fm_SW*H_SW+Fm_AR*H_AR=Fm_AE*H_AE;
H_AE=PP.LiquidEnthalpy(T_AE,P_SW,x_SW);
# Proceso
Q=Fm_EW*H_EW-Fm_AE*H_AE;
SET
# Entrada de aire humedo
T_EA=(273.15+30)*'K';
HR_EA=65;
P_EA=1*'atm';
# Salida de aire humedo
T_SA=(273.15+35)*'K';
HR_SA=100;
P_SA=1*'atm';
# Entrada de agua
T_EW=(273.15+50)*'K';
P_EW= 1*'atm';
x_EW(1)=1;
x_EW(2)=0;
x_EW(3)=0;
T_AR=(25+273.15)*'K';
INITIAL
GUESS
OPTIONS
TimeStart=288.05;
TimeEnd=313;
TimeStep=0.05;
TimeUnit='K';
DAESolver(File="dassl");
Dynamic=false;
end

```

Resultados:

Variable	unidad	Valor		unidad	Valor
T_EA	'K'	303.15		°C	30.00
P_EA	'atm'	1.0000		mmHg	760
HR_EA	%	65.0000			
T_SA	'K'	308.15		°C	35.00

Variable	unidad	Valor		unidad	Valor
P_SA	'atm'	1.0000		mmHg	760
HR_SA	%	100.00			
T_EW	'K'	323.15		°C	50.00
x_EW(1)		1.0000			
x_EW(2)		0.0000			
x_EW(3)		0.0000			
P_EW	'atm'	1.0000		mmHg	760.0
T_AR	'K'	298.15		°C	25.00
rel		0.6244			
M(1)	'kg/kmol'	18.02			
M(2)	'kg/kmol'	28.01			
M(3)	'kg/kmol'	32.00			
M_EA	'kg/kmol'	28.56			
PS_EA(1)	'atm'	0.0419		mmHg	31.82
PS_EA(2)	'atm'	32.67		mmHg	2.483E+04
PS_EA(3)	'atm'	48.43		mmHg	3.681E+04
Ps_EA	'atm'	0.0419		mmHg	31.82
PV_EA	'atm'	0.0272		mmHg	20.68
HAm_EA	kmol V/kmol GS	0.0280			
HA_EA	kg V/kg GS	0.0175			
y_EA(1)		0.0272			
y_EA(2)		0.7685			
y_EA(3)		0.2043			
H_EA	'kJ/kmol'	92.2			
F_EA	'kg/h'	1287.4			
Fm_EA	'kmol/h'	45.08			
FGS	'kg/h'	1265.3			
M_SA	'kg/kmol'	28.25			
PS_SA(1)	'atm'	0.0555		mmHg	42.18
PS_SA(2)	'atm'	32.67		mmHg	2.483E+04
PS_SA(3)	'atm'	48.43		mmHg	3.681E+04
Ps_SA	'atm'	0.0555		mmHg	42.18
PV_SA	'atm'	0.0555		mmHg	42.18
HAm_SA	kmol V/kmol GS	0.0588			
HA_SA	kg V/kg GS	0.0367			
y_SA(1)		0.0555			
y_SA(2)		0.7462			
y_SA(3)		0.1983			
H_SA	'kJ/kmol'	239.6		kCal/kmol	57.23
F_SA	'kg/h'	1325.98			
Fm_SA	'kmol/h'	46.44			
M_EW	'kg/kmol'	18.0152			
H_EW	'kJ/kmol'	-4.374E+04		kCal/kmol	-1.045E+04
F_EW	'kg/h'	1000			
Fm_EW	'kmol/h'	55.51			
T_SW	'K'	308.2		°C	35.00
P_SW	'atm'	1.0000		mmHg	760
x_SW(1)		1.0000			
x_SW(2)		0.0000			

Variable	unidad	Valor		unidad	Valor
x_SW(3)		0.0000			
H_SW	'kJ/kmol'	-4.496E+04		kCal/kmol	-1.074E+04
F_SW	'kg/h'	975.7			
Fm_SW	'kmol/h'	54.16			
M_SW	'kg/kmol'	18.02			
F_Ev	'kg/h'	24.33			
Fm_AR	'kmol/h'	1.351			
Fm_AE	'kmol/h'	55.51			
F_AR	'kg/h'	24.33			
F_AE	'kg/h'	1000			
H_AR	'kJ/kmol'	-4.577E+04		kCal/kmol	-1.093E+04
H_AE	'kJ/kmol'	-4.498E+04		kCal/kmol	-1.074E+04
T_AE	'K'	307.91		°C	34.76
Q	'kW'	19.11		kCal/hr	16441.09

Comparación de resultados:

Variable	Manual	Hysys	dwsim	EMSO	GAMS
F _{EA} [kg/hr]	1244	1250	1236,09	1287,4	1243,0
Evap [kg/hr]	23,00	23,56	23,3288	24,33	23,40
T _{AE} [°C]	34,77	34,65	34,7673	34,76	34,77
T _{AE} [°K]	307,92	307,8	307,9173	307,91	307,92
Q [kcal/hr]	1,525x10 ⁴	1,547x10 ⁴	1,529x10 ⁴	1,644x10 ⁴	1,523x10 ⁴
Q [kW]	17,72	17,98	17,77	19,11	17,71

ANEXO: Otras herramientas para psicrometría

Propiedades del aire a la entrada:

THE RESULTS ARE:

DRY-BULB TEMPERATURE: **30.00** DEGREES C
WET-BULB TEMPERATURE: 24.67 DEGREES C
DEW POINT TEMPERATURE: 22.69 DEGREES C
RELATIVE HUMIDITY: **65.00** PERCENT
ENTHALPY: 74.66 J/G
HUMIDITY RATIO: .1741E-01
DEGREE OF SATURATION: .6402
SPECIFIC VOLUME: .883 CU. M/KG
VAPOR PARTIAL PRESSURE: 2.759 KPA

Propiedades del aire a la salida:

THE RESULTS ARE:

DRY-BULB TEMPERATURE: **35.00** DEGREES C
WET-BULB TEMPERATURE: 35.00 DEGREES C
DEW POINT TEMPERATURE: 35.04 DEGREES C
RELATIVE HUMIDITY: **100** PERCENT
ENTHALPY: 128.94 J/G
HUMIDITY RATIO: .3657E-01
DEGREE OF SATURATION: 1.0000
SPECIFIC VOLUME: .924 CU. M/KG
VAPOR PARTIAL PRESSURE: 5.626 KPA

Psychrometric Chart

Barometric Pressure: 101.36 kPa
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