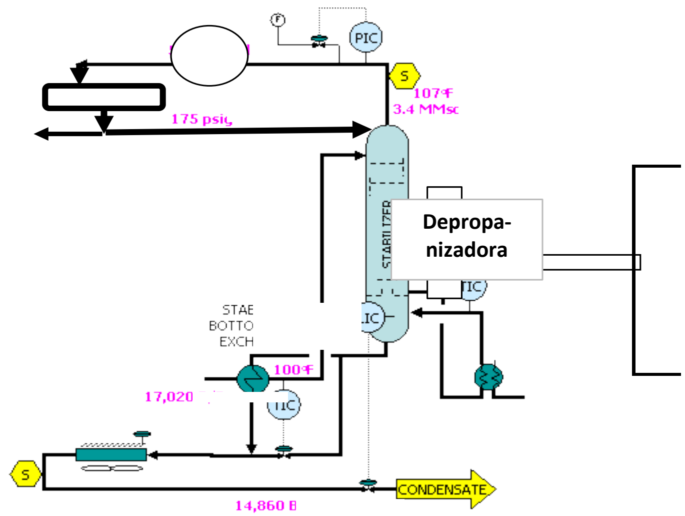
DESTILACION DE MULTICOMPONENTES

Se desea separa un mezcla gaseosa de 100 moles por hora constituida por



	Comp.	% molar	F(mol/hr)
	C2	0.1%	0.1
CL	C3	32.0%	32.0
CP	C4	16.0%	16.0
	C5	16.5%	16.5
	C6	17.0%	17.0
	C8	18.4%	18.4
	Total	100.0%	100.00

Se quiere producir Propano por el tope el cual no debe
tener más de 0.5% en volumen de etano ni mas del 2% de butano
Se desea determinar la presión de operación
Se desea efectuar el balance de materia sobre la columna
La carga está en punto de burbuja

SOLUCION

	Comp.	% molar	F(mol/hr)
	C2	0.10%	0.10
CL	C3	32.00%	32.00
CP	C4	16.00%	16.00
	C5	16.50%	16.50
	C6	17.00%	17.00
	C8	18.40%	18.40
	Total	100.00%	100.00

A.- Separacion Claves

F = D +B
fi = di + bi

Separacion Clave Ligero

Clave Ligero C3 — f_{nC3} 32.0 → d_{nC3} 31.84 Destilado recuperado en 99.5%
99.5% tope 99.5% → b_{nC3} 0.16 Remanente al tope

Clave Pesado C4 — f_{nC4} 16.0 → b_{nC4} 15.84 Fondos recuperado sea 99.0%
99% fondo 99.0% → d_{nC4} 0.16 Remanente al fondo

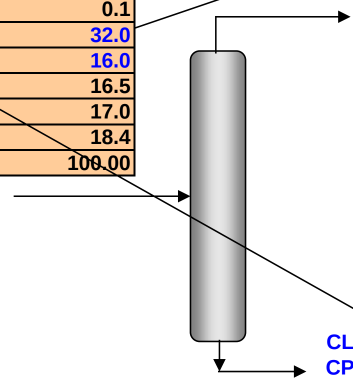
B.- Separacion preliminar de los no claves

Màs pesados clave pesado al fondo

Mas ligeros clave ligero al tope

Comp.	% molar	fi(mol/hr)
C2	0.10%	0.1
C3	32.00%	32.0
C4	16.00%	16.0
C5	16.50%	16.5
C6	17.00%	17.0
C8	18.40%	18.4
Total	100.00%	100.00

CL (C3)
CP (C4)



Comp.	% molar	di(mol/hr)
C2	0.31%	0.10
C3	99.19%	31.84
C4	0.50%	0.16
C5	0.00%	0.00
C6	0.00%	0.00
C8	0.00%	0.00
Total	100.0%	32.10

CL (C3)
CP (C4)

Comp.	% molar	bi(mol/hr)	
C2	0.0%	0.00	
C3	0.2%	0.16	32.0
C4	23.3%	15.84	
C5	24.3%	16.50	
C6	25.0%	17.00	
C8	27.1%	18.40	
Total	100.0%	67.90	100.00

CL (C3)
CP (C4)

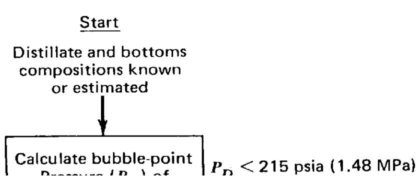
Balance Global

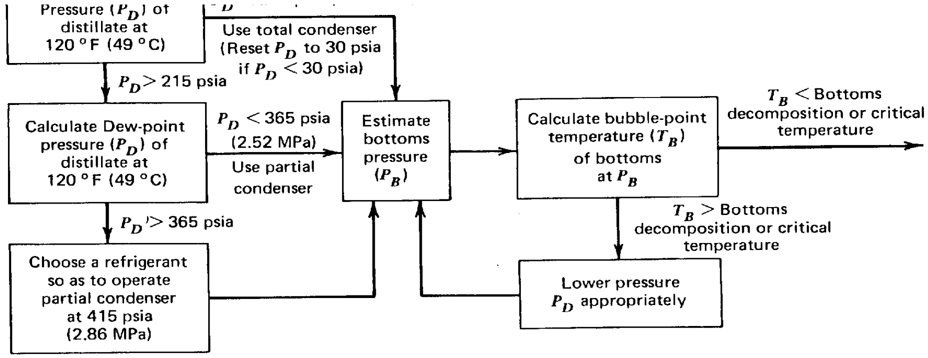
F =	B +	D
100.00	67.90	32.10

Balance Componente

f_{nC3} =	b_{nC3} +	d_{nC3}
32.00	0.16	31.84

C.- Determinacion Presión





Calcule presion burbuja a 49ºC con la composición tope
Temperatura para algoritmo **49 ºC**

Constante de Equilibrio

$$k=\left(\frac{Pc_i}{P}\right)*\exp\left[5.37*(1+\omega_i)*\left(1-\frac{Tc_i}{T}\right)\right]$$

Pto burbuj

ESTE VALOR ES EL QUE SE CALCULA

Producto	xdi	TC (°K)	PC(psia)	w	P(psia)	T(°C)	TC (°K)	ki	Ki*zi
C2	0.0031	305.42	707.784	0.0990	247.1	49.0	322.0	3.8808	0.012
C3	0.9919	369.82	616.265	0.1520	247.1	49.0	322.0	0.9950	0.987
C4	0.0050	425.18	550.708	0.1990	247.1	49.0	322.0	0.2831	0.001
C5	0.0000	469.65	488.632	0.2490	247.1	49.0	322.0	0.0913	0.000
C6	0.0000	507.43	436.854	0.3050	247.1	49.0	322.0	0.0312	0.000
C8	0.0000	568.83	360.564	0.3960	247.1	49.0	322.0	0.0047	0.000
Suma	1.0000								1.000

Presión es 247.15 un poco mayor a 215 psia

Calcule presion rocio a 49ºC con la composición tope
Temperatura para algoritmo **49 ºC**

Constante de Equilibrio

$$k=\left(\frac{Pc_i}{P}\right)*\exp\left[5.37*(1+\omega_i)*\left(1-\frac{Tc_i}{T}\right)\right]$$

Producto	zi	TC (°K)	PC(psia)	w	P(psia)	T(°C)	TC (°K)	ki	zi/ki
C2	0.0031	305.420	707.784	0.099	243.422	49.000	322.000	3.940	0.0008
C3	0.9919	369.820	616.265	0.152	243.422	49.000	322.000	1.010	0.9819
C4	0.0050	425.180	550.708	0.199	243.422	49.000	322.000	0.287	0.0173
C5	0.0000	469.650	488.632	0.249	243.422	49.000	322.000	0.093	0.0000
C6	0.0000	507.430	436.854	0.305	243.422	49.000	322.000	0.032	0.0000
C8	0.0000	568.830	360.564	0.396	243.422	49.000	322.000	0.005	0.0000
Suma	1.0000								1.0000

Presión es 243.42 menor a 365 psia

Trabajaremos a 250 psia con agua como refrigerante
FLASHEAR A LA PRESION COLUMNA

P(psia) =	**250**		
Temp(C) =	96.23	205.2211321 gr/mol	80

$$\sum_{i=1} y_i = 1 = \sum_i x_i k_i$$

Constante de Equilibrio

$$k = \left(\frac{Pc_i}{P}\right) * \exp\left[5.37 * (1+\omega_i) * \left(1 - \frac{Tc_i}{T}\right)\right]$$

CALCULO PUNTO BURBUJA

Producto	zi	TC (°K)	PC(psia)	w	P(psia)	T(°C)	TC (°K)	ki	Ki*zi
C2	0.001	305.420	707.784	0.099	250.0	96.2	369.2	7.8510	0.008
C3	0.320	369.820	616.265	0.152	250.0	96.2	369.2	2.4410	0.781
C4	0.160	425.180	550.708	0.199	250.0	96.2	369.2	0.8304	0.133
C5	0.165	469.650	488.632	0.249	250.0	96.2	369.2	0.3154	0.052
C6	0.170	507.430	436.854	0.305	250.0	96.2	369.2	0.1269	0.022
C8	0.184	568.830	360.564	0.396	250.0	96.2	369.2	0.0251	0.005
Suma	1.000								1.000

La carga se encuentra a 250 psia y 96.23 °C

HENSTEBECK & GEDDES

ALIMENTACION

	Producto	zi	TC (°K)	PC(Bar)	w	P(Bar)	T(°C)	TC (°K)	ki	αi(ki/k$_{iCP}$)
	C2	0.00	305.42	707.784	0.0990	250.0	96.2	369.2	7.8510	**9.454**
C.L	**C3**	0.32	369.82	616.265	0.1520	250.0	96.2	369.2	2.4410	**2.939**
C.P	**C4**	0.16	425.18	550.708	0.1990	250.0	96.2	369.2	0.8304	**1.000**
	C5	0.17	469.65	488.632	0.2490	250.0	96.2	369.2	0.3154	**0.380**
	C6	0.17	507.43	436.854	0.3050	250.0	96.2	369.2	0.1269	**0.153**
	C8	0.18	568.83	360.564	0.3960	250.0	96.2	369.2	0.0251	**0.030**
	Suma	1.00								

Clave ligero: C3 **% recuperacion.** 99.5%

CLAVE LIGERO

di$_{C2}$	31.84
bi$_{C2}$	0.16

Log(di/bi) 2.2989

Clave pesado:C4 **%recuperación** 99.0%

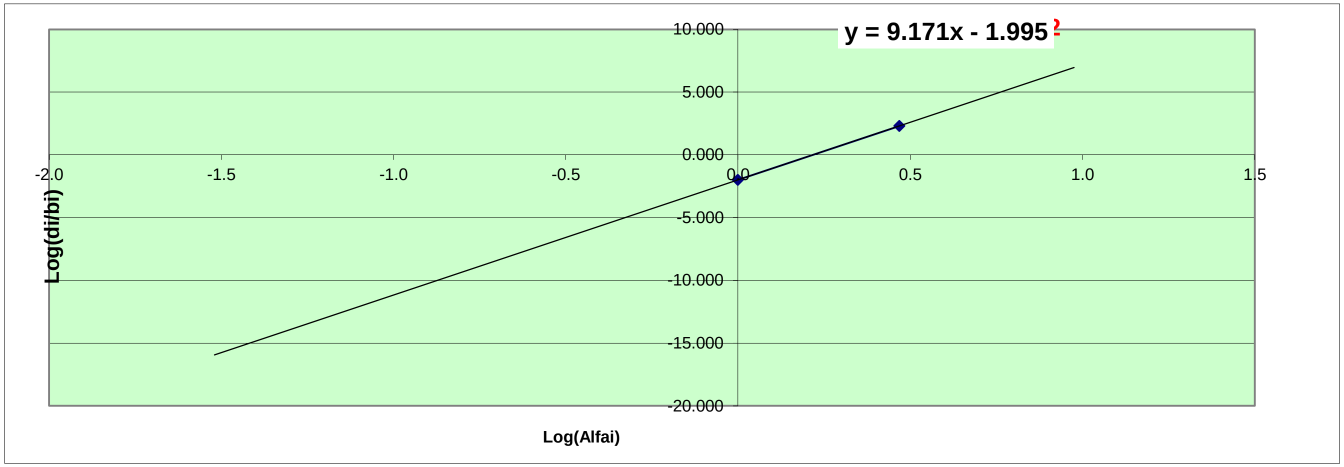
di$_{C3}$	0.16
bi$_{C3}$	15.84

Log(di/bi) -1.99563519

		Log(αi)
	C2	0.976
CL	C3	0.468
CP	C4	0.000
	C5	-0.420

C6	-0.816
C8	-1.520

PRIMERA ITERACION EMPLEANDO HENSTEBECK Y GEDDES



Construyendo la gráfica.

	Componente	log(alfai)	Log(di/Bi)
C.L	**C3**	0.468	2.299
C.P	**C4**	0.000	-1.996

5.7482

ALIMENTACION

Del Grafico.

		zi	flujo	X Log (Alfai)	Y Log(di/bi)	di/bi	bi		di	
	C2	**0.00**	**0.10**	**0.976**	6.953	8,964,495	0.0000		0.1000	^^^
C.L	**C3**	**0.32**	**32.00**	**0.468**	2.299	199.000	0.1600		31.8400	199.0000
C.P	**C4**	**0.16**	**16.00**	**0.000**	-1.996	0.010	15.8400		0.1600	
	C5	**0.17**	**16.50**	**-0.420**	-5.851	0.000	16.5000		0.0000	
	C6	**0.17**	**17.00**	**-0.816**	-9.479	0.000	17.0000		0.0000	
	C8	**0.18**	**18.40**	**-1.520**	-15.937	0.000	18.4000		0.0000	
	Total	**1.00**	**100.00**							

Balance despues de la primera distribucion Y =log(d/b)i

carga

	Componentes	zi	Flujo molar	di	xdi	bi	xbi
	C2	**0.0010**	**0.10**	**0.1000**	**0.003**	**0.0000**	**0.0000**
C.L	**C3**	**0.3200**	**32.00**	**31.8400**	**0.992**	**0.1600**	**0.0024**
C.P	**C4**	**0.1600**	**16.00**	**0.1600**	**0.005**	**15.8400**	**0.2333**
	C5	**0.1650**	**16.50**	**0.0000**	**0.000**	**16.5000**	**0.2430**
	C6	**0.1700**	**17.00**	**0.0000**	**0.000**	**17.0000**	**0.2504**
	C8	**0.1840**	**18.40**	**0.0000**	**-**	**18.4000**	**0.2710**

Total	1.0000	100.00	32.1000	1.000	67.9000	1.0000
		100.00				

CALCULOS DE BURBUJA Y ROCIO EN TOPES PARA HALLAR UN NUEVO ALFA PROMEDIO

		DESTILADO								
		TOPES		TOPES					TOPES	
		P psia =	280	Tburb (°C) =	49.48		P psia =	280	Trocio (°C)	50.18
	Componentes	xdi	ki	alfai	ki*xi		yi		ki	alfai
	C2	0.003	3.8683	13.6492	0.012		0.00312		3.916000584	13.56281
C.L	C3	0.992	0.9940	3.5073	0.986		0.99190		1.009585053	3.4966
C.P	C4	0.005	0.2834	1.0000	0.001		0.00498		0.288730711	1.0000
	C5	0.000	0.0915	0.3230	0.000		0.00000		0.093528295	0.3239
	C6	0.000	0.0314	0.1108	0.000		0.00000		0.032161021	0.1114
	C8	0.000	0.0047	0.0166	0.000		0.00000		0.00483565	0.0167
	Total	1.0000			0.999		1.0000			

CALCULOS DE BURBUJA EN FONDOS PARA HALLAR UN NUEVO ALFA PROMEDIO

		FONDOS			
		P psia =	280	Tburb (°C) =	0.00
	Componentes	xbi	ki	alfai	ki*xi
	C2	0.000	1.405	23.086	0.000
C.L	C3	0.002	0.275	4.516	0.001
C.P	C4	0.233	0.061	1.000	0.014
	C5	0.243	0.016	0.256	0.004
	C6	0.250	0.004	0.070	0.001
	C8	0.271	0.000	0.007	0.000
	Total	1.000			0.020

$$\alpha_{PRO} = \sqrt[3]{\alpha_{ALIM}\,\alpha_{TOPE}\,\alpha_{FONDO}}$$

άά

Componentes	ά feed	ά topes	ά fondos	ά promedio	Log(ά)	Log(ά) inicial
C2	9.4544	13.5628	23.0857	14.3585	1.1571	0.9756
C3	2.9395	3.4966	4.5160	3.5938	0.5556	0.4683
C4	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000
C5	0.3798	0.3239	0.2562	0.3159	-0.5005	-0.4204
C6	0.1528	0.1114	0.0699	0.1060	-0.9748	-0.8160
C8	0.0302	0.0167	0.0070	0.0153	-1.8165	-1.5202

SE PARA LOS ALFAS SON IGUALES άά

resultados

	Componentes	zi	Flujo molar	di	xdi	bi	xbi
	C2	0.0010	0.1000	0.1000	0.0031	0.0000	0.0000
C.L	C3	0.3200	32.0000	31.8400	0.9919	0.1600	0.0024
C.P	C4	0.1600	16.0000	0.1600	0.0050	15.8400	0.2333
	C5	0.1650	16.5000	0.0000	0.0000	16.5000	0.2430
	C6	0.1700	17.0000	0.0000	0.0000	17.0000	0.2504
	C8	0.1840	18.4000	0.0000	0.0000	18.4000	0.2710

Total	1.0000	100.0000	32.1000	1.0000	67.9000	1.0000
		100.00				

C.- NUMERO MINIMO DE PLATOS FENSKE

$$N_m = \frac{\log\left(\dfrac{\left[d_{CL}/d_{CP}\right]}{\left[b_{CL}/b_{CP}\right]}\right)}{\log\left(\alpha_{CL/CP}\right)_{PROM}}$$

		#¡REF!	di	bi	x =log(α$_{icp}$)	fi
	#¡REF!	0.001	0.100	0.000	1.157	0.100
CL	#¡REF!	0.320	31.840	0.160	0.556	32.000
CP	#¡REF!	0.160	0.160	15.840	0.000	16.000
	#¡REF!	0.165	0.000	16.500	-0.500	16.500
	#¡REF!	0.170	0.000	17.000	-0.975	17.000
	#¡REF!	0.184	0.000	18.400	-1.816	18.400
	#¡REF!	1.000	32.100	67.900		100.000
				100.000		

Nm = **7.73** **platos**
NP = **19**

D.- REFLUJO MINIMO
Se manejan con las ecuaciones de Underwood
i.- Calcule θ de la Primera Ecuación de Underwood φφφφ

$$\sum_{i=1}^{NC}\frac{z_f}{(\alpha_i-\theta)/\alpha_i}=1-q=\frac{(\alpha_1 z_1)}{\alpha_1-\theta}+\frac{(\alpha_2 z_2)}{\alpha_2-\theta}+\text{--------}+\frac{(\alpha_{NC} z_{NC})}{\alpha_{NC}-\theta}$$

Cuando los componentes claves son adyacentes (no hay compuesto intermedio)

$$\alpha_{CL} < \theta < \alpha_{CP}$$

ii.- Sustituya el valor de θ en la Ecuación

$$\left(\frac{L_0}{D}\right)_{\min}+1=\sum_{i=1}^{NC}\left(\frac{x_D}{(\alpha_i-\theta)/\alpha_i}\right)=\frac{(\alpha_1 x_1)_D}{(\alpha_1-\theta)}+\frac{(\alpha_2 x_2)_D}{(\alpha_2-\theta)}+\text{-------}+\frac{(\alpha_{NC} x_{NC})_D}{(\alpha_{NC}-1)}$$

Si existe un clave distribuido existirán dos valores de θ

$$\alpha_{CL} < \theta < \alpha_{CD}$$

Este caso es más complejo y requiere un proceso un poco más complicado

Resolvamos el problema suponiendo para el cálculo que los no claves son no distribuidos

	f_i	z_i	α_{ALI}	d_i	x_{iD}	α_{TOP}	b_i	x_{iB}
#¡REF!	0.100	0.001	9.454	0.100	0.003	13.563	0.000	0.000
#¡REF!	32.000	0.320	2.939	31.840	0.992	3.497	0.160	0.002
#¡REF!	16.000	0.160	1.000	0.160	0.005	1.000	15.840	0.233
#¡REF!	16.500	0.165	0.380	0.000	0.000	0.324	16.500	0.243
#¡REF!	17.000	0.170	0.153	0.000	0.000	0.111	17.000	0.250
#¡REF!	18.400	0.184	0.030	0.000	0.000	0.017	18.400	0.271
#¡REF!	100.000	1.000		32.100	1.000		67.900	1.000

Se cumple razonablemente lo indicado 100.000

Debemos saber que **1- q =** **Fracción Vaporizada en la carga**

Fracción vaporizada = **0** Punto Burbuja **Primera ecuacion underwood**

q = **1**

Debo resolver

$$\sum_{i=1}^{NC}\frac{z_f}{(\alpha_i-\theta)/\alpha_i}=1-q=\frac{(\alpha_1 z_1)}{\alpha_1-\theta}+\frac{(\alpha_2 z_2)}{\alpha_2-\theta}+\text{--------}+\frac{(\alpha_{NC} z_{NC})}{\alpha_{NC}-\theta}$$

θ	f(θ)
1.326	0.00000
2.000	0.78694
1.400	0.12588
1.326	0.00000
1.100	-1.20713

Emplee buscar objetivo

El valor de θ es 1.000 1.326 2.939

1.326

Ahora calculamos el Reflujo Mínimo según:

$$\left(\frac{L_0}{D}\right)_{\min}+1=\sum_{i=1}^{NC}\left(\frac{x_D}{(\alpha_i-\theta)/\alpha_i}\right)=\frac{(\alpha_1 x_1)_D}{(\alpha_1-\theta)}+\frac{(\alpha_2 x_2)_D}{(\alpha_2-\theta)}+\text{-------}+\frac{(\alpha_{NC} x_{NC})_D}{(\alpha_{NC}-1)}$$

Segunda ecuacion underwood tope
Topes

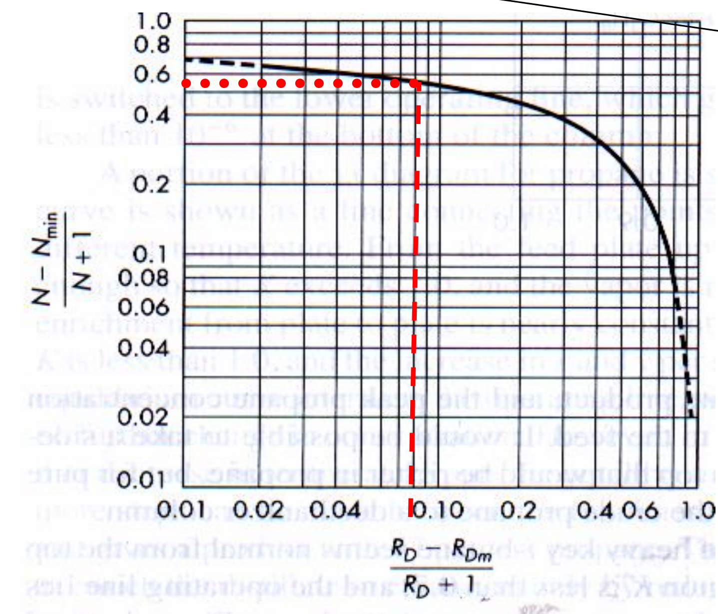
Rmin =$(L_0/D)_{min}$ = **0.586**

E.- NUMERO PLATOS

R =(L_0/D) = 1.25*(L_0/D)min **0.732147632**

- **Correlation for Number of Stages at Finite Reflux Ratio**
  - **Gilliland - empirically related N at finite L/D to N_{min} and (**
  - **Figure next page contains the Gilliland correlation as m**

Absisa 0.085



Nmin=	7.730035224
N=	**19**
f(N)=	0.55
f(N)=	0.572058739

N Platos 19

- **Procedure to use the Gilliland correlation:**

1. **Calculate N_{min} from the Fenske equation**
2. **Calculate $(L/D)_{min}$ from Underwood equation**
3. **Choose actual (L/D)**
4. **Calculate abscissa**

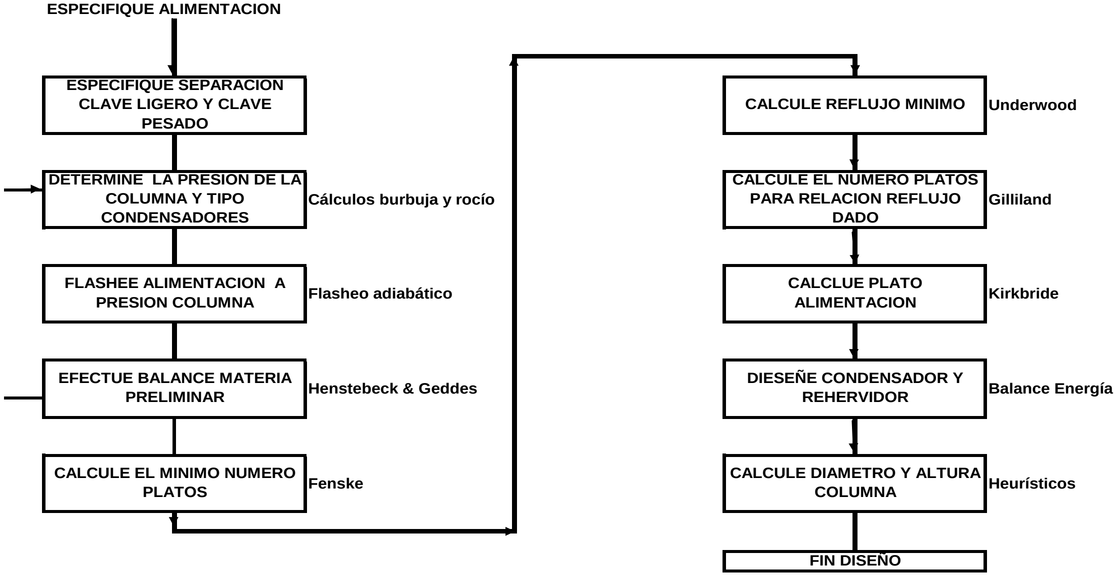
$$\frac{L/D - (L/D)_{min}}{L/D + 1}$$

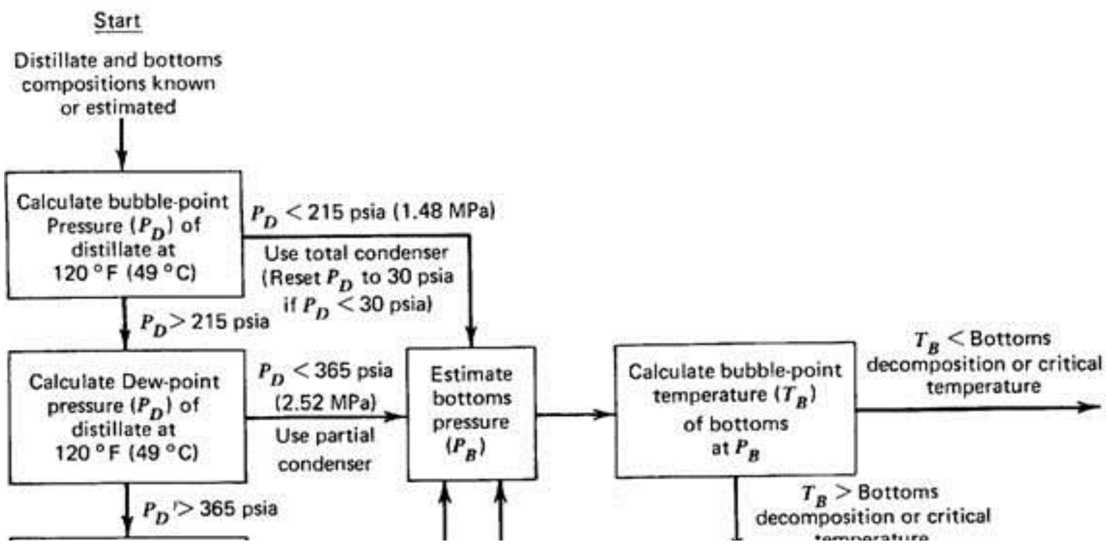
5. **Determine ordinate value from graph** $\left(\frac{N - N_{min}}{N+1}\right)$
6. **Calculate actual number of stages, N**

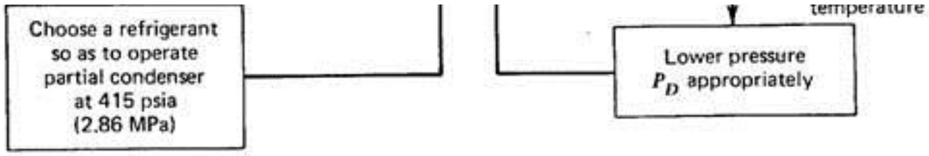
Use correlation only for rough estimates
N can be ± 30% but usually w/i ± 7%

N-Nmin/(N+1) =	**0.550**	Chem Cad
N =	**19**	**0**

DESTILACION MULTICOMPONENTES METODO FUG

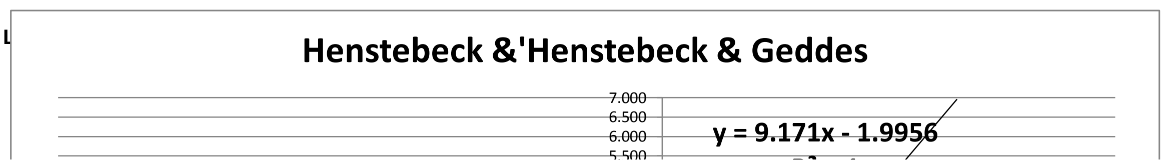


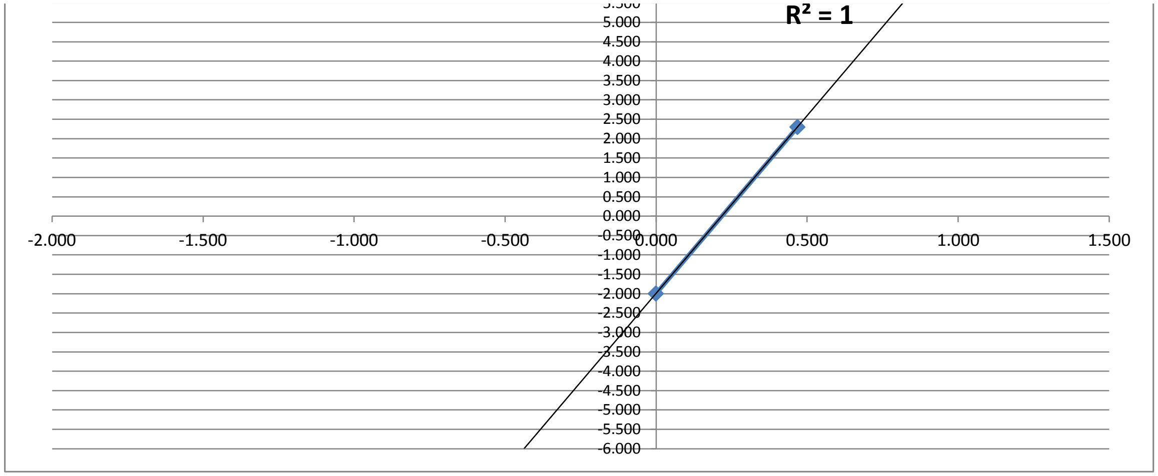



temperature
Choose a refrigerant so as to operate partial condenser at 415 psia (2.86 MPa)
Lower pressure P_D appropriately

a Suma Ki*Zi = 1

Log(αi)
0.976
0.468
0.000
-0.420
-0.816
-1.520




$R^2 = 1$
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
-1.500
-2.000
-2.500
-3.000
-3.500
-4.000
-4.500
-5.000
-5.500
-6.000
-2.000
-1.500
-1.000
-0.500
0.000
0.500
1.000
1.500

xi=yi/ki
0.000795521
0.982482446
0.017263214
7.74951E-06
5.47097E-09
0
1.001

s

$(L/D)_{min}$
odified by Liddle

min