Clase 84 20 Enero 2021

Título de la nota 20/01/2021

Vap = L → V

\+

Fusión = S → L

Sublimación = S → V

$$\overline{\Delta H_S} = \overline{\Delta H_F} + \overline{\Delta H_V}$$

$$\overline{\Delta H_F} = \overline{\Delta H_S} - \overline{\Delta H_V}$$

$$\log P_{v(s)} = A - \frac{B}{T}$$

$$\log P_{v(L)} = A - \frac{B}{T}$$

$$A_s - \frac{B_s}{T} = A_L - \frac{B_L}{T}$$

A = adimensional.

B = [K]

$$A_s - A_L = \frac{B_L}{T} - \frac{B_s}{T}$$

$$A_s - A_L = [B_L - B_s] \frac{1}{T}$$

Entalpía de vaporización | Ecuación de Antoine | Punto triple

Obtención de las coordenadas del punto triple de una sustancia pura

Insertar en las celdas de color amarillo los valores correspondientes

Constantes Antoine	
A_L	B_L [K]
6.692	2460
A_S	B_S [K]
10.808	6947

R [cal/molK]	1.9889

Coordenadas del punto triple	
T (K)	1090.1361
p (mmHg)	27252.1604
p [atm]	35.8581

Modelos

$$\log p_L\,(\text{mm Hg}) = A_L - \frac{B_L}{T}$$

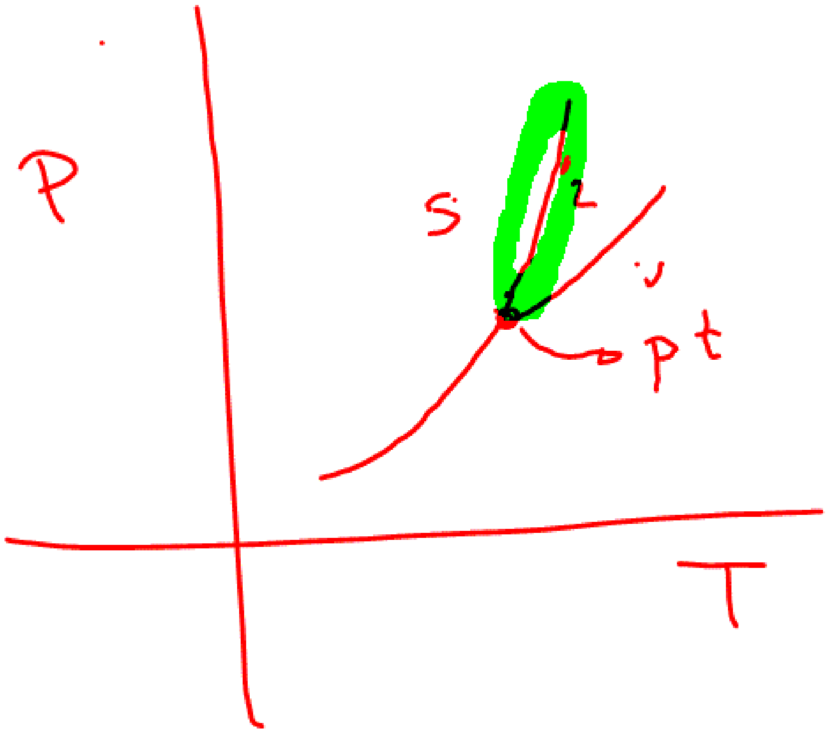
$$\log p_S\,(\text{mm Hg}) = A_S - \frac{B_S}{T}$$

$$p_v(L) = 10^{A_L - \frac{B_L}{T}} = 27252.1663 \text{ mmHg}$$

$$27252.1716 =$$

$$p_v(s) = 10^{A_s - \frac{B_s}{T}} = 27252.1770 \text{ mmHg}$$

$$\left(27252.16 \text{ mmHg}\right)\left(\frac{1 \text{ atm}}{760 \text{ mmHg}}\right) = 35.85 \text{ atm}$$


P
s
l
v
pt
T

Entalpía de vaporización | Ecuación de Antoine | Punto triple

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Modelos

$$\log p_L\ (\text{mm Hg}) = A_L - \frac{B_L}{T}$$

$$\log p_S\ (\text{mm Hg}) = A_S - \frac{B_S}{T}$$

$$\log p_{V(l)} = A - \frac{B}{T}$$

TNE

T (K)	1/T	p (mm Hg)	Ln p
645.4683	0.00154926	760.00	6.633318
644.4955	0.00155160	750.00	6.620073
643.5127	0.00155397	740.00	6.606650
642.5196	0.00155637	730.00	6.593045

b (ordenada al origen)	15.4089
m (pendiente) K	-5664.3593
r	-1.0
ΔH_v (cal/mol)	11265.8443

$$\log p_L - A = -\frac{B}{T}$$

TNS

T (K)	1/T	p (mm Hg)	Ln p
876.3513	0.00114109	760.00	6.633318
875.7158	0.00114192	750.00	6.620073
875.0728	0.00114276	740.00	6.606650
874.4219	0.00114361	730.00	6.593045

b =ordenada al origen	24.8863
m (pendiente) K	-15996.0586
r	-1.0
ΔH_{sub} (cal/mol)	31814.5610

$$T = -\frac{B}{(\log p_L - A)}$$

ΔH_v [cal/mol]	11265.8443
ΔH_v [J/mol]	47158.8241
ΔH_F [cal/mol]	20548.7168
ΔH_F [J/mol]	86016.9284
ΔH_{sub} [cal/mol]	31814.5610
ΔH_{sub} [J/mol]	133175.7525

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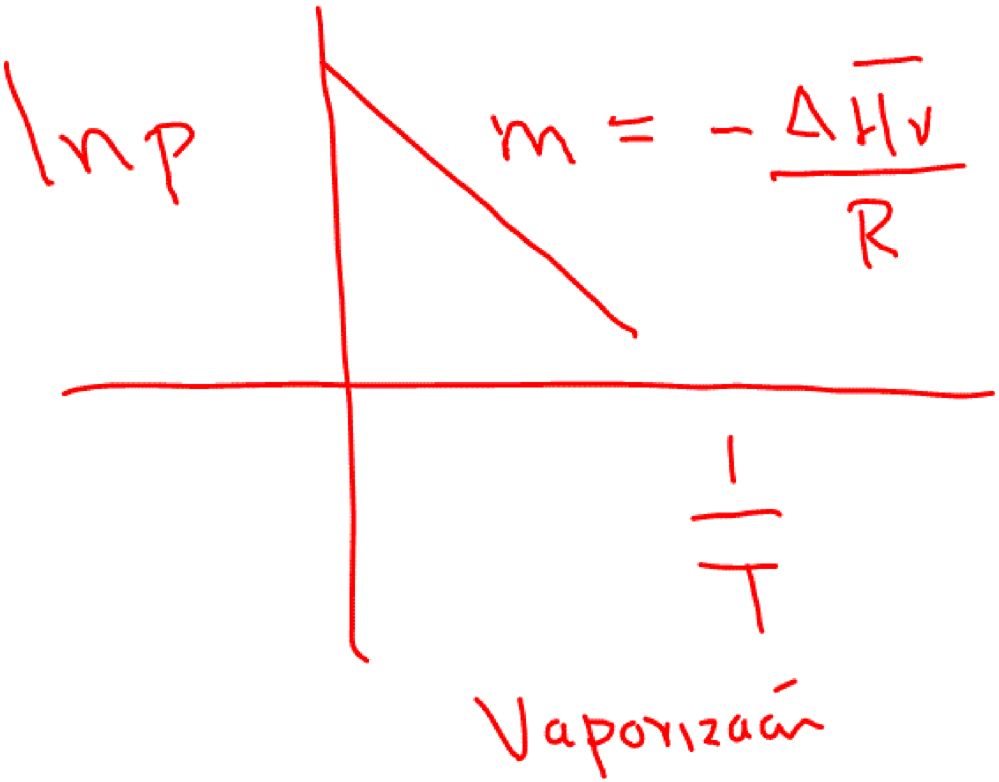
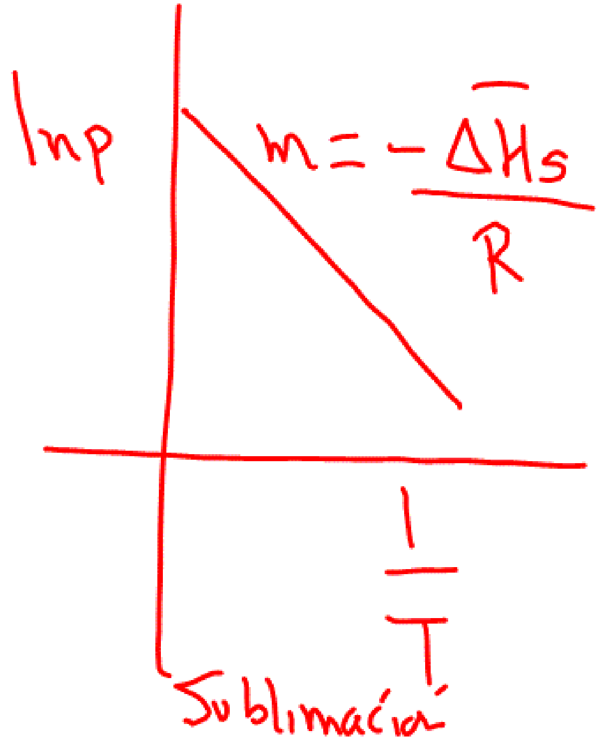
$$T = \left[\frac{-B}{(\log 760 - A)}\right]$$


lnp
$m = -\frac{\Delta \bar{H}_v}{R}$
$\frac{1}{T}$
Vaporización

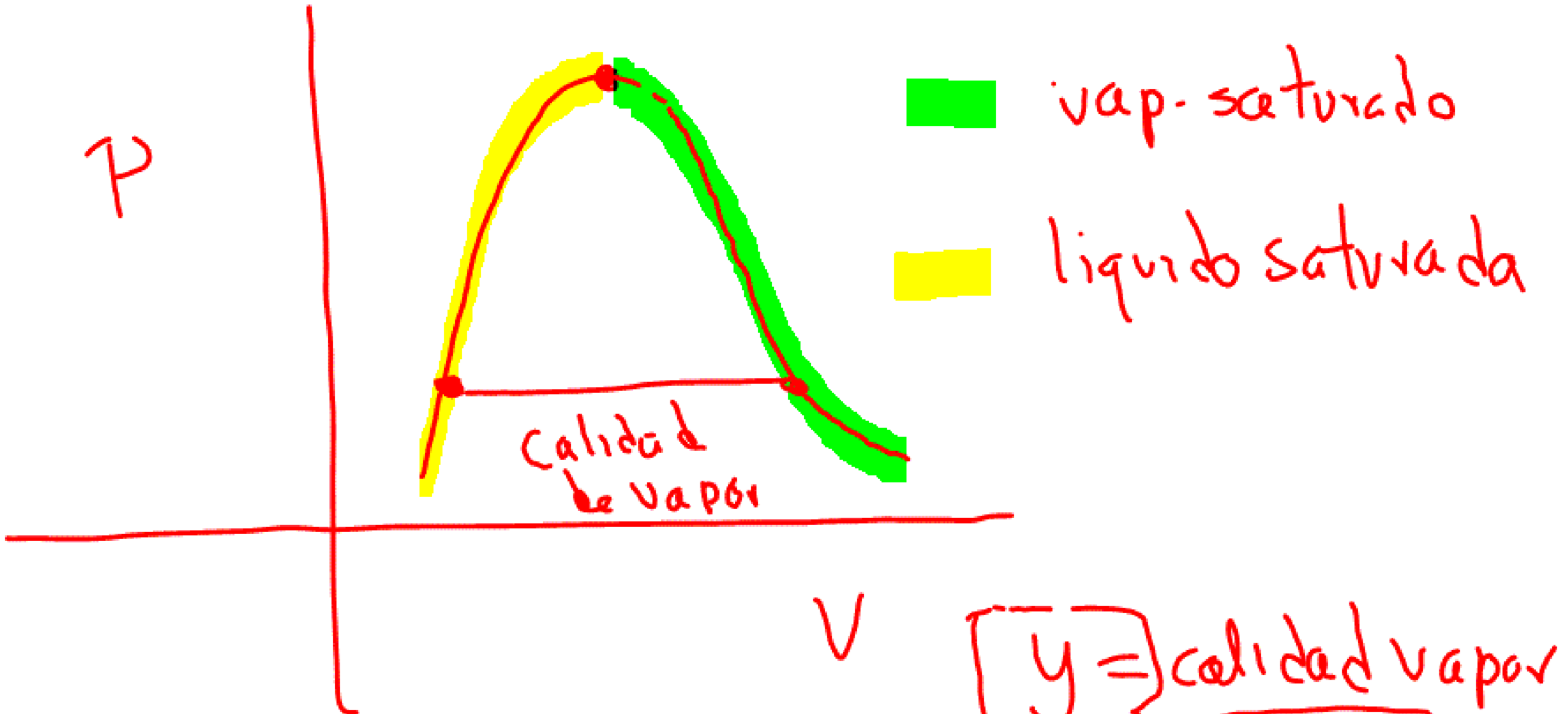

lnp
$m = -\frac{\Delta \bar{H}_s}{R}$
$\frac{1}{T}$
Sublimación

$$-\frac{\overline{\Delta H_v}}{R} = -m$$

$$-5664.42\,K = -\frac{\overline{\Delta H_v}}{R}$$

$$\overline{\Delta H_v} = (5664.42\,K)(1.9889\ cal/mol\,K) = cal/mol$$

$$= 11266.06\ cal/mol$$



y = calidad vapor
0 – 1

Sustancia pura y = Fracción mol
= Fracción masa

$$y = \text{Fracción mol} = \frac{n_{vap}}{n_{vap} + n_{Liq}}$$

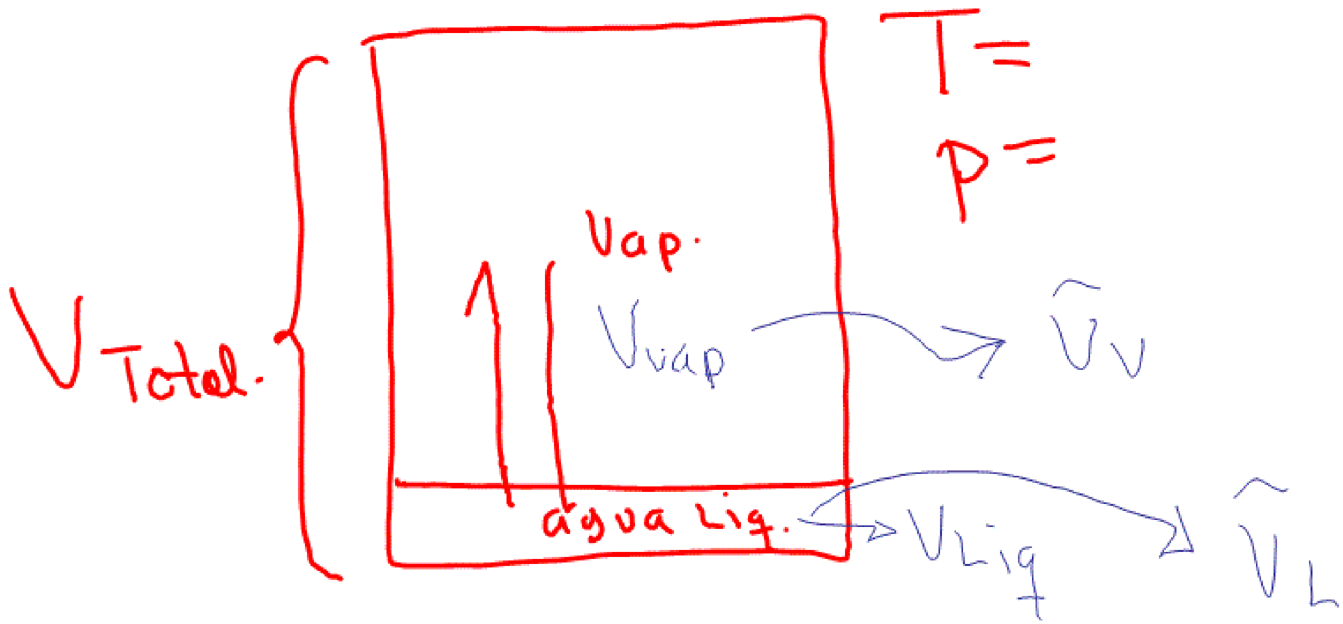
$$n_{vap} = m_{vap}/M_{vap} \qquad = \frac{m_{vap}/M_{vap}}{m_{vap}/M_{vap} + m_{Liq}/M_{Liq}}$$

$$n_{liq} = m_{Liq}/M_L$$

$$M_{vap} = M_{Liq} = \text{sust. pura}$$

$$\boxed{y = \frac{m_{vap}}{m_{vap} + m_{Liq}}}$$

calidad de vapor.



$$\tilde{V}_{Total} = \frac{V_{total}}{m_{total}}$$

$$\hat{V}_T = y\hat{V}_V + (1-y)\hat{V}_L$$

$y = 1$ $\quad$ $y = 0$

Calidad de vapor | Interpolación | Tabla

Calidad de vapor (y) en un sistema cerrado

Introducir en las celdas de color amarillo los valores correspondientes

$V_{sistema}$ [L]	800.00
m total [kg]	1.0000
T (°C)	80.00
p [bar]	0.4736
V_v [m^3/kg]	3.4100
V_v [L/kg]	3410.00
V_L [L/kg]	1.0293

V_{Total} [L/kg]	800.00

y	0.23437		
m_v [kg]	0.23437	V_v [L]	799.2119
m_L [kg]	0.76563	V_L [L]	0.7881
ρ_L [g/mL]	0.97153		

$$\tilde{V}_T = \frac{V_{Total}}{m_{total}} = \frac{800 L}{1 Kg}$$

Una calidad de vapor mayor a 1 indica que solo existe vapor saturado seco

Modelos

$$\tilde{V}_{total} = y\tilde{V}_v + (1\text{-}y)\,\tilde{V}_L$$

$$m_v = y m_{total} \quad \therefore \quad m_L = m_{total} - m_v$$

$$V_v = m_v \tilde{V}_v \quad \therefore \quad V_L = m_L \tilde{V}_L$$

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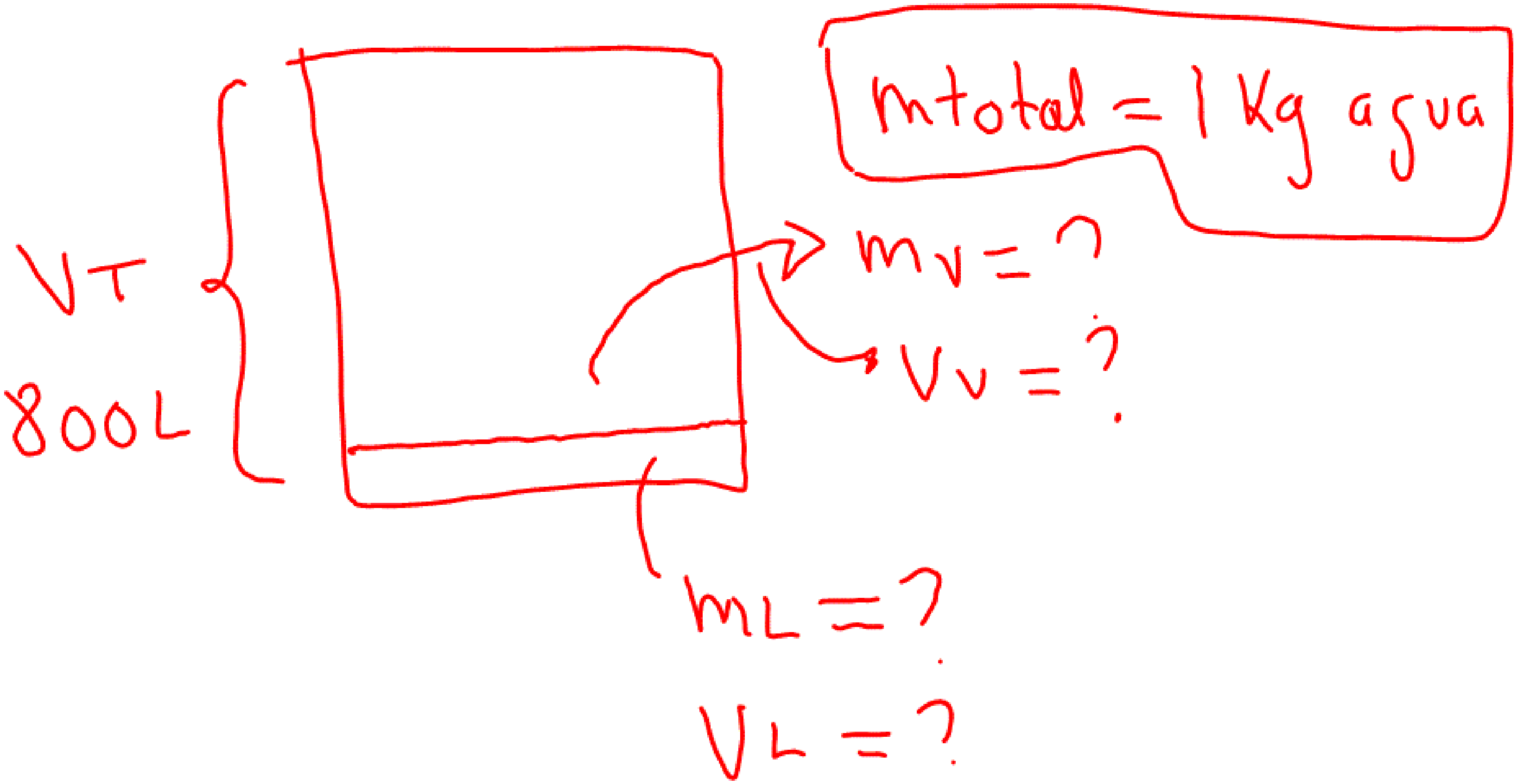
mtotal = 1 Kg agua
VT
800L
mv = ?
Vv = ?
mL = ?
VL = ?

Calidad de vapor | Interpolación | Tabla

Calidad de vapor (y) en un sistema cerrado

Introducir en las celdas de color amarillo los valores correspondientes

$V_{sistema}$ [L]	800.00			V_{Total} [L/kg]	800.00
m total [kg]	1.0000				
T (°C)	80.00				
p [bar]	0.4736	y	0.23437		
V_v [m³/kg]	3.4100	m_v [kg]	0.23437	V_v [L]	799.2119
V_v [L/kg]	3410.00	m_L [kg]	0.76563	V_L [L]	0.7881
V_L [L/kg]	1.0293	ρ_L [g/mL]	0.97153		

Una calidad de vapor mayor a 1 indica que solo existe vapor saturado seco

Modelos

$$\tilde{V}_{total} = y\tilde{V}_v + (1-y)\tilde{V}_L$$

$$m_v = y m_{total} \quad \therefore \quad m_L = m_{total} - m_v$$

$$V_v = m_v \tilde{V}_v \quad \therefore \quad V_L = m_L \tilde{V}_L$$

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Región de dos fases: liquido y vapor saturados

T	p	Volumen.		U		H		S	
°C	bar	Liquido L/kg	Vapor m³/kg	Liquido kJ/kg	Vapor kJ/kg	Liquido kJ/kg	Vapor kJ/kg	Liquido kJ/kgK	Vapor kJ/kgK
0	0.006107	1.0002	206.3	0	2374.5	0	2500.5	0	9.1545
5	0.008722	1.0000	147.1	21.05	2360.4	21.05	2509.7	0.0764	9.0234
10	0.012275	1.0002	106.4	42.03	2388.3	42.03	2518.9	0.1511	8.8985
15	0.017045	1.0008	77.96	62.96	2395.2	62.96	2528.1	0.2244	8.7793
20	0.02337	1.0017	57.84	83.86	2402.1	83.86	2537.3	0.2963	8.6652
25	0.03166	1.0029	43.41	104.74	2409	104.74	2546.4	0.366	8.5561
30	0.04241	1.0043	32.94	125.61	2415.7	125.61	2555.5	0.4364	8.4516
35	0.05621	1.0059	22.26	146.46	2422.5	146.47	2564.5	0.5046	8.3514
40	0.07374	1.0078	19.56	167.33	2429.3	167.34	2573.5	0.5718	8.2553
45	0.09581	1.0099	15.28	188.21	2436	188.22	2582.4	0.6379	8.1631
50	0.12334	1.0121	12.05	209.1	2442.7	209.11	2591.3	0.7031	8.0747
55	0.1574	1.0146	9.583	229.98	2449.3	230	2600.1	0.7672	7.9893
60	0.1992	1.0172	7.682	250.89	2455.8	250.91	2608.8	0.8304	7.9074
65	0.2501	1.02	6.205	271.81	2462.2	271.84	2617.4	0.8928	7.8286
70	0.3116	1.0229	5.048	292.75	2468.6	292.78	2625.9	0.9542	7.7526
75	0.3855	1.026	4.135	313.7	2474.8	313.74	2634.2	1.0149	7.6794
80	0.4736	1.0293	3.41	334.67	2481	334.72	2642.5	1.0747	7.6088

$$\hat{V}_T = y\hat{V}_v + (1-y)\hat{V}_L$$

$T = 80°C$

$p = 0.4736$ bar

$$\hat{V}_T = y\hat{V}_v + \hat{V}_L - y\hat{V}_L$$

$$\hat{V}_T = y\hat{V}_V + \hat{V}_L - y\hat{V}_L$$

$$\hat{V}_T - \hat{V}_L = y\hat{V}_V - y\hat{V}_L$$

$$\hat{V}_T - \hat{V}_L = y(\hat{V}_V - \hat{V}_L)$$

$$\left.\begin{array}{l}\hat{V}_T\\ \hat{V}_L\\ \hat{V}_V\end{array}\right\} L/kg \qquad \boxed{y = \frac{\hat{V}_T - \hat{V}_L}{\hat{V}_V - \hat{V}_L}} = \frac{800 - 1.0293}{3410 - 1.0293}$$

$$= 0.234373$$

$m_v =$

$m_L =$

$y = \dfrac{m_{vap}}{m_{vap} + m_{liq}}$ $= m_{total}$

$0.23437 = \dfrac{m_{vap}}{1\,Kg}$

$m_{Total} = m_v + m_L$

$m_{vap} = 1\,Kg\,(y)$
$= 1\,Kg\,(0.23437)$
$= 0.23437\,Kg$

$m_L = m_{total} - m_{vap}$

$= 1\,Kg - 0.23437\,Kg = 0.7656\,Kg$

$$V_v = m_v \hat{V}_v = (0.23437\ kg)(3410\ L/kg)$$
$$= 799.20\ L$$

$$V_L = m_L \hat{V}_L = (0.7656\ kg)(1.0293\ L/kg)$$
$$= 0.7880\ L$$

$$\boxed{799.2\ L + 0.7880\ L} = \sim 800\ L$$

$$\rho L = \frac{mL}{VL} = \frac{Kg}{L} = \frac{g}{ml}$$

$$= \frac{0.76563\ Kg}{0.7881\ L} = \frac{0.9715\ g}{mL}$$