UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO

FACULTAD DE QUÍMICA

3.- Tablas de Vapor

Taller *Ciclos de Generación de Potencia en Excel*

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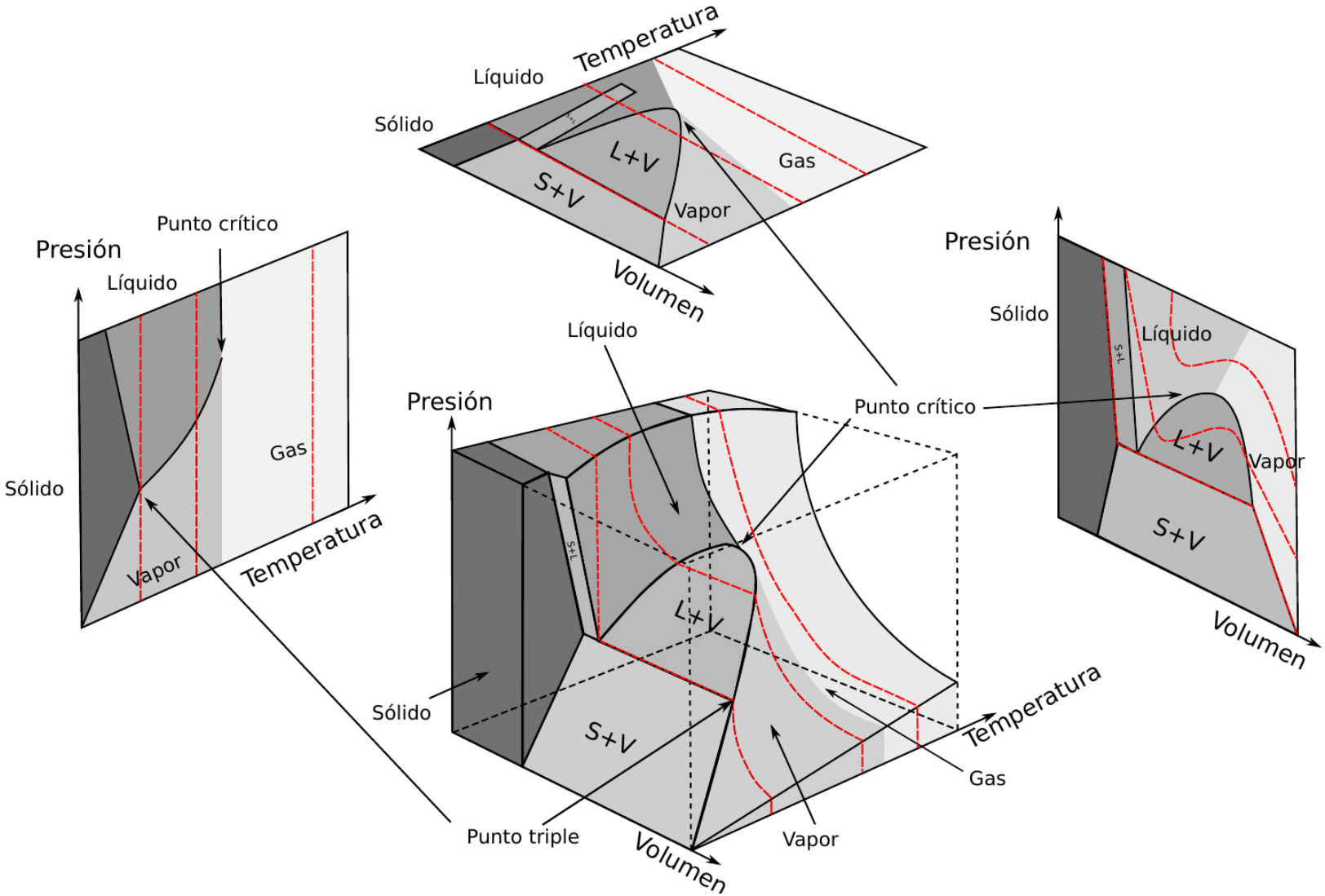
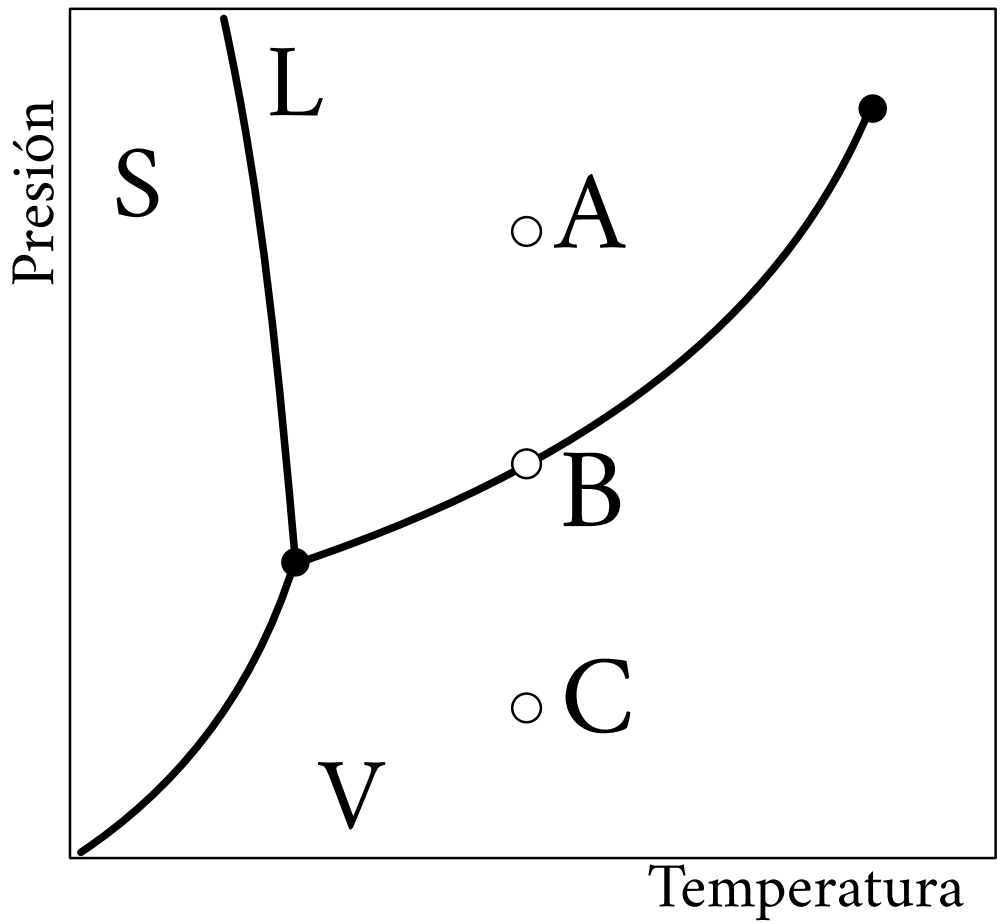
Diagramas de Unarios

Diagrama Unarios



A. Garcia-Figueroa (2015), *Diagramas seudo-ternarios hidrocarburo, agua, alcohol y tensoactivo*

Diagrama Unarios



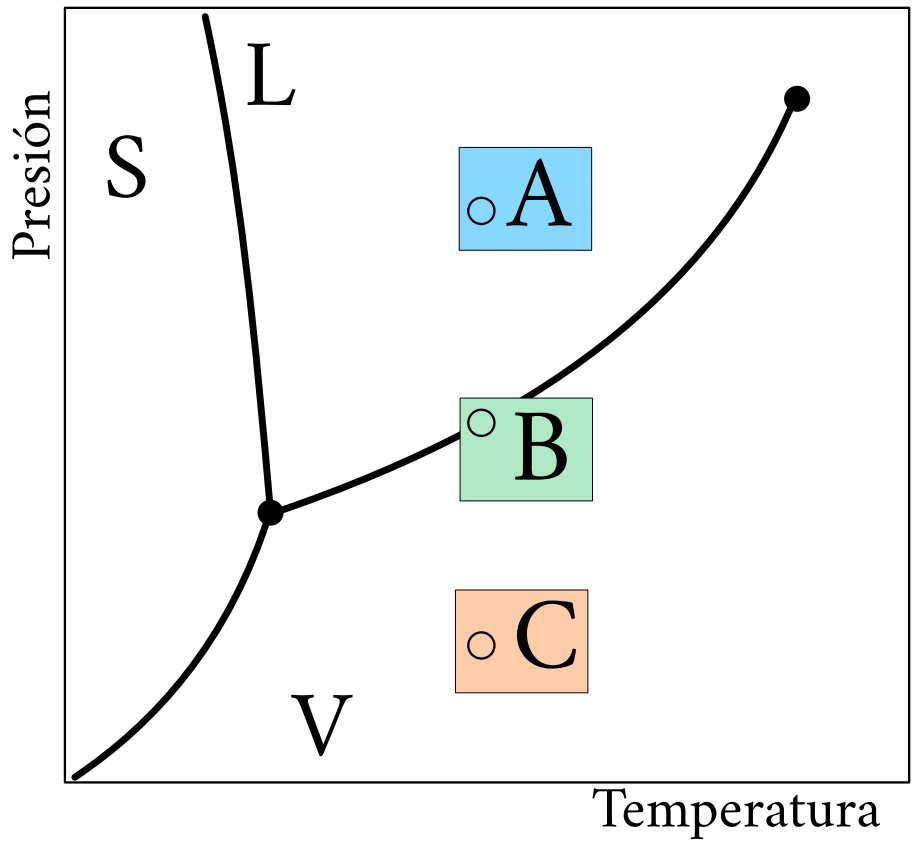
$$GL = 2 + n_c - n_\pi$$

A:

B:

C:

Diagrama Unarios. P-T



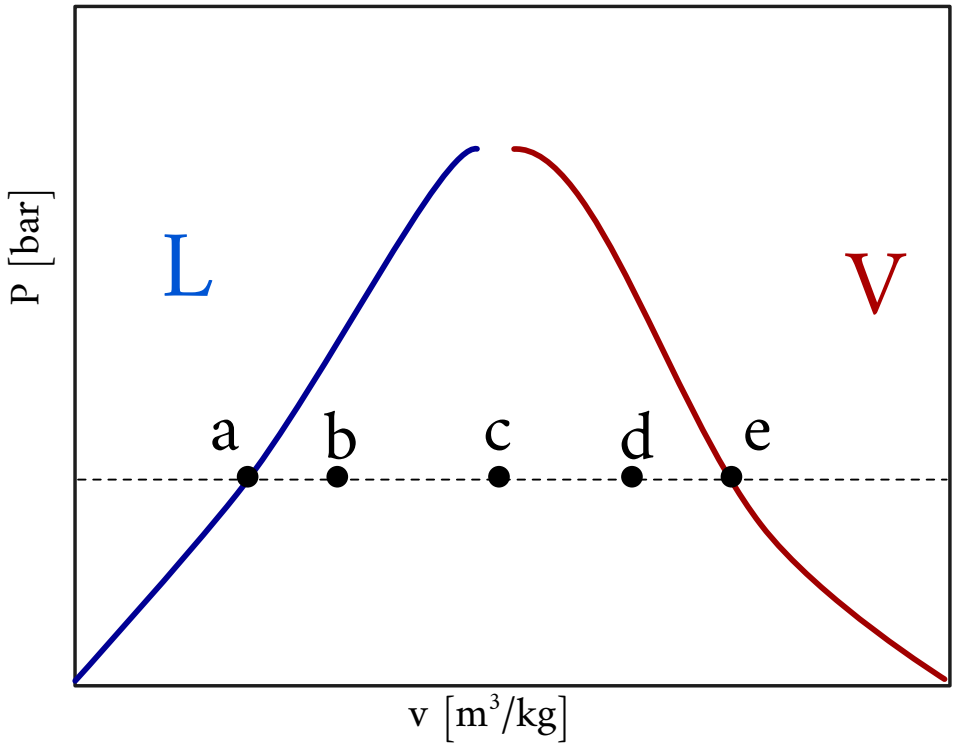
$$GL = 2 + n_c - n_\pi$$

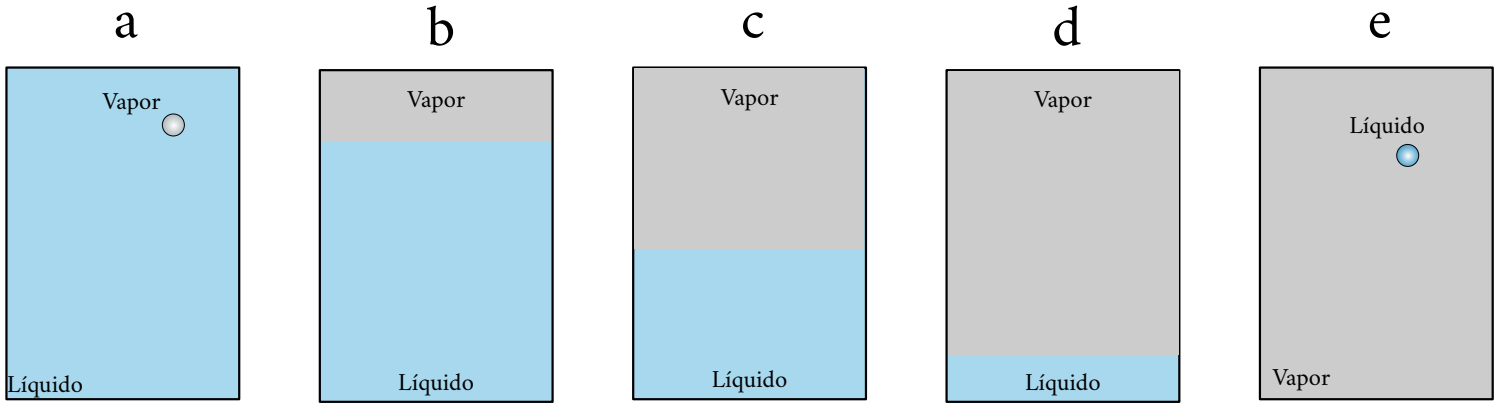
A: GL=2, Líquido comprimido o subenfriado (T y P)

B: GL=1, Vapor saturado o líquido saturado (T ó P)

C: GL=2, Vapor sobrecalentado o expandido (T y P)

Diagrama Unarios. P-v

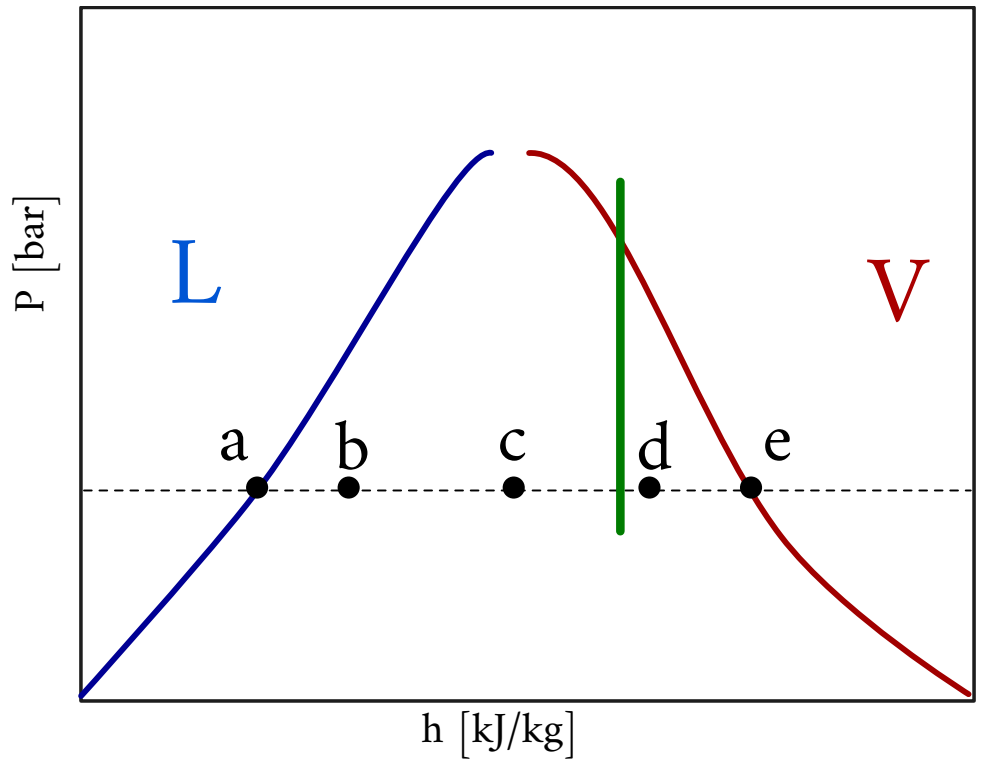




punto de burbuja

punto de rocío

Diagrama Unarios. P-h



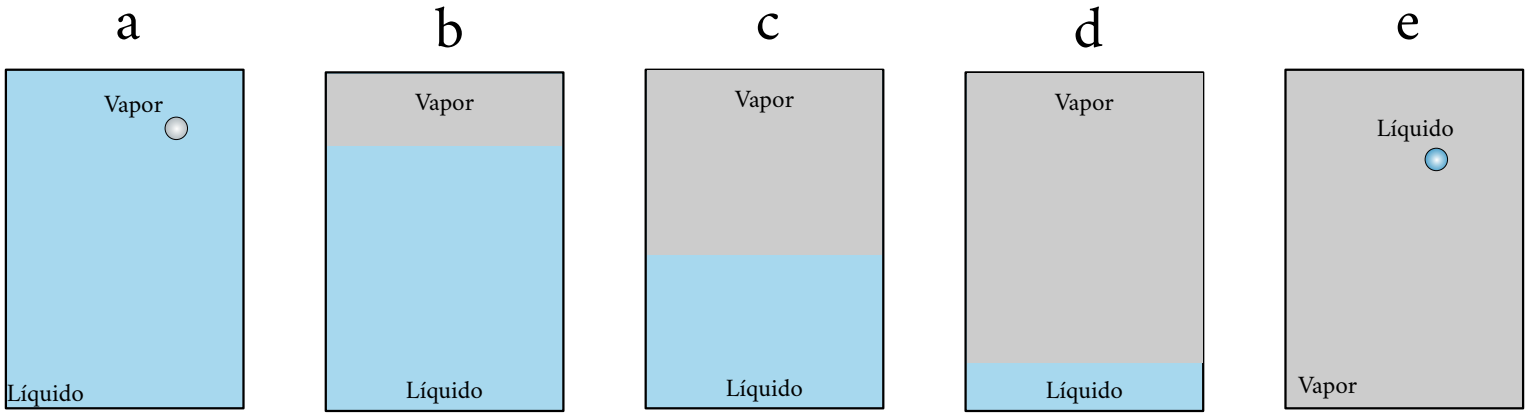
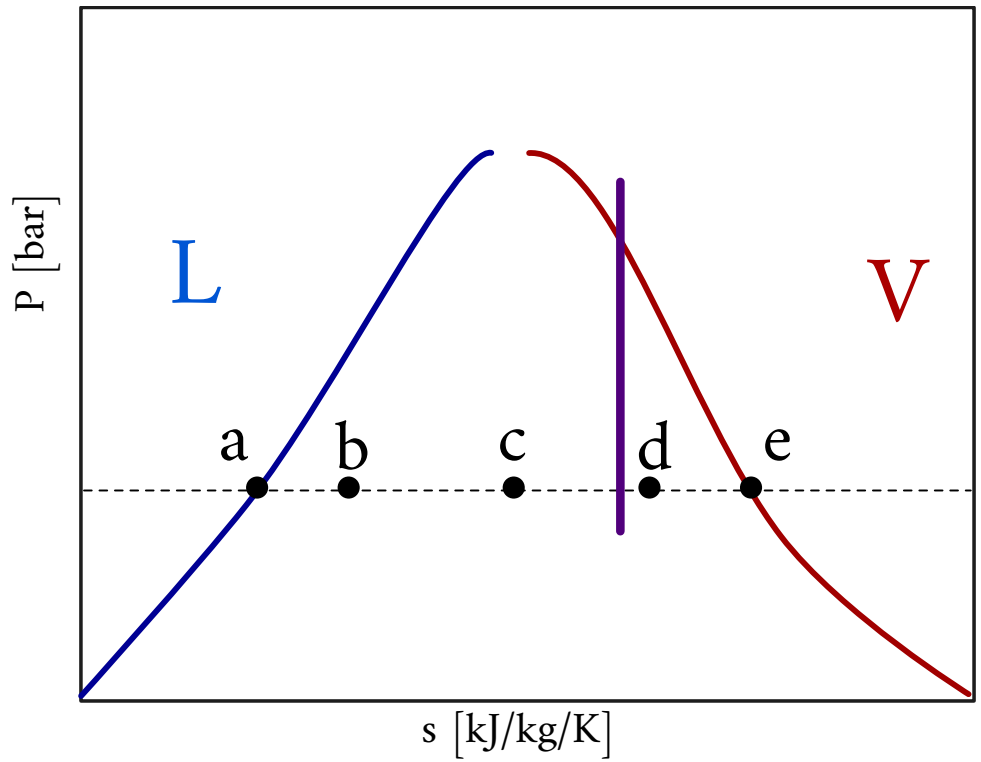
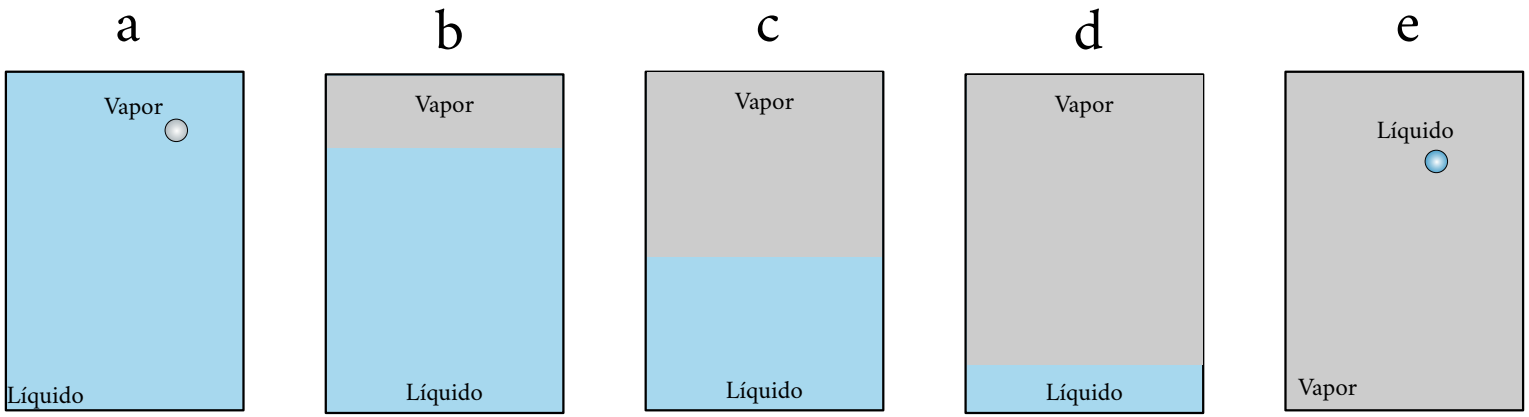


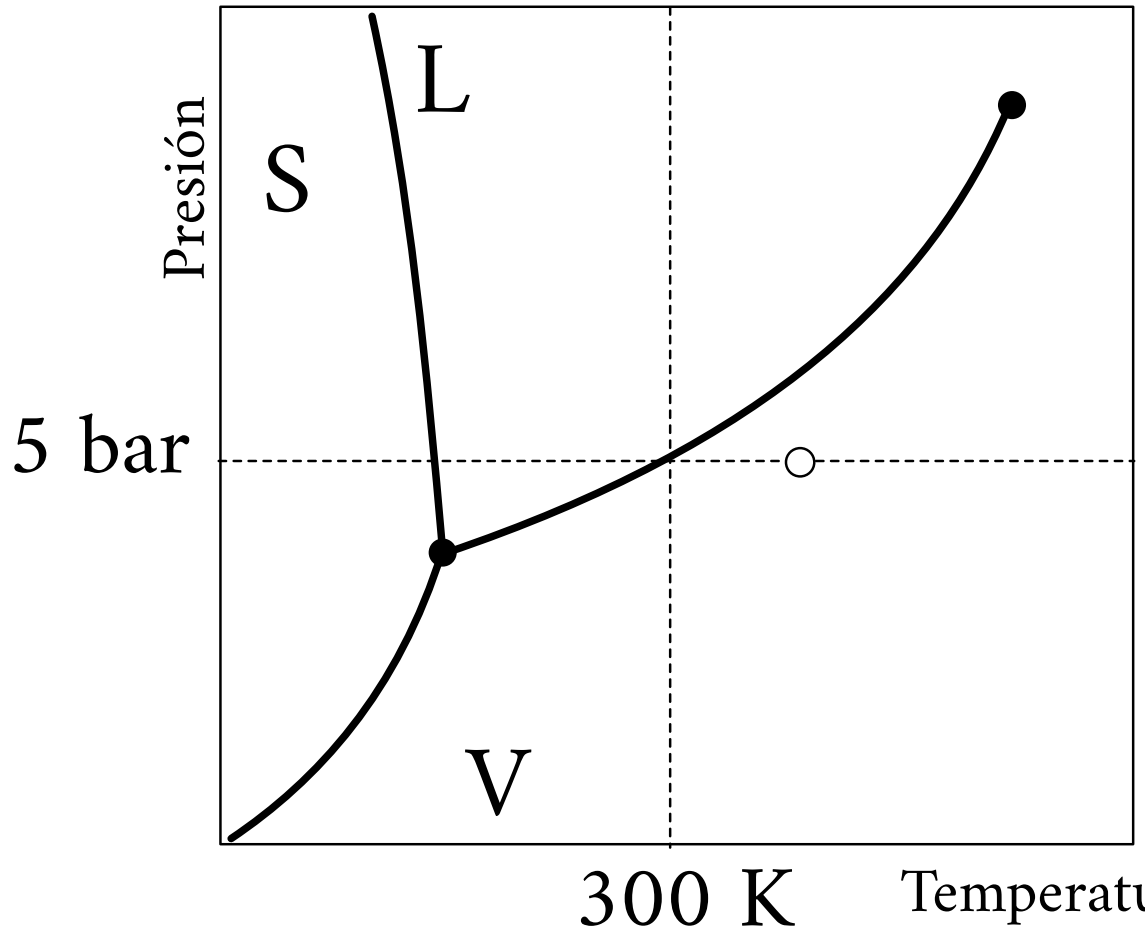
Diagrama Unarios. P-s





Tipo de Fluido

Tipo de Fluido. P-T

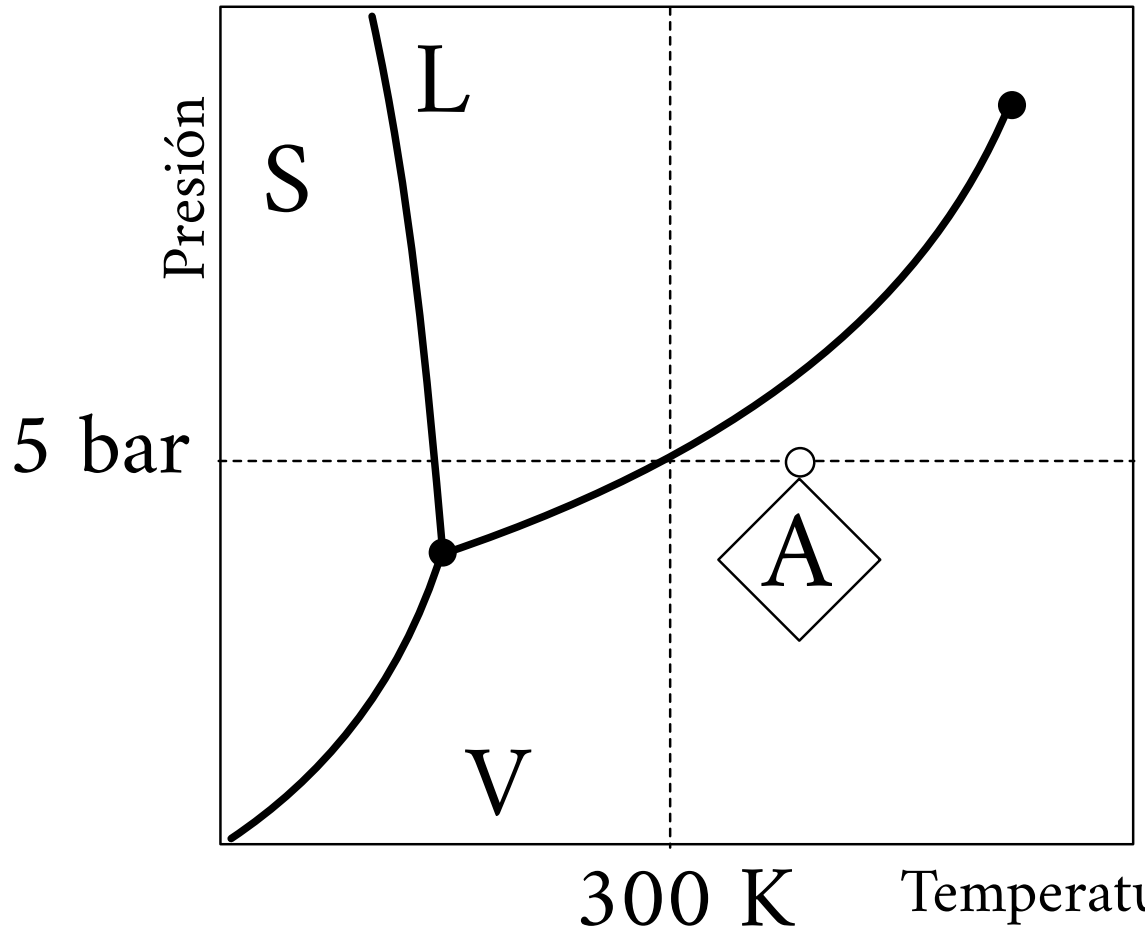


A

T=320 K
P=5 bar

a) Vapor-líquido saturado
b) Vapor sobre calentado
c) Líquido comprimido

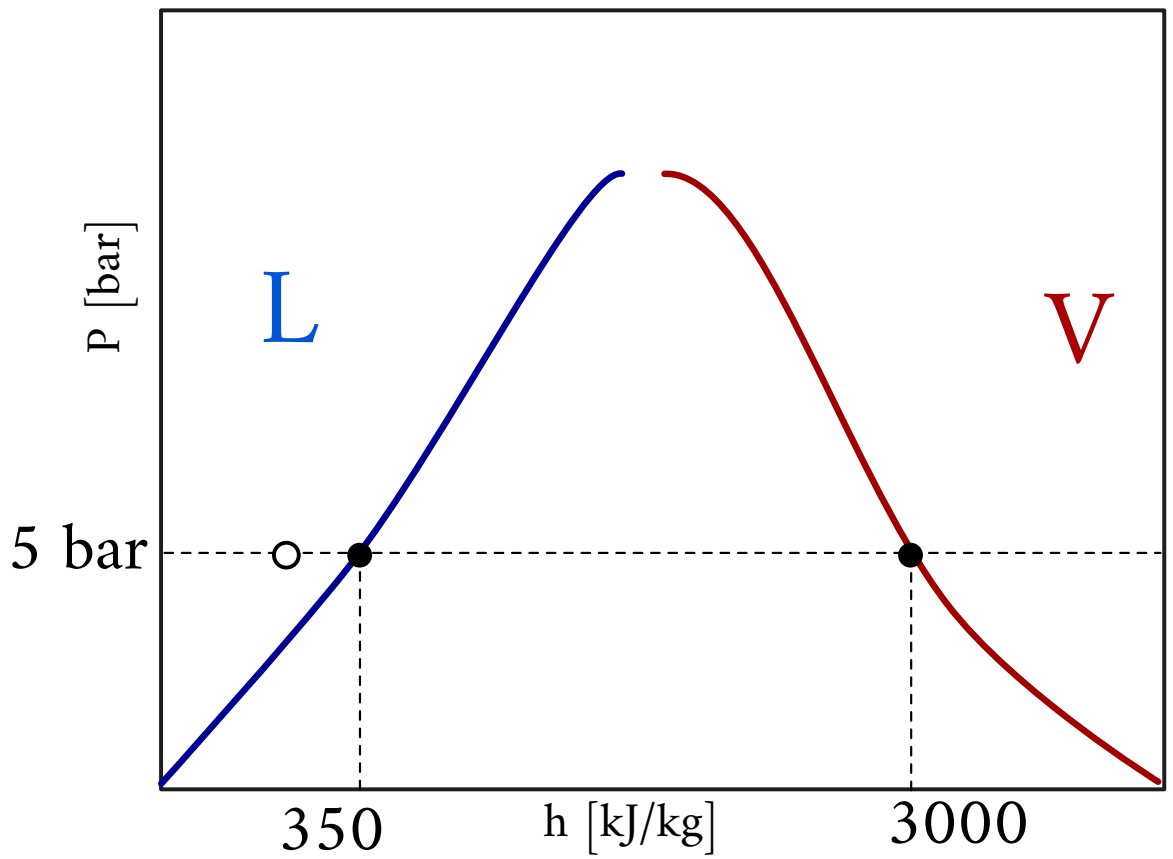
Tipo de fluido. P-T



T=320 K
P=5 bar

a) Vapor-líquido saturado
b) Vapor sobre calentado
c) Líquido comprimido

Tipo de fluido. P-h

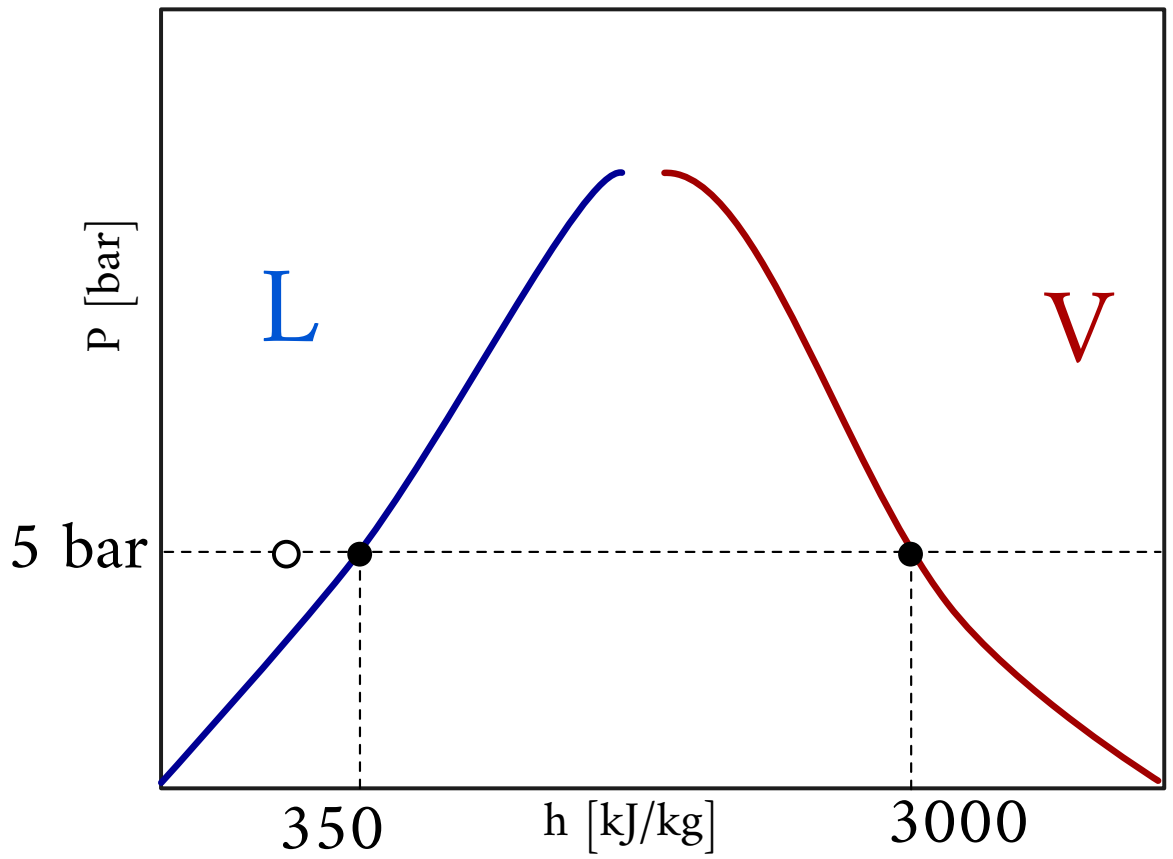


B

h=310 kJ /kg
P=5 bar

a) Vapor-líquido saturado
b) Vapor sobre calentado
c) Líquido comprimido

Tipo de fluido. P-h

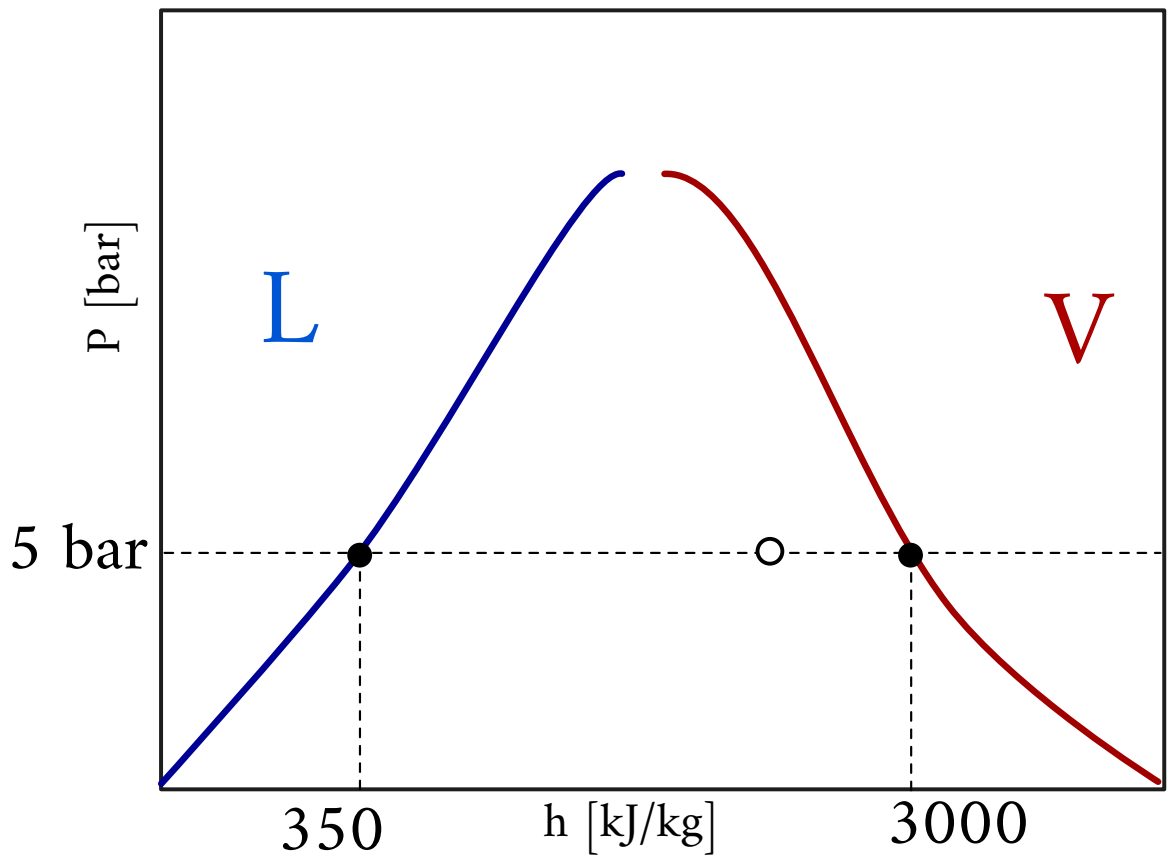


B

h=310 kJ /kg
P=5 bar

a) Vapor-líquido saturado
b) Vapor sobre calentado
c) Líquido comprimido

Tipo de fluido. P-h

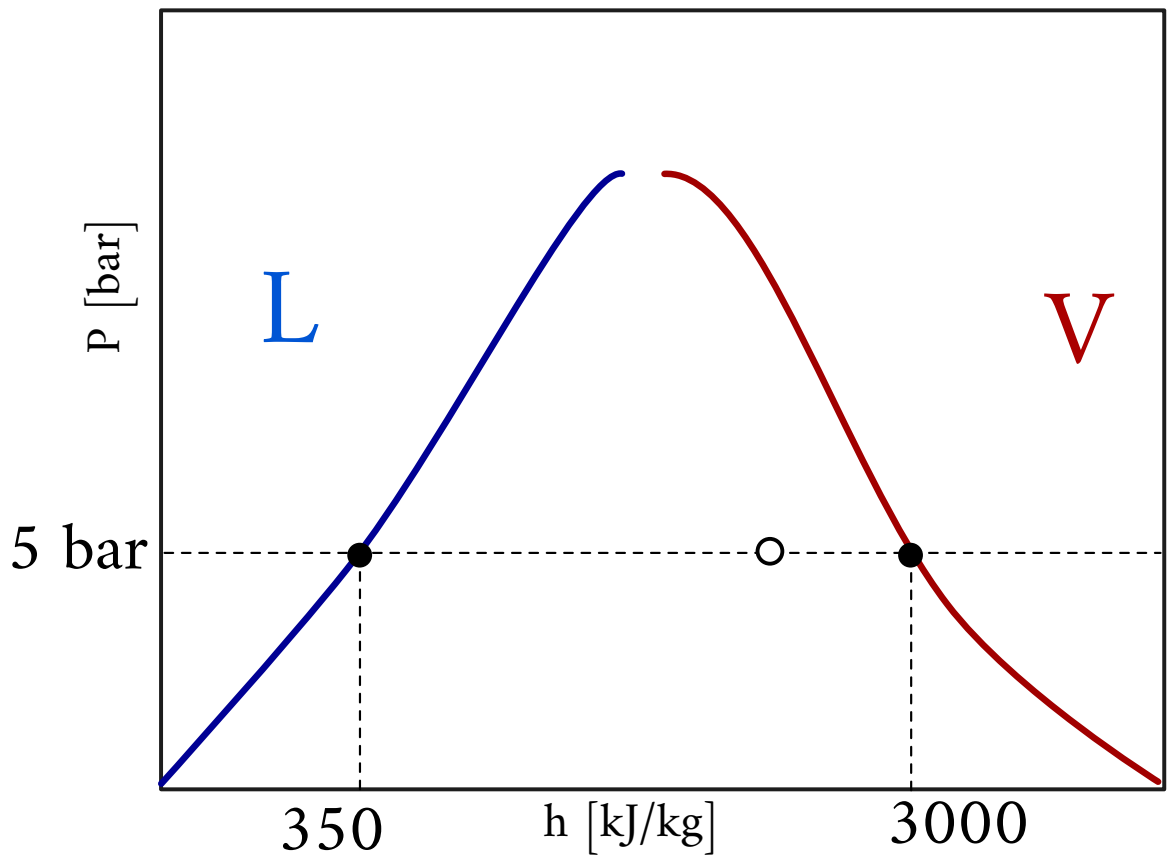


C

h=2800 kJ /kg
P=5 bar

a) Vapor-líquido saturado
b) Vapor sobre calentado
c) Líquido comprimido

Tipo de fluido. P-h

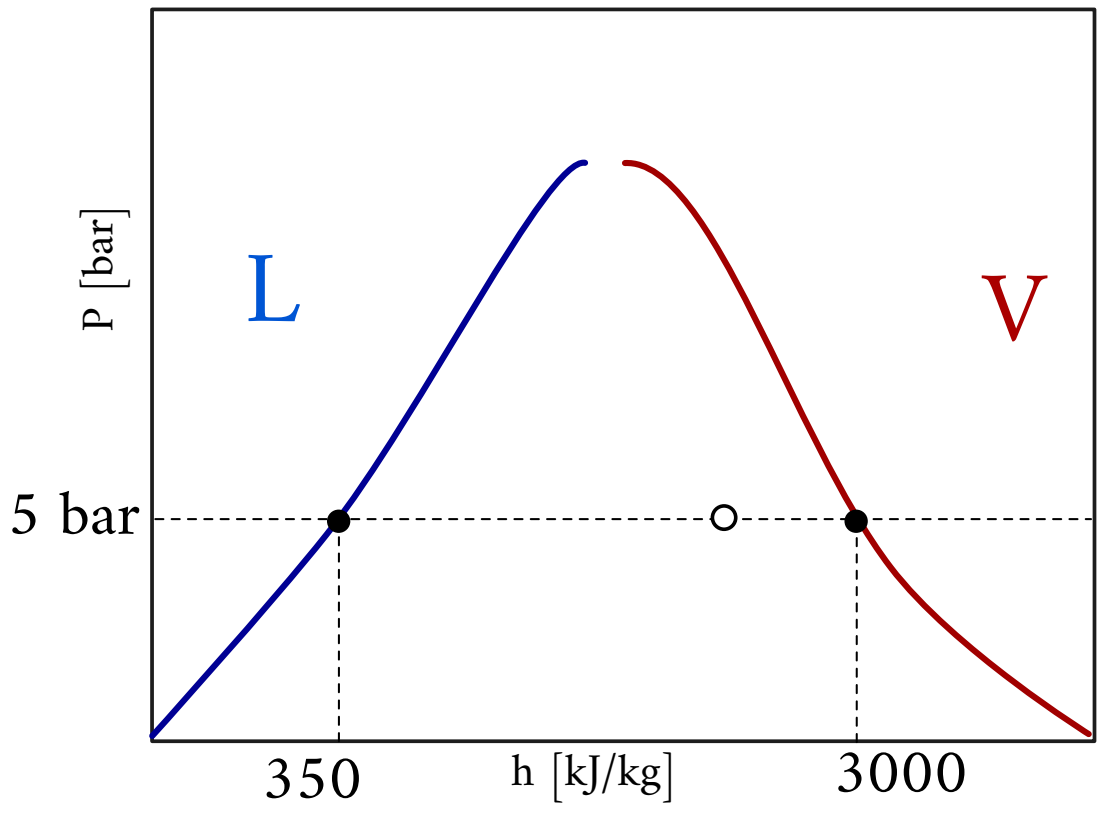


C

h=2800 kJ /kg
P=5 bar

a) Vapor-líquido saturado
b) Vapor sobre calentado
c) Líquido comprimido

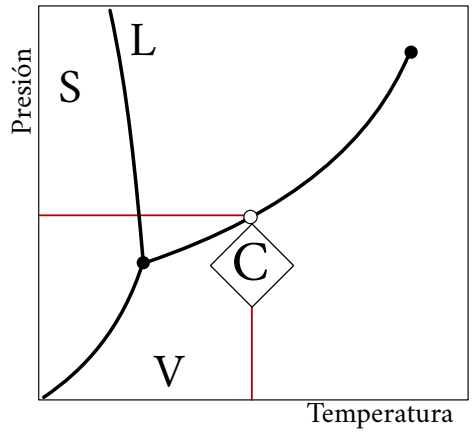
Tipo de fluido. P-h



C

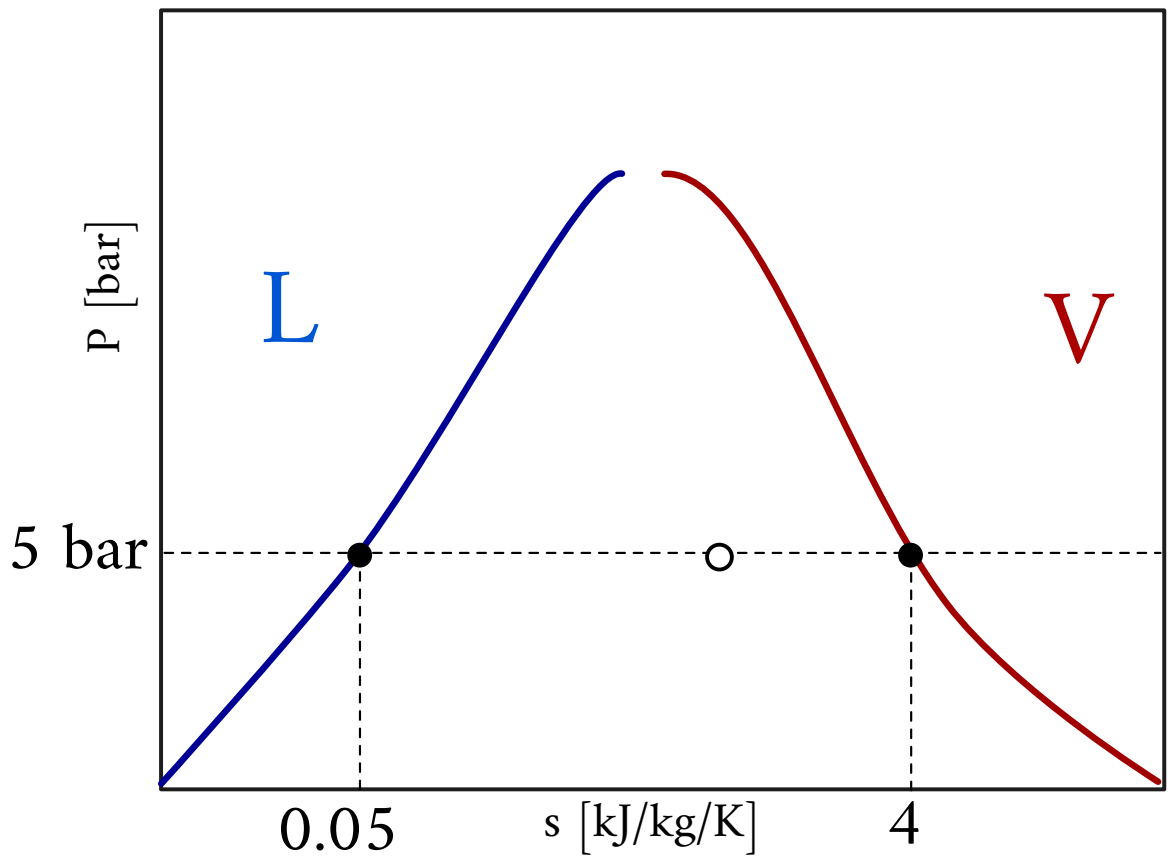
h=2800 kJ /kg
P=5 bar

a) Vapor-líquido saturado
b) Vapor sobre calentado
c) Líquido comprimido



$$w = \frac{h_C - h_L}{h_V - h_L}$$

Tipo de fluido. P-s

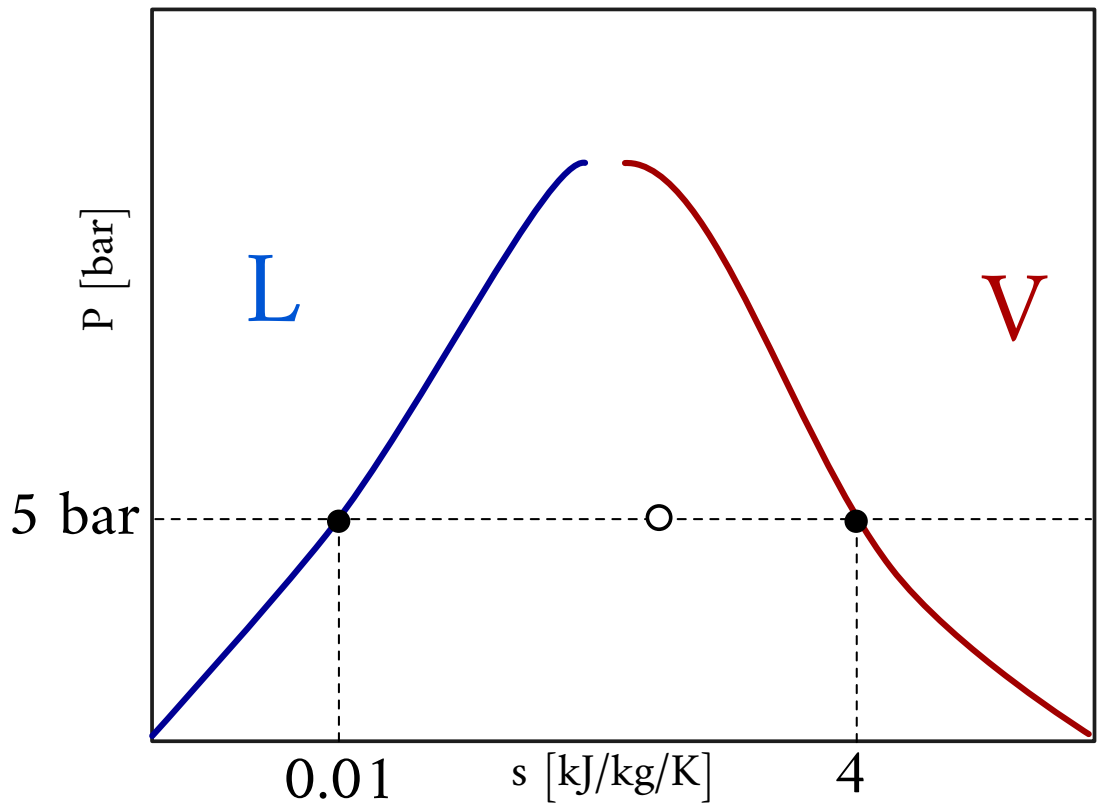


D

h=3.1 kJ/kg/K
P=5 bar

a) Vapor-líquido saturado
b) Vapor sobre calentado
c) Líquido comprimido

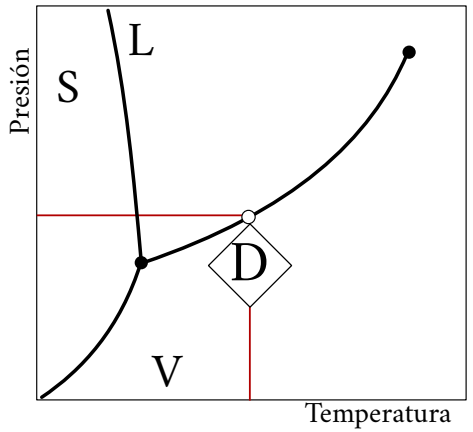
Tipo de fluido. P-s



D

h=3.1 kJ /kg
P=5 bar

a) Vapor-líquido saturado
b) Vapor sobre calentado
c) Líquido comprimido



$$s = \frac{s_D - s_L}{s_V - s_L}$$

Tablas de Vapor

En el libro

International Steam Tables
Properties of Water and Steam
Wolfgang Wagner · Hans-Joachim Kretzschmar

las tablas comienzan en la página 172 para entrada de temperatura y en la página 185 para la entrada en presión

Entrada por presión

Las entradas son temperatura ó presión

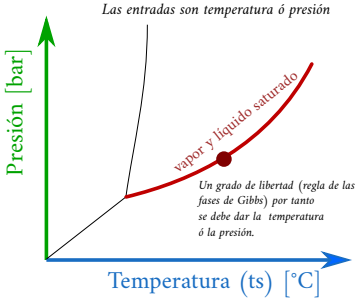


Table 2 **Saturation state** – Continued
(Pressure table)

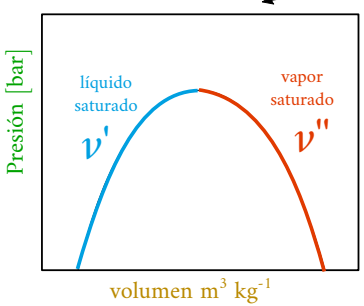
$\Delta h = h'' - h'$ $\Delta s = s'' - s'$

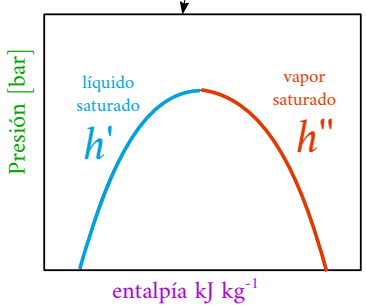
entalpía y entropía de evaporación

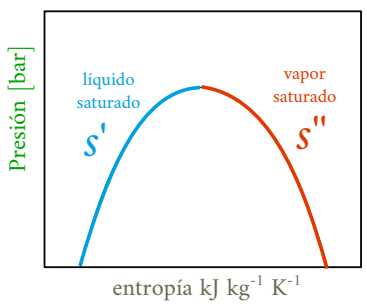
p [bar]	t_s [°C]	v' [$m^3 kg^{-1}$]	v'' [$m^3 kg^{-1}$]	h' [kJ kg^{-1}]	h'' [kJ kg^{-1}]	Δh_v	s' [kJ $kg^{-1} K^{-1}$]	s'' [kJ $kg^{-1} K^{-1}$]	Δs_v
3.5	138.861	0.00107858	0.524196	584.311	2731.97	2147.65	1.7275	6.9401	5.2126
3.6	139.853	0.00107961	0.510510	588.569	2733.25	2144.68	1.7378	6.9307	5.1929
3.7	140.823	0.00108062	0.497539	592.735	2734.51	2141.77	1.7478	6.9215	5.1737
3.8	141.773	0.00108161	0.485228	596.813	2735.72	2138.91	1.7576	6.9126	5.1550
3.9	142.702	0.00108259	0.473527	600.808	2736.91	2136.10	1.7672	6.9039	5.1367
4.0	143.613	0.00108356	0.462392	604.723	2738.06	2133.33	1.7766	6.8954	5.1188
4.1	144.505	0.00108451	0.451781	608.563	2739.18	2130.62	1.7858	6.8872	5.1014
4.2	145.380	0.00108545	0.441658	612.330	2740.27	2127.94	1.7948	6.8791	5.0843
4.3	146.238	0.00108638	0.431990	616.027	2741.33	2125.31	1.8036	6.8712	5.0676
4.4	147.081	0.00108729	0.422747	619.657	2742.37	2122.72	1.8122	6.8635	5.0513

Saturado = Equilibrio

Diagramas de equilibrio del agua pura







Entrada por temperatura

Table 1 **Saturation state**
(Temperature table)

t [°C]	T [K]	p_s [bar]	v' [$m^3 kg^{-1}$]	v'' [$m^3 kg^{-1}$]	h' [kJ kg^{-1}]	h'' [kJ kg^{-1}]	Δh_v	s' [kJ $kg^{-1} K^{-1}$]	s'' [kJ $kg^{-1} K^{-1}$]
0	273.15	0.006112127	0.00100021	206.140	−0.04159	2500.89	2500.93	−0.0001545	9.1558
0.01[a]	273.16	0.006116570	0.00100021	205.997	0.0006118	2500.91	2500.91	0	9.1555
1	274.15	0.00657088	0.00100015	192.445	4.17665	2502.73	2498.55	0.015260	9.1291
2	275.15	0.00705988	0.00100011	179.764	8.39160	2504.57	2496.17	0.030606	9.1027
3	276.15	0.00758082	0.00100008	168.014	12.6035	2506.40	2493.80	0.045886	9.0765
4	277.15	0.00813549	0.00100007	157.121	16.8127	2508.24	2491.42	0.061101	9.0506
5	278.15	0.00872575	0.00100008	147.017	21.0194	2510.07	2489.05	0.076252	9.0249
6	279.15	0.00935353	0.00100011	137.638	25.2237	2511.91	2486.68	0.091340	8.9994
7	280.15	0.0100209	0.00100014	128.928	29.4258	2513.74	2484.31	0.10637	8.9742
8	281.15	0.0107299	0.00100020	120.834	33.6260	2515.57	2481.94	0.12133	8.9492
9	282.15	0.0114828	0.00100027	113.309	37.8244	2517.40	2479.58	0.13624	8.9244

Tablas de Vapor

En el libro

International Steam Tables
Properties of Water and Steam
Wolfgang Wagner · Hans-Joachim Kretzschmar

las tablas de vapor sobrecalentado comienzan en la página 190

Para el caso de vapor sobre calentado (línea verde) o líquido comprimido (línea azul)se tiene dos grados de libertad (regla de las fases de Gibbs) por tanto se debe dar la presión y la temperatura para obtener las propieades.

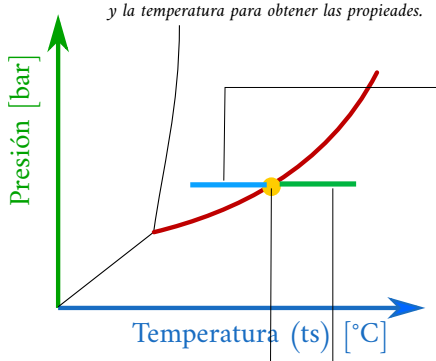


Table 3 Single-phase region (0 °C to 800 °C)

Vapor sobrecalentado

p = 0.006112127 bar — Presión

t [°C]	v [m³ kg⁻¹]	h [kJ kg⁻¹]	s [kJ kg⁻¹ K⁻¹]	c_p [kJ kg⁻¹ K⁻¹]	w [m s⁻¹]	κ [–]	η [10⁻⁶ Pa s]	λ [10⁻³ W m⁻¹ K⁻¹]
t_s = 0 °C			**Saturation**					
Liquid	0.00100021	−0.041586	−0.000154542	4.2199	1402.3	3216538	1792.0	562.0
Vapour	206.140	2500.89	9.1558	1.8882	408.88	1.3269	8.945	16.49
2	207.657	2504.66	9.1695	1.8822	410.50	1.3277	9.003	16.64
4	209.173	2508.42	9.1831	1.8780	412.08	1.3282	9.062	16.78
6	210.688	2512.18	9.1966	1.8750	413.63	1.3286	9.121	16.92
8	212.203	2515.92	9.2100	1.8730	415.15	1.3288	9.180	17.07
10	213.717	2519.67	9.2233	1.8716	416.65	1.3289	9.240	17.21
12	215.231	2523.41	9.2364	1.8706	418.13	1.3290	9.301	17.36
14	216.744	2527.15	9.2495	1.8700	419.60	1.3290	9.362	17.50
16	218.258	2530.89	9.2625	1.8696	421.06	1.3290	9.424	17.65
18	219.771	2534.63	9.2754	1.8694	422.51	1.3290	9.486	17.79
20	221.284	2538.37	9.2882	1.8693	423.95	1.3289	9.549	17.94

EQUILIBRIO LÍQUIDO VAPOR

VAPOR SOBRECALENTADO

Table 3 Single-phase region – Continued (0 °C to 800 °C)

p = 0.01 bar — Presión

t [°C]	v [m³ kg⁻¹]	h [kJ kg⁻¹]	s [kJ kg⁻¹ K⁻¹]	c_p [kJ kg⁻¹ K⁻¹]	w [m s⁻¹]	κ [–]	η [10⁻⁶ Pa s]	λ [10⁻³ W m⁻¹ K⁻¹]
0	0.00100021	−0.04119	−0.0001545	4.2199	1402.3	1965991	1792.0	562.0
2	0.00100011	8.39190	0.030607	4.2133	1412.1	1993738	1673.7	566.2
4	0.00100007	16.8129	0.061101	4.2078	1421.5	2020451	1567.4	570.3
6	0.00100011	25.2237	0.091340	4.2031	1430.5	2046110	1471.6	574.3
t_s = 6.96963 °C			**Saturation**					
Liquid	0.00100014	29.2982	0.10591	4.2011	1434.7	2058167	1428.5	576.1
Vapour	129.183	2513.68	8.9749	1.8932	413.95	1.3265	9.148	16.99
8	129.662	2515.63	8.9819	1.8898	414.78	1.3269	9.179	17.07
10	130.590	2519.41	8.9953	1.8846	416.36	1.3275	9.239	17.21
12	131.517	2523.17	9.0085	1.8810	417.91	1.3279	9.300	17.36
14	132.444	2526.93	9.0216	1.8784	419.42	1.3282	9.361	17.50
16	133.370	2530.68	9.0347	1.8765	420.91	1.3284	9.423	17.65
18	134.296	2534.44	9.0476	1.8752	422.39	1.3285	9.485	17.80
20	135.222	2538.19	9.0604	1.8743	423.85	1.3285	9.548	17.94

LÍQUIDO SUB ENFRIADO O COMPRIMIDO

EQUILIBRIO LÍQUIDO VAPOR

VAPOR SOBRECALENTADO

Descargar Libro