

TABLAS Y DIAGRAMAS DE TERMODINAMICA

(Recopilación de tablas de propiedades Termodinamicas, Fuentes: Termodinámica, Van Wylen, 2ºEdc, 2002, Limusa., Termodinámica, Yunus Cengel, 5ºEdc. 2006, Mc Graw Hill)

Prof. Carlos G. Villamar L.
Dpto. de Ciencias Térmicas.

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TABLA A-1

Masa molar, constante de gas y propiedades del punto crítico

Sustancia	- Fórmula	Masa molar, M kg/kmol	Constante de gas, R kJ/kg · K*	Propiedades del punto crítico		
				Temperatura, K	Presión, MPa	Volumen, m³/kmol
Agua	H ₂ O	18.015	0.4615	647.1	22.06	0.0560
Aire	—	28.97	0.2870	132.5	3.77	0.0883
Alcohol etílico	C ₂ H ₅ OH	46.07	0.1805	516	6.38	0.1673
Alcohol metílico	CH ₃ OH	32.042	0.2595	513.2	7.95	0.1180
Amoníaco	NH ₃	17.03	0.4882	405.5	11.28	0.0724
Argón	Ar	39.948	0.2081	151	4.86	0.0749
Benceno	C ₆ H ₆	78.115	0.1064	562	4.92	0.2603
Bromo	Br ₂	159.808	0.0520	584	10.34	0.1355
n-Butano	C ₄ H ₁₀	58.124	0.1430	425.2	3.80	0.2547
Cloro	Cl ₂	70.906	0.1173	417	7.71	0.1242
Cloroformo	CHCl ₃	119.38	0.06964	536.6	5.47	0.2403
Cloruro metílico	CH ₃ Cl	50.488	0.1647	416.3	6.68	0.1430
Criptón	Kr	83.80	0.09921	209.4	5.50	0.0924
Diclorodifluorometano (R-12)	CCl ₂ F ₂	120.91	0.06876	384.7	4.01	0.2179
Diclorofluorometano (R-21)	CHCl ₂ F	102.92	0.08078	451.7	5.17	0.1973
Dióxido de carbono	CO ₂	44.01	0.1889	304.2	7.39	0.0943
Dióxido de sulfuro	SO ₂	64.063	0.1298	430.7	7.88	0.1217
Etano	C ₂ H ₆	30.070	0.2765	305.5	4.48	0.1480
Etileno	C ₂ H ₄	28.054	0.2964	282.4	5.12	0.1242
Helio	He	4.003	2.0769	5.3	0.23	0.0578
n-Hexano	C ₆ H ₁₄	86.179	0.09647	507.9	3.03	0.3677
Hidrógeno (normal)	H ₂	2.016	4.1240	33.3	1.30	0.0649
Metano	CH ₄	16.043	0.5182	191.1	4.64	0.0993
Monóxido de carbono	CO	28.011	0.2968	133	3.50	0.0930
Neón	Ne	20.183	0.4119	44.5	2.73	0.0417
Nitrógeno	N ₂	28.013	0.2968	126.2	3.39	0.0899
Óxido nítrico	N ₂ O	44.013	0.1889	309.7	7.27	0.0961
Oxígeno	O ₂	31.999	0.2598	154.8	5.08	0.0780
Propano	C ₃ H ₈	44.097	0.1885	370	4.26	0.1998
Propileno	C ₃ H ₆	42.081	0.1976	365	4.62	0.1810
Tetracloruro de carbono	CCl ₄	153.82	0.05405	556.4	4.56	0.2759
Tetrafluoroetano (R-134a)	CF ₃ CH ₂ F	102.03	0.08149	374.2	4.059	0.1993
Triclorofluorometano (R-11)	CCl ₃ F	137.37	0.06052	471.2	4.38	0.2478
Xenón	Xe	131.30	0.06332	289.8	5.88	0.1186

*La unidad en kJ/kg · K es equivalente a kPa · m³/kg · K. La constante de gas se calcula de $R = R_u/M$, donde $R_u = 8.31447$ kJ/kmol · K y M es la masa molar.

Fuente: K. A. Kobe y R. E. Lynn, Jr., *Chemical Review* 52 (1953), pp. 117-236; y ASHRAE, *Handbook of Fundamentals* (Atlanta, GA: Sociedad Americana de Ingenieros de Calefacción, Refrigeración y Acondicionamiento de Aire, Inc., 1993), pp. 16.4 y 35.1.

TABLA A-2

Calores específicos de gas ideal de varios gases comunes

a) A 300 K

Gas	Fórmula	Constante de gas, R kJ/kg · K	c_p kJ/kg · K	c_v kJ/kg · K	k
Aire	—	0.2870	1.005	0.718	1.400
Argón	Ar	0.2081	0.5203	0.3122	1.667
Butano	C ₄ H ₁₀	0.1433	1.7164	1.5734	1.091
Dióxido de carbono	CO ₂	0.1889	0.846	0.657	1.289
Etano	C ₂ H ₆	0.2765	1.7662	1.4897	1.186
Etileno	C ₂ H ₄	0.2964	1.5482	1.2518	1.237
Helio	He	2.0769	5.1926	3.1156	1.667
Hidrógeno	H ₂	4.1240	14.307	10.183	1.405
Metano	CH ₄	0.5182	2.2537	1.7354	1.299
Monóxido de carbono	CO	0.2968	1.040	0.744	1.400
Neón	Ne	0.4119	1.0299	0.6179	1.667
Nitrógeno	N ₂	0.2968	1.039	0.743	1.400
Octano	C ₈ H ₁₈	0.0729	1.7113	1.6385	1.044
Oxígeno	O ₂	0.2598	0.918	0.658	1.395
Propano	C ₃ H ₈	0.1885	1.6794	1.4909	1.126
Vapor	H ₂ O	0.4615	1.8723	1.4108	1.327

Nota: La unidad kJ/kg · K es equivalente a kJ/kg · °C.

Fuente: *Chemical and Process Thermodynamics* tercera edición, por Kyle, B.G., © 2000. Adaptado con permiso de Pearson Education, Inc., Upper Saddle River, Nueva Jersey.

TABLA A-2

Calores específicos de gas ideal de varios gases comunes (continuación)

b) A diversas temperaturas

Temperatura, K	c_p kJ/kg · K	c_v kJ/kg · K	k	c_p kJ/kg · K	c_v kJ/kg · K	k	c_p kJ/kg · K	c_v kJ/kg · K	k
	Aire			Dióxido de carbono, CO ₂			Monóxido de carbono, CO		
250	1.003	0.716	1.401	0.791	0.602	1.314	1.039	0.743	1.400
300	1.005	0.718	1.400	0.846	0.657	1.288	1.040	0.744	1.399
350	1.008	0.721	1.398	0.895	0.706	1.268	1.043	0.746	1.398
400	1.013	0.726	1.395	0.939	0.750	1.252	1.047	0.751	1.395
450	1.020	0.733	1.391	0.978	0.790	1.239	1.054	0.757	1.392
500	1.029	0.742	1.387	1.014	0.825	1.229	1.063	0.767	1.387
550	1.040	0.753	1.381	1.046	0.857	1.220	1.075	0.778	1.382
600	1.051	0.764	1.376	1.075	0.886	1.213	1.087	0.790	1.376
650	1.063	0.776	1.370	1.102	0.913	1.207	1.100	0.803	1.370
700	1.075	0.788	1.364	1.126	0.937	1.202	1.113	0.816	1.364
750	1.087	0.800	1.359	1.148	0.959	1.197	1.126	0.829	1.358
800	1.099	0.812	1.354	1.169	0.980	1.193	1.139	0.842	1.353
900	1.121	0.834	1.344	1.204	1.015	1.186	1.163	0.866	1.343
1000	1.142	0.855	1.336	1.234	1.045	1.181	1.185	0.888	1.335
Temperatura, K	Hidrógeno, H ₂			Nitrógeno, N ₂			Oxígeno, O ₂		
	c_p	c_v	k	c_p	c_v	k	c_p	c_v	k
250	14.051	9.927	1.416	1.039	0.742	1.400	0.913	0.653	1.398
300	14.307	10.183	1.405	1.039	0.743	1.400	0.918	0.658	1.395
350	14.427	10.302	1.400	1.041	0.744	1.399	0.928	0.668	1.389
400	14.476	10.352	1.398	1.044	0.747	1.397	0.941	0.681	1.382
450	14.501	10.377	1.398	1.049	0.752	1.395	0.956	0.696	1.373
500	14.513	10.389	1.397	1.056	0.759	1.391	0.972	0.712	1.365
550	14.530	10.405	1.396	1.065	0.768	1.387	0.988	0.728	1.358
600	14.546	10.422	1.396	1.075	0.778	1.382	1.003	0.743	1.350
650	14.571	10.447	1.395	1.086	0.789	1.376	1.017	0.758	1.343
700	14.604	10.480	1.394	1.098	0.801	1.371	1.031	0.771	1.337
750	14.645	10.521	1.392	1.110	0.813	1.365	1.043	0.783	1.332
800	14.695	10.570	1.390	1.121	0.825	1.360	1.054	0.794	1.327
900	14.822	10.698	1.385	1.145	0.849	1.349	1.074	0.814	1.319
1000	14.983	10.859	1.380	1.167	0.870	1.341	1.090	0.830	1.313

Fuente: Kenneth Wark, *Thermodynamics*, cuarta edición, Nueva York, McGraw-Hill, 1983, p. 783, Tabla A-4M. Publicada originalmente en *Tables of Thermal Properties of Gases*, NBS Circular 564, 1955.

TABLA A-2

Calores específicos de gas ideal de varios gases comunes (conclusión)

c) Como una función de la temperatura

$\bar{c}_p = a + bT + cT^2 + dT^3$ (T en K, c_p en kJ/kmol · K)						Rango de temp., K	% de error	
Sustancia	Fórmula	a	b	c	d			
Acetileno	C ₂ H ₂	21.8	9.2143 × 10 ⁻²	-6.527 × 10 ⁻⁵	18.21 × 10 ⁻⁹	273-1500	1.46	0.59
Aire	—	28.11	0.1967 × 10 ⁻²	0.4802 × 10 ⁻⁵	-1.966 × 10 ⁻⁹	273-1800	0.72	0.33
Amoniaco	NH ₃	27.568	2.5630 × 10 ⁻²	0.99072 × 10 ⁻⁵	-6.6909 × 10 ⁻⁹	273-1500	0.91	0.36
Azufre	S ₂	27.21	2.218 × 10 ⁻²	-1.628 × 10 ⁻⁵	3.986 × 10 ⁻⁹	273-1800	0.99	0.38
Benceno	C ₆ H ₆	-36.22	48.475 × 10 ⁻²	-31.57 × 10 ⁻⁵	77.62 × 10 ⁻⁹	273-1500	0.34	0.20
i-Butano	C ₄ H ₁₀	-7.913	41.60 × 10 ⁻²	-23.01 × 10 ⁻⁵	49.91 × 10 ⁻⁹	273-1500	0.25	0.13
n-Butano	C ₄ H ₁₀	3.96	37.15 × 10 ⁻²	-18.34 × 10 ⁻⁵	35.00 × 10 ⁻⁹	273-1500	0.54	0.24
Cloruro de hidrógeno	HCl	30.33	-0.7620 × 10 ⁻²	1.327 × 10 ⁻⁵	-4.338 × 10 ⁻⁹	273-1500	0.22	0.08
Dióxido de azufre	SO ₂	25.78	5.795 × 10 ⁻²	-3.812 × 10 ⁻⁵	8.612 × 10 ⁻⁹	273-1800	0.45	0.24
Dióxido de carbono	CO ₂	22.26	5.981 × 10 ⁻²	-3.501 × 10 ⁻⁵	7.469 × 10 ⁻⁹	273-1800	0.67	0.22
Dióxido de nitrógeno	NO ₂	22.9	5.715 × 10 ⁻²	-3.52 × 10 ⁻⁵	7.87 × 10 ⁻⁹	273-1500	0.46	0.18
Etano	C ₂ H ₆	6.900	17.27 × 10 ⁻²	-6.406 × 10 ⁻⁵	7.285 × 10 ⁻⁹	273-1500	0.83	0.28
Etolanol	C ₂ H ₆ O	19.9	20.96 × 10 ⁻²	-10.38 × 10 ⁻⁵	20.05 × 10 ⁻⁹	273-1500	0.40	0.22
Etileno	C ₂ H ₄	3.95	15.64 × 10 ⁻²	-8.344 × 10 ⁻⁵	17.67 × 10 ⁻⁹	273-1500	0.54	0.13
n-Hexano	C ₆ H ₁₄	6.938	55.22 × 10 ⁻²	-28.65 × 10 ⁻⁵	57.69 × 10 ⁻⁹	273-1500	0.72	0.20
Hidrógeno	H ₂	29.11	-0.1916 × 10 ⁻²	0.4003 × 10 ⁻⁵	-0.8704 × 10 ⁻⁹	273-1800	1.01	0.26
Metano	CH ₄	19.89	5.024 × 10 ⁻²	1.269 × 10 ⁻⁵	-11.01 × 10 ⁻⁹	273-1500	1.33	0.57
Metanol	CH ₄ O	19.0	9.152 × 10 ⁻²	-1.22 × 10 ⁻⁵	-8.039 × 10 ⁻⁹	273-1000	0.18	0.08
Monóxido de carbono	CO	28.16	0.1675 × 10 ⁻²	0.5372 × 10 ⁻⁵	-2.222 × 10 ⁻⁹	273-1800	0.89	0.37
Nitrógeno	N ₂	28.90	-0.1571 × 10 ⁻²	0.8081 × 10 ⁻⁵	-2.873 × 10 ⁻⁹	273-1800	0.59	0.34
Óxido nítrico	NO	29.34	-0.09395 × 10 ⁻²	0.9747 × 10 ⁻⁵	-4.187 × 10 ⁻⁹	273-1500	0.97	0.36
Óxido nitroso	N ₂ O	24.11	5.8632 × 10 ⁻²	-3.562 × 10 ⁻⁵	10.58 × 10 ⁻⁹	273-1500	0.59	0.26
Oxígeno	O ₂	25.48	1.520 × 10 ⁻²	-0.7155 × 10 ⁻⁵	1.312 × 10 ⁻⁹	273-1800	1.19	0.28
n-Pentano	C ₅ H ₁₂	6.774	45.43 × 10 ⁻²	-22.46 × 10 ⁻⁵	42.29 × 10 ⁻⁹	273-1500	0.56	0.21
Propano	C ₃ H ₈	-4.04	30.48 × 10 ⁻²	-15.72 × 10 ⁻⁵	31.74 × 10 ⁻⁹	273-1500	0.40	0.12
Propileno	C ₃ H ₆	3.15	23.83 × 10 ⁻²	-12.18 × 10 ⁻⁵	24.62 × 10 ⁻⁹	273-1500	0.73	0.17
Trióxido de azufre	SO ₃	16.40	14.58 × 10 ⁻²	-11.20 × 10 ⁻⁵	32.42 × 10 ⁻⁹	273-1300	0.29	0.13
Vapor de agua	H ₂ O	32.24	0.1923 × 10 ⁻²	1.055 × 10 ⁻⁵	-3.595 × 10 ⁻⁹	273-1800	0.53	0.24

Fuente: B. G. Kyle, *Chemical and Process Thermodynamics*, Englewood Cliffs, Nueva Jersey, Prentice Hall, 1984. Usada con permiso

TABLA A-3

Propiedades de líquidos, sólidos y alimentos comunes

a) Líquidos

Sustancia	Datos de ebullición a 1 atm		Datos de congelación		Propiedades del líquido		
	Punto normal de ebullición, °C	Calor latente de vaporización h_{fg} , kJ/kg	Punto de congelación, °C	Calor latente de fusión h_{if} , kJ/kg	Temperatura, °C	Densidad ρ , kg/m ³	Calor específico c_p , kJ/kg · K
Aceite (ligero)					25	910	1.80
Agua	100	2257	0.0	333.7	0	1000	4.22
					25	997	4.18
					50	988	4.18
					75	975	4.19
					100	958	4.22
Alcohol etílico	78.6	855	-156	108	20	789	2.84
					-33.3	682	4.43
Amoniaco	-33.3	1357	-77.7	322.4	-20	665	4.52
					0	639	4.60
					25	602	4.80
					-185.6	1394	1.14
					20	879	1.72
Argón	-185.9	161.6	-189.3	28	-185.6	1394	1.14
Benceno	80.2	394	5.5	126	20	879	1.72
n-Butano	-0.5	385.2	-138.5	80.3	-0.5	601	2.31
Dióxido de carbono	-78.4*	230.5 (a 0°C)	-56.6	—	0	298	0.59
Etanol	78.2	838.3	-114.2	109	25	783	2.46
Etilén glicol	198.1	800.1	-10.8	181.1	20	1109	2.84
Glicerina	179.9	974	18.9	200.6	20	1261	2.32
Helio	-268.9	22.8	—	—	-268.9	146.2	22.8
Hidrógeno	-252.8	445.7	-259.2	59.5	-252.8	70.7	10.0
Isobutano	-11.7	367.1	-160	105.7	-11.7	593.8	2.28
Mercurio	356.7	294.7	-38.9	11.4	25	13,560	0.139
Metano	-161.5	510.4	-182.2	58.4	-161.5	423	3.49
					-100	301	5.79
Metanol	64.5	1100	-97.7	99.2	25	787	2.55
					-195.8	809	2.06
Nitrógeno	-195.8	198.6	-210	25.3	-160	596	2.97
					20	703	2.10
Octano	124.8	306.3	-57.5	180.7	20	703	2.10
Oxígeno	-183	212.7	-218.8	13.7	-183	1141	1.71
Petróleo	—	230-384	—	—	20	640	2.0
Propano	-42.1	427.8	-187.7	80.0	-42.1	581	2.25
					0	529	2.53
Queroseno	204-293	251	-24.9	—	50	449	3.13
					20	820	2.00
Refrigerante 134a	-26.1	217.0	-96.6	—	-50	1443	1.23
Salmuera (20% de cloruro de sodio por masa)	103.9	—	-17.4	—	20	1150	3.11
					-26.1	1374	1.27
					0	1295	1.34
					25	1207	1.43

* Temperatura de sublimación. (A presiones por debajo de la presión de punto triple de 518 kPa, el dióxido de carbono existe como sólido o como gas. También, la temperatura de punto de congelamiento del dióxido de carbono es la temperatura de punto triple de -56.5°C.)

TABLA A-3

Propiedades de líquidos, sólidos y alimentos comunes (conclusión)

b) Sólidos (los valores son para temperatura ambiente, excepto que se indique otra cosa)

Sustancia	Densidad, ρ kg/m ³	Calor específico, c_p kJ/kg · K	Sustancia	Densidad, ρ kg/m ³	Calor específico, c_p kJ/kg · K
Metales			No metales		
Aceite dulce	7,830	0.500	Arena	1520	0.800
Aluminio			Arcilla	1000	0.920
200 K		0.797	Asfalto	2110	0.920
250 K		0.859	Caucho (blando)	1100	1.840
300 K	2,700	0.902	Caucho (duro)	1150	2.009
350 K		0.929	Concreto	2300	0.653
400 K		0.949	Diamante	2420	0.616
450 K		0.973	Grafito	2500	0.711
500 K		0.997	Granito	2700	1.017
Bronce (76% Cu, 2% Zn, 2% Al)	8,280	0.400	Hielo		
			200 K		1.56
Cobre		0.254	220 K		1.71
			240 K		1.86
			260 K		2.01
			273 K	921	2.11
			Ladrillo común	1922	0.79
-173°C		0.342	Ladrillo refractario (500°C)	2300	0.960
-100°C		0.367	Madera contrachapada (abeto Douglas)	545	1.21
-50°C		0.381	Maderas duras (maple, encino, etc.)	721	1.26
0°C		0.386	Maderas suaves (abeto, pino, etc.)	513	1.38
27°C	8,900	0.393	Mármol	2600	0.880
100°C		0.403	Piedra	1500	0.800
200°C		0.45	Piedra caliza	1650	0.909
Hierro	7,840	0.400	Vidrio para ventanas	2700	0.800
Latón amarillo (65% Cu, 35% Zn)	8,310	1.000	Vidrio pirex	2230	0.840
Magnesio	1,730	0.440	Yeso o tabla de yeso	800	1.0
Níquel	8,890	0.235			
Plata	10,470	0.128			
Plomo	11,310	0.130			
Tungsteno	19,400				

c) Alimentos

Alimentos	Contenido de agua, % (masa)	Punto de congelación, °C	Por encima del punto de congelación	Por debajo del punto de congelación	Calor latente de fusión, kJ/kg	Alimentos	Contenido de agua, % (masa)	Punto de congelación, °C	Por encima del punto de congelación	Por debajo del punto de congelación	Calor latente de fusión, kJ/kg
Brócoli	90	-0.6	3.86	1.97	301	Helado	63	-5.6	2.95	1.63	210
Camarón	83	-2.2	3.62	1.89	277	Mantequilla	16	—	—	1.04	53
Carne de pollo	74	-2.8	3.32	1.77	247	Manzanas	84	-1.1	3.65	1.90	281
Carne de res	67	—	3.08	1.68	224	Naranjas	87	-0.8	3.75	1.94	291
Cerezas	80	-1.8	3.52	1.85	267	Papas	78	-0.6	3.45	1.82	261
Espinaca	93	-0.3	3.96	2.01	311	Pavo	64	—	2.98	1.65	214
Fresas	90	-0.8	3.86	1.97	301	Plátanos	75	-0.8	3.35	1.78	251
Huevo entero	74	-0.6	3.32	1.77	247	Queso suizo	39	-10.0	2.15	1.33	130
Leche entera	88	-0.6	3.79	1.95	294	Salmón	64	-2.2	2.98	1.65	214
Lechuga	95	-0.2	4.02	2.04	317	Sandía	93	-0.4	3.96	2.01	311
Maíz dulce	74	-0.6	3.32	1.77	247	Tomates (maduros)	94	-0.5	3.99	2.02	314

Fuente: Los valores han sido obtenidos de varios manuales y otras fuentes, o se han calculado. El contenido de agua y los datos de punto de congelación para alimentos provienen del ASHRAE, Handbook of Fundamentals, versión SI, Atlanta, Georgia, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1993, Capítulo 30, Tabla 1. El punto de congelación es la temperatura a la que comienza la congelación para frutas y verduras, así como la temperatura promedio de congelación para otros alimentos.

TABLA A-4

Agua saturada. Tabla de temperaturas

Temp., T °C	Pres. sat., P _{sat} kPa	Volumen específico, m ³ /kg		Energía interna, kJ/kg			Entalpía, kJ/kg			Entropía, kJ/kg · K		
		Liq. sat., v _f	Vapor sat., v _g	Liq. sat., u _f	Evap., u _{fg}	Vapor sat., u _g	Liq. sat., h _f	Evap., h _{fg}	Vapor sat., h _g	Liq. sat., s _f	Evap., s _{fg}	Vapor sat., s _g
0.01	0.6117	0.001000	206.00	0.000	2374.9	2374.9	0.001	2500.9	2500.9	0.0000	9.1556	9.1556
5	0.8725	0.001000	147.03	21.019	2360.8	2381.8	21.020	2489.1	2510.1	0.0763	8.9487	9.0249
10	1.2281	0.001000	106.32	42.020	2346.6	2388.7	42.022	2477.2	2519.2	0.1511	8.7488	8.8999
15	1.7057	0.001001	77.885	62.980	2332.5	2395.5	62.982	2465.4	2528.3	0.2245	8.5559	8.7803
20	2.3392	0.001002	57.762	83.913	2318.4	2402.3	83.915	2453.5	2537.4	0.2965	8.3696	8.6661
25	3.1698	0.001003	43.340	104.83	2304.3	2409.1	104.83	2441.7	2546.5	0.3672	8.1895	8.5567
30	4.2469	0.001004	32.879	125.73	2290.2	2415.9	125.74	2429.8	2555.6	0.4368	8.0152	8.4520
35	5.6291	0.001006	25.205	146.63	2276.0	2422.7	146.64	2417.9	2564.6	0.5051	7.8466	8.3517
40	7.3851	0.001008	19.515	167.53	2261.9	2429.4	167.53	2406.0	2573.5	0.5724	7.6832	8.2556
45	9.5953	0.001010	15.251	188.43	2247.7	2436.1	188.44	2394.0	2582.4	0.6386	7.5247	8.1633
50	12.352	0.001012	12.026	209.33	2233.4	2442.7	209.34	2382.0	2591.3	0.7038	7.3710	8.0748
55	15.763	0.001015	9.5639	230.24	2219.1	2449.3	230.26	2369.8	2600.1	0.7680	7.2218	7.9898
60	19.947	0.001017	7.6670	251.16	2204.7	2455.9	251.18	2357.7	2608.8	0.8313	7.0769	7.9082
65	25.043	0.001020	6.1935	272.09	2190.3	2462.4	272.12	2345.4	2617.5	0.8937	6.9360	7.8296
70	31.202	0.001023	5.0396	293.04	2175.8	2468.9	293.07	2333.0	2626.1	0.9551	6.7989	7.7540
75	38.597	0.001026	4.1291	313.99	2161.3	2475.3	314.03	2320.6	2634.6	1.0158	6.6655	7.6812
80	47.416	0.001029	3.4053	334.97	2146.6	2481.6	335.02	2308.0	2643.0	1.0756	6.5355	7.6111
85	57.868	0.001032	2.8261	355.96	2131.9	2487.8	356.02	2295.3	2651.4	1.1346	6.4089	7.5435
90	70.183	0.001036	2.3593	376.97	2117.0	2494.0	377.04	2282.5	2659.6	1.1929	6.2853	7.4782
95	84.609	0.001040	1.9808	398.00	2102.0	2500.1	398.09	2269.6	2667.6	1.2504	6.1647	7.4151
100	101.42	0.001043	1.6720	419.06	2087.0	2506.0	419.17	2256.4	2675.6	1.3072	6.0470	7.3542
105	120.90	0.001047	1.4186	440.15	2071.8	2511.9	440.28	2243.1	2683.4	1.3634	5.9319	7.2952
110	143.38	0.001052	1.2094	461.27	2056.4	2517.7	461.42	2229.7	2691.1	1.4188	5.8193	7.2382
115	169.18	0.001056	1.0360	482.42	2040.9	2523.3	482.59	2216.0	2698.6	1.4737	5.7092	7.1829
120	198.67	0.001060	0.89133	503.60	2025.3	2528.9	503.81	2202.1	2706.0	1.5279	5.6013	7.1292
125	232.23	0.001065	0.77012	524.83	2009.5	2534.3	525.07	2188.1	2713.1	1.5816	5.4956	7.0771
130	270.28	0.001070	0.66808	546.10	1993.4	2539.5	546.38	2173.7	2720.1	1.6346	5.3919	7.0265
135	313.22	0.001075	0.58179	567.41	1977.3	2544.7	567.75	2159.1	2726.9	1.6872	5.2901	6.9773
140	361.53	0.001080	0.50850	588.77	1960.9	2549.6	589.16	2144.3	2733.5	1.7392	5.1901	6.9294
145	415.68	0.001085	0.44600	610.19	1944.2	2554.4	610.64	2129.2	2739.8	1.7908	5.0919	6.8827
150	476.16	0.001091	0.39248	631.66	1927.4	2559.1	632.18	2113.8	2745.9	1.8418	4.9953	6.8371
155	543.49	0.001096	0.34648	653.19	1910.3	2563.5	653.79	2098.0	2751.8	1.8924	4.9002	6.7927
160	618.23	0.001102	0.30680	674.79	1893.0	2567.8	675.47	2082.0	2757.5	1.9426	4.8066	6.7492
165	700.93	0.001108	0.27244	696.46	1875.4	2571.9	697.24	2065.6	2762.8	1.9923	4.7143	6.7067
170	792.18	0.001114	0.24260	718.20	1857.5	2575.7	719.08	2048.8	2767.9	2.0417	4.6233	6.6650
175	892.60	0.001121	0.21659	740.02	1839.4	2579.4	741.02	2031.7	2772.7	2.0906	4.5335	6.6242
180	1002.8	0.001127	0.19384	761.92	1820.9	2582.8	763.05	2014.2	2777.2	2.1392	4.4448	6.5841
185	1123.5	0.001134	0.17390	783.91	1802.1	2586.0	785.19	1996.2	2781.4	2.1875	4.3572	6.5447
190	1255.2	0.001141	0.15636	806.00	1783.0	2589.0	807.43	1977.9	2785.3	2.2355	4.2705	6.5059
195	1398.8	0.001149	0.14089	828.18	1763.6	2591.7	829.78	1959.0	2788.8	2.2831	4.1847	6.4678
200	1554.9	0.001157	0.12721	850.46	1743.7	2594.2	852.26	1939.8	2792.0	2.3305	4.0997	6.4302

TABLA A-4

Agua saturada. Tabla de temperaturas (conclusión)

Temp., T °C	Pres. sat., P _{sat} kPa	Volumen específico, m³/kg		Energía interna, kJ/kg			Entalpía, kJ/kg			Entropía, kJ/kg · K		
		Liq. sat., v _f	Vapor sat., v _g	Liq. sat., u _f	Evap., u _{fg}	Vapor sat., u _g	Liq. sat., h _f	Evap., h _{fg}	Vapor sat., h _g	Liq. sat., s _f	Evap., s _{fg}	Vapor sat., s _g
205	1724.3	0.001164	0.11508	872.86	1723.5	2596.4	874.87	1920.0	2794.8	2.3776	4.0154	6.3930
210	1907.7	0.001173	0.10429	895.38	1702.9	2598.3	897.61	1899.7	2797.3	2.4245	3.9318	6.3563
215	2105.9	0.001181	0.094680	918.02	1681.9	2599.9	920.50	1878.8	2799.3	2.4712	3.8489	6.3200
220	2319.6	0.001190	0.086094	940.79	1660.5	2601.3	943.55	1857.4	2801.0	2.5176	3.7664	6.2840
225	2549.7	0.001199	0.078405	963.70	1638.6	2602.3	966.76	1835.4	2802.2	2.5639	3.6844	6.2482
230	2797.1	0.001209	0.071505	986.76	1616.1	2602.9	990.14	1812.8	2802.9	2.6100	3.6028	6.2126
235	3062.6	0.001219	0.065300	1010.0	1593.2	2603.2	1013.7	1789.5	2803.2	2.6560	3.5216	6.1775
240	3347.0	0.001229	0.059707	1033.4	1569.8	2603.1	1037.5	1765.5	2803.0	2.7018	3.4405	6.1424
245	3651.2	0.001240	0.054656	1056.9	1545.7	2602.7	1061.5	1740.8	2802.2	2.7476	3.3596	6.1077
250	3976.2	0.001252	0.050085	1080.7	1521.1	2601.8	1085.7	1715.3	2801.0	2.7933	3.2788	6.0731
255	4322.9	0.001263	0.045941	1104.7	1495.8	2600.5	1110.1	1689.0	2799.1	2.8390	3.1979	6.0385
260	4692.3	0.001276	0.042175	1128.8	1469.9	2598.7	1134.8	1661.8	2796.6	2.8847	3.1169	6.0040
265	5085.3	0.001289	0.038748	1153.3	1443.2	2596.5	1159.8	1633.7	2793.5	2.9304	3.0358	5.9694
270	5503.0	0.001303	0.035622	1177.9	1415.7	2593.7	1185.1	1604.6	2789.7	2.9762	2.9542	5.9348
275	5945.4	0.001317	0.032767	1202.9	1387.4	2590.3	1210.7	1574.5	2785.2	3.0221	2.8723	5.8994
280	6416.6	0.001333	0.030153	1228.2	1358.2	2586.4	1236.7	1543.2	2779.9	3.0681	2.7898	5.8570
285	6914.6	0.001349	0.027756	1253.7	1328.1	2581.8	1263.1	1510.7	2773.7	3.1144	2.7066	5.8210
290	7441.8	0.001366	0.025554	1279.7	1296.9	2576.5	1289.8	1476.9	2766.7	3.1608	2.6225	5.7834
295	7999.0	0.001384	0.023528	1306.0	1264.5	2570.5	1317.1	1441.6	2758.7	3.2076	2.5374	5.7450
300	8587.9	0.001404	0.021659	1332.7	1230.9	2563.6	1344.8	1404.8	2749.6	3.2548	2.4511	5.7056
305	9209.4	0.001425	0.019932	1360.0	1195.9	2555.8	1373.1	1366.3	2739.4	3.3024	2.3633	5.6657
310	9865.0	0.001447	0.018	1387.7	1159.3	2547.1	1402.0	1325.9	2727.9	3.3506	2.2737	5.6244
315	10556	0.001472	0.016849	1416.1	1121.1	2537.2	1431.6	1283.4	2715.0	3.3994	2.1821	5.5810
320	11284	0.001499	0.015470	1445.1	1080.9	2526.0	1462.0	1238.5	2700.6	3.4491	2.0881	5.5374
325	12051	0.001528	0.014183	1475.0	1038.5	2513.4	1493.4	1191.0	2684.3	3.4998	1.9911	5.4900
330	12858	0.001560	0.012979	1505.7	993.5	2499.2	1525.8	1140.3	2666.0	3.5516	1.8906	5.4442
335	13707	0.001597	0.011848	1537.5	945.5	2483.0	1559.4	1086.0	2645.4	3.6050	1.7857	5.3990
340	14601	0.001638	0.010783	1570.7	893.8	2464.5	1594.6	1027.4	2622.0	3.6602	1.6756	5.3358
345	15541	0.001685	0.009772	1605.5	837.7	2443.2	1631.7	963.4	2595.1	3.7179	1.5585	5.2760
350	16529	0.001741	0.008806	1642.4	775.9	2418.3	1671.2	892.7	2563.9	3.7788	1.4326	5.2144
355	17570	0.001808	0.007872	1682.2	706.4	2388.6	1714.0	812.9	2526.9	3.8442	1.2942	5.1364
360	18666	0.001895	0.006950	1726.2	625.7	2351.9	1761.5	720.1	2481.6	3.9165	1.1373	5.0507
365	19822	0.002015	0.006009	1777.2	526.4	2303.6	1817.2	605.5	2422.7	4.0004	0.9489	4.9499
370	21044	0.002217	0.004953	1844.5	385.6	2230.1	1891.2	443.1	2334.3	4.1119	0.6890	4.8000
373.95	22064	0.003106	0.003106	2015.7	0	2015.7	2084.3	0	2084.3	4.4070	0	4.4070

Tabla A-5

Agua saturada. Tabla de presiones

Pres., P kPa	Temp. sat., T _{sat} °C	Volumen específico, m ³ /kg		Energía interna, kJ/kg			Entalpía, kJ/kg		Entropía, kJ/kg · K		
		Liq. sat., v _f	Vapor sat., v _g	Liq. sat., u _f	Evap., u _{fg}	Vapor sat., u _g	Liq. sat., h _f	Vapor sat., h _g	Liq. sat., s _f	Evap., s _{fg}	Vapor sat., s _g
1.0	6.97	0.001000	129.19	29.302	2355.2	2384.5	29.303	2484.4	0.1059	8.8690	8.9749
1.5	13.02	0.001001	87.964	54.686	2338.1	2392.8	54.688	2470.1	0.1956	8.6314	8.8270
2.0	17.50	0.001001	66.990	73.431	2325.5	2398.9	73.433	2459.5	0.2606	8.4621	8.7227
2.5	21.08	0.001002	54.242	88.422	2315.4	2403.8	88.424	2451.0	0.3118	8.3302	8.6421
3.0	24.08	0.001003	45.654	100.98	2306.9	2407.9	100.98	2443.9	0.3543	8.2222	8.5765
4.0	28.96	0.001004	34.791	121.39	2293.1	2414.5	121.39	2432.3	0.4224	8.0510	8.4734
5.0	32.87	0.001005	28.185	137.75	2282.1	2419.8	137.75	2423.0	0.4762	7.9176	8.3938
7.5	40.29	0.001008	19.233	168.74	2261.1	2429.8	168.75	2405.3	0.5763	7.6738	8.2501
10	45.81	0.001010	14.670	191.79	2245.4	2437.2	191.81	2392.1	0.6492	7.4996	8.1488
15	53.97	0.001014	10.020	225.93	2222.1	2448.0	225.94	2372.3	0.7549	7.2522	8.0071
20	60.06	0.001017	7.6481	251.40	2204.6	2456.0	251.42	2357.5	0.8320	7.0752	7.9073
25	64.96	0.001020	6.2034	271.93	2190.4	2462.4	271.96	2345.5	0.8932	6.9370	7.8302
30	69.09	0.001022	5.2287	289.24	2178.5	2467.7	289.27	2335.3	0.9441	6.8234	7.7675
40	75.86	0.001026	3.9933	317.58	2158.8	2476.3	317.62	2318.4	1.0261	6.6430	7.6691
50	81.32	0.001030	3.2403	340.49	2142.7	2483.2	340.54	2304.7	1.0912	6.5019	7.5931
75	91.76	0.001037	2.2172	384.36	2111.8	2496.1	384.44	2278.0	1.2132	6.2426	7.4558
100	99.61	0.001043	1.6941	417.40	2088.2	2505.6	417.51	2257.5	1.3028	6.0562	7.3589
101.325	99.97	0.001043	1.6734	418.95	2087.0	2506.0	419.06	2256.5	1.3069	6.0476	7.3545
125	105.97	0.001048	1.3750	444.23	2068.8	2513.0	444.36	2240.6	1.3741	5.9100	7.2841
150	111.35	0.001053	1.1694	466.97	2052.3	2519.2	467.13	2226.0	1.4337	5.7894	7.2231
175	116.04	0.001057	1.0037	486.82	2037.7	2524.5	487.01	2213.1	1.4850	5.6865	7.1716
200	120.21	0.001061	0.88578	504.50	2024.6	2529.1	504.71	2201.6	1.5302	5.5968	7.1270
225	123.97	0.001064	0.79329	520.47	2012.7	2533.2	520.71	2191.0	1.5706	5.5171	7.0877
250	127.41	0.001067	0.71873	535.08	2001.8	2536.8	535.35	2181.2	1.6072	5.4453	7.0525
275	130.58	0.001070	0.65732	548.57	1991.6	2540.1	548.86	2172.0	1.6408	5.3800	7.0207
300	133.52	0.001073	0.60582	561.11	1982.1	2543.2	561.43	2163.5	1.6717	5.3200	6.9917
325	136.27	0.001076	0.56199	572.84	1973.1	2545.9	573.19	2155.4	1.7005	5.2645	6.9650
350	138.85	0.001079	0.52422	583.89	1964.6	2548.5	584.26	2147.7	1.7274	5.2128	6.9402
375	141.30	0.001081	0.49133	594.32	1956.6	2550.9	594.73	2140.4	1.7526	5.1645	6.9171
400	143.61	0.001084	0.46242	604.22	1948.9	2553.1	604.66	2133.4	1.7765	5.1191	6.8955
450	147.90	0.001088	0.41392	622.65	1934.5	2557.1	623.14	2120.3	1.8205	5.0356	6.8561
500	152.83	0.001093	0.37483	639.54	1921.2	2560.7	640.09	2108.0	1.8604	4.9603	6.8207
550	158.46	0.001097	0.34261	655.16	1908.8	2563.9	655.77	2096.6	1.8970	4.8916	6.7886
600	164.93	0.001101	0.31560	669.72	1897.1	2566.8	670.38	2085.8	1.9308	4.8285	6.7593
650	172.98	0.001104	0.29260	683.37	1886.1	2569.4	684.08	2075.5	1.9623	4.7699	6.7322
700	182.95	0.001108	0.27278	696.23	1875.6	2571.8	697.00	2065.8	1.9918	4.7153	6.7071
750	194.75	0.001111	0.25552	708.40	1865.6	2574.0	709.24	2056.4	2.0195	4.6642	6.6837

Tabla A-5

Agua saturada. Tabla de presiones (conclusión)

Pres., P kPa	Temp. sat., T _{sat} °C	Volumen específico, m ³ /kg		Energía interna, kJ/kg			Entalpía, kJ/kg		Entropía, kJ/kg · K		
		Liq. sat., v _f	Vapor sat., v _g	Liq. sat., u _f	Evap., u _{fg}	Vapor sat., u _g	Liq. sat., h _f	Vapor sat., h _g	Liq. sat., s _f	Evap., s _{fg}	Vapor sat., s _g
800	170.41	0.001115	0.24035	719.97	1856.1	2576.0	720.87	2047.5	2.0457	4.6160	6.6616
850	172.94	0.001118	0.22690	731.00	1846.9	2577.9	731.95	2038.8	2.0705	4.5705	6.6407
900	175.35	0.001121	0.21489	741.55	1838.1	2579.6	742.56	2030.5	2.0941	4.5273	6.621
950	177.66	0.001124	0.20411	751.67	1829.6	2581.3	752.74	2022.4	2.1166	4.4862	6.6027
1000	179.88	0.001127	0.19436	761.39	1821.4	2582.8	762.51	2014.6	2.1381	4.4470	6.5850
1100	184.06	0.001133	0.17745	779.78	1805.7	2585.5	781.03	1999.6	2.1785	4.3735	6.5520
1200	187.96	0.001138	0.16326	796.96	1790.9	2587.8	798.33	1985.4	2.2159	4.3058	6.5217
1300	191.60	0.001144	0.15119	813.10	1776.8	2589.9	814.59	1971.9	2.2508	4.2428	6.4938
1400	195.04	0.001149	0.14078	828.35	1763.4	2591.8	829.96	1958.9	2.2835	4.1840	6.4675
1500	198.29	0.001154	0.13171	842.82	1750.6	2593.4	844.55	1946.4	2.3143	4.1287	6.4430
1750	205.72	0.001166	0.11344	876.12	1720.6	2596.7	878.16	1917.1	2.3844	4.0033	6.3877
2000	212.38	0.001177	0.099587	906.12	1693.0	2599.1	908.47	1889.8	2.4467	3.8923	6.3390
2250	218.41	0.001187	0.088717	933.54	1667.3	2600.9	936.21	1864.3	2.5029	3.7926	6.2954
2500	223.95	0.001197	0.079952	958.87	1643.2	2602.1	961.87	1840.1	2.5542	3.7016	6.2558
3000	233.85	0.001217	0.066667	1004.6	1598.5	2603.2	1008.3	1794.9	2.6454	3.5402	6.1856
3500	242.56	0.001235	0.057061	1045.4	1557.6	2603.0	1049.7	1753.0	2.7253	3.3991	6.1244
4000	250.35	0.001252	0.049779	1082.4	1519.3	2601.7	1087.4	1713.5	2.7966	3.2731	6.0696
5000	263.94	0.001286	0.039448	1148.1	1448.9	2597.0	1154.5	1639.7	2.9207	3.0530	5.9737
6000	275.59	0.001319	0.032449	1205.8	1384.1	2589.9	1213.8	1570.9	2.784.6	3.0275	5.8902
7000	285.83	0.001352	0.027378	1258.0	1323.0	2581.0	1267.5	1505.2	2.772.6	3.1220	5.8148
8000	295.01	0.001384	0.023525	1306.0	1264.5	2570.5	1317.1	1441.6	2.758.7	3.2077	5.7450
9000	303.35	0.001418	0.020489	1350.9	1207.6	2558.5	1363.7	1379.3	2.742.9	3.2866	5.6791
10,000	311.00	0.001452	0.018028	1393.3	1151.8	2545.2	1407.8	1317.6	2.725.5	3.3603	5.6159
11,000	318.08	0.001488	0.015988	1433.9	1096.6	2530.4	1450.2	1256.1	2.706.3	3.4299	5.5544
12,000	324.68	0.001526	0.014264	1473.0	1041.3	2514.3	1491.3	1194.1	2.685.4	3.4964	5.4939
13,000	330.85	0.001566	0.012781	1511.0	985.5	2496.6	1531.4	1131.3	2.662.7	3.5606	5.4336
14,000	336.67	0.001610	0.011487	1548.4	928.7	2477.1	1571.0	1067.0	2.637.9	3.6232	5.3728
15,000	342.16	0.001657	0.010341	1585.5	870.3	2455.7	1610.3	1000.5	2.610.8	3.6848	5.3108
16,000	347.36	0.001710	0.009312	1622.6	809.4	2432.0	1649.9	931.1	2.581.0	3.7461	5.2466
17,000	352.29	0.001770	0.008374	1660.2	745.1	2405.4	1690.3	857.4	2.547.7	3.8082	5.1791
18,000	356.99	0.001840	0.007504	1699.1	675.9	2375.0	1732.2	777.8	2.510.0	3.8720	5.1064
19,000	361.47	0.001926	0.006677	1740.3	598.9	2339.2	1776.8	689.2	2.466.0	3.9396	5.0256
20,000	365.75	0.002038	0.005862	1785.8	509.0	2294.8	1826.6	585.5	2.412.1	4.0164	4.9310
21,000	369.83	0.002207	0.004994	1841.6	391.9	2233.5	1888.0	450.4	2.338.4	4.1071	4.8076
22,000	373.71	0.002703	0.003644	1951.7	140.8	2092.4	2011.1	161.5	2.172.6	4.2942	4.5439
22,064	373.95	0.003106	0.003106	2015.7	0	2015.7	2084.3	0	2.084.3	4.4070	4.4070

TABLA A-5

Vapor de agua sobrecalentado												
T °C	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/kg · K
P = 0.01 MPa (45.81°C):				P = 0.05 MPa (81.32°C):				P = 0.10 MPa (99.61°C):				
Sat.	14.670	2437.2	2583.9	8.1488	3.2403	2483.2	2645.2	7.5931	1.6941	2505.6	2675.0	7.3589
50	14.867	2443.3	2592.0	8.1741								
100	17.196	2515.5	2687.5	8.4489	3.4187	2511.5	2682.4	7.6953	1.6959	2506.2	2675.8	7.3611
150	19.513	2587.9	2783.0	8.6893	3.8897	2585.7	2780.2	7.9413	1.9367	2582.9	2776.6	7.6148
200	21.826	2661.4	2879.6	8.9049	4.3562	2660.0	2877.8	8.1592	2.1724	2658.2	2875.5	7.8356
250	24.136	2736.1	2977.5	9.1015	4.8206	2735.1	2976.2	8.3568	2.4062	2733.9	2974.5	8.0346
300	26.446	2812.3	3076.7	9.2827	5.2841	2811.6	3075.8	8.5387	2.6389	2810.7	3074.5	8.2172
400	31.063	2969.3	3280.8	9.6094	6.2094	2968.9	3279.3	8.8659	3.1027	2968.3	3278.6	8.5452
500	35.680	3132.9	3489.7	9.8998	7.1338	3132.6	3489.3	9.1566	3.5655	3132.2	3488.7	8.8362
600	40.296	3303.3	3706.3	10.1631	8.0577	3303.1	3706.0	9.4201	4.0279	3302.8	3705.6	9.0999
700	44.911	3480.8	3929.9	10.4056	8.9813	3480.6	3929.7	9.6626	4.4900	3480.4	3929.4	9.3424
800	49.527	3665.4	4160.6	10.6312	9.9047	3665.2	4160.4	9.8883	4.9519	3665.0	4160.2	9.5682
900	54.143	3856.9	4398.3	10.8429	10.8280	3856.8	4398.2	10.1000	5.4137	3856.7	4398.0	9.7800
1000	58.758	4055.3	4642.8	11.0429	11.7513	4055.2	4642.7	10.3000	5.8755	4055.0	4642.6	9.9800
1100	63.373	4260.0	4893.8	11.2326	12.6745	4259.9	4893.7	10.4897	6.3372	4259.8	4893.6	10.1698
1200	67.989	4470.9	5150.8	11.4132	13.5977	4470.8	5150.7	10.6704	6.7988	4470.7	5150.6	10.3504
1300	72.604	4687.4	5413.4	11.5857	14.5209	4687.3	5413.3	10.8429	7.2605	4687.2	5413.3	10.5229
P = 0.20 MPa (120.21°C):				P = 0.30 MPa (133.52°C):				P = 0.40 MPa (143.61°C):				
Sat.	0.88578	2529.1	2706.3	7.1270	0.60582	2543.2	2724.9	6.9917	0.46242	2553.1	2738.1	6.8955
150	0.95986	2577.1	2769.1	7.2810	0.63402	2571.0	2761.2	7.0792	0.47088	2564.4	2752.8	6.9306
200	1.08049	2654.6	2870.7	7.5081	0.71643	2651.0	2865.9	7.3132	0.53434	2647.2	2860.9	7.1723
250	1.19890	2731.4	2971.2	7.7100	0.79645	2728.9	2967.9	7.5180	0.59520	2726.4	2964.5	7.3804
300	1.31623	2808.8	3072.1	7.8941	0.87535	2807.0	3069.6	7.7037	0.65489	2805.1	3067.1	7.5677
400	1.54934	2967.2	3277.0	8.2236	1.03155	2966.0	3275.5	8.0347	0.77265	2964.9	3273.9	7.9003
500	1.78142	3131.4	3487.7	8.5153	1.18672	3130.6	3486.6	8.3271	0.88936	3129.8	3485.5	8.1933
600	2.01302	3302.2	3704.8	8.7793	1.34139	3301.6	3704.0	8.5915	1.00558	3301.0	3703.3	8.4580
700	2.24434	3479.9	3928.8	9.0221	1.49580	3479.5	3928.2	8.8345	1.12152	3479.0	3927.6	8.7012
800	2.47550	3664.7	4159.8	9.2479	1.65004	3664.3	4159.3	9.0605	1.23730	3663.9	4158.9	8.9274
900	2.70656	3856.3	4397.7	9.4598	1.80417	3856.0	4397.3	9.2725	1.35298	3855.7	4396.9	9.1394
1000	2.93755	4054.8	4642.3	9.6599	1.95824	4054.5	4642.0	9.4726	1.46859	4054.3	4641.7	9.3396
1100	3.16848	4259.6	4893.3	9.8497	2.11226	4259.4	4893.1	9.6624	1.58414	4259.2	4892.9	9.5295
1200	3.39938	4470.5	5150.4	10.0304	2.26624	4470.3	5150.2	9.8431	1.69966	4470.2	5150.0	9.7102
1300	3.63026	4687.1	5413.1	10.2029	2.42019	4686.9	5413.0	10.0157	1.81516	4686.7	5412.8	9.8828
P = 0.50 MPa (151.83°C):				P = 0.60 MPa (158.83°C):				P = 0.80 MPa (170.41°C):				
Sat.	0.37483	2560.7	2748.1	6.8207	0.31560	2566.8	2756.2	6.7593	0.24035	2576.0	2768.3	6.6616
200	0.42503	2643.3	2855.8	7.0610	0.35212	2639.4	2850.6	6.9683	0.26088	2631.1	2839.9	6.8177
250	0.47443	2723.8	2961.0	7.2725	0.39390	2721.2	2957.6	7.1833	0.29321	2715.9	2950.4	7.0402
300	0.52261	2803.3	3064.6	7.4614	0.43442	2801.4	3052.0	7.3740	0.32416	2797.5	3056.9	7.2345
350	0.57015	2883.0	3168.1	7.6346	0.47428	2881.6	3166.1	7.5481	0.35442	2878.6	3162.2	7.4107
400	0.61731	2963.7	3272.4	7.7956	0.51374	2962.5	3270.8	7.7097	0.38429	2960.2	3267.7	7.5735
500	0.71095	3129.0	3484.5	8.0893	0.59200	3128.2	3483.4	8.0041	0.44332	3126.6	3481.3	7.8692
600	0.80409	3300.4	3702.5	8.3544	0.66976	3299.8	3701.7	8.2695	0.50186	3298.7	3700.1	8.1354
700	0.89696	3478.6	3927.0	8.5978	0.74725	3478.1	3926.4	8.5132	0.56011	3477.2	3925.3	8.3794
800	0.98966	3663.6	4158.4	8.8240	0.82457	3663.2	4157.9	8.7395	0.61820	3662.5	4157.0	8.6061
900	1.08227	3855.4	4396.6	9.0362	0.90179	3855.1	4396.2	8.9518	0.67619	3854.5	4395.5	8.8185
1000	1.17480	4054.0	4641.4	9.2364	0.97893	4053.8	4641.1	9.1521	0.73411	4053.3	4640.5	9.0189
1100	1.26728	4259.0	4892.6	9.4263	1.05603	4258.8	4892.4	9.3420	0.79197	4258.3	4891.9	9.2090
1200	1.35972	4470.0	5149.8	9.6071	1.13309	4469.8	5149.6	9.5229	0.84980	4469.4	5149.3	9.3898
1300	1.45214	4686.6	5412.6	9.7797	1.21012	4686.4	5412.5	9.6955	0.90761	4686.1	5412.2	9.5625

*La temperatura entre paréntesis es la temperatura de saturación a la presión especificada.

*Propiedades del vapor saturado a la presión especificada.

TABLA A-6

Vapor de agua sobrecalentado (continuación)												
T °C	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K
P = 1.00 MPa (179.88°C)					P = 1.20 MPa (187.96°C)				P = 1.40 MPa (195.04°C)			
Sat.	0.19437	2582.8	2777.1	6.5850	0.16326	2587.8	2783.8	6.5217	0.14078	2591.8	2788.9	6.4675
200	0.20602	2622.3	2828.3	6.6956	0.16934	2612.9	2816.1	6.5909	0.14303	2602.7	2803.0	6.4975
250	0.23275	2710.4	2943.1	6.9265	0.19241	2704.7	2935.6	6.8313	0.16356	2698.9	2927.9	6.7488
300	0.25799	2793.7	3051.6	7.1246	0.21386	2789.7	3046.3	7.0335	0.18233	2785.7	3040.9	6.9553
350	0.28250	2875.7	3158.2	7.3029	0.23455	2872.7	3154.2	7.2139	0.20029	2869.7	3150.1	7.1379
400	0.30661	2957.9	3264.5	7.4670	0.25482	2955.5	3261.3	7.3793	0.21782	2953.1	3258.1	7.3046
500	0.35411	3125.0	3479.1	7.7642	0.29464	3123.4	3477.0	7.6779	0.25216	3121.8	3474.8	7.6047
600	0.40111	3297.5	3698.6	8.0311	0.33395	3296.3	3697.0	7.9456	0.28597	3295.1	3695.5	7.8730
700	0.44783	3476.3	3924.1	8.2755	0.37297	3475.3	3922.9	8.1904	0.31951	3474.4	3921.7	8.1183
800	0.49438	3661.7	4156.1	8.5024	0.41184	3661.0	4155.2	8.4176	0.35288	3660.3	4154.3	8.3458
900	0.54083	3853.9	4394.8	8.7150	0.45059	3853.3	4394.0	8.6303	0.38614	3852.7	4393.3	8.5587
1000	0.58721	4052.7	4640.0	8.9155	0.48928	4052.2	4639.4	8.8310	0.41933	4051.7	4638.8	8.7595
1100	0.63354	4257.9	4891.4	9.1057	0.52792	4257.5	4891.0	9.0212	0.45247	4257.0	4890.5	8.9497
1200	0.67983	4469.0	5148.9	9.2866	0.56652	4468.7	5148.5	9.2022	0.48558	4468.3	5148.1	9.1308
1300	0.72610	4685.8	5411.9	9.4593	0.60509	4685.5	5411.6	9.3750	0.51866	4685.1	5411.3	9.3036
P = 1.60 MPa (201.37°C)					P = 1.80 MPa (207.11°C)				P = 2.00 MPa (212.38°C)			
Sat.	0.12374	2594.8	2792.8	6.4200	0.11037	2597.3	2795.9	6.3775	0.09959	2599.1	2798.3	6.3390
225	0.13293	2645.1	2857.8	6.5537	0.11678	2637.0	2847.2	6.4825	0.10381	2628.5	2836.1	6.4160
250	0.14190	2692.9	2919.9	6.6753	0.12502	2686.7	2911.7	6.6088	0.11150	2680.3	2903.3	6.5475
300	0.15866	2781.6	3035.4	6.8864	0.14025	2777.4	3029.9	6.8246	0.12551	2773.2	3024.2	6.7684
350	0.17459	2866.6	3146.0	7.0713	0.15460	2863.6	3141.9	7.0120	0.13860	2860.5	3137.7	6.9583
400	0.19007	2950.8	3254.9	7.2394	0.16849	2948.3	3251.6	7.1814	0.15122	2945.9	3248.4	7.1292
500	0.22029	3120.1	3472.6	7.5410	0.19551	3118.5	3470.4	7.4845	0.17568	3116.9	3468.3	7.4337
600	0.24999	3293.9	3693.9	7.8101	0.22200	3292.7	3692.3	7.7543	0.19962	3291.5	3690.7	7.7043
700	0.27941	3473.5	3920.5	8.0558	0.24822	3472.6	3919.4	8.0005	0.22326	3471.7	3918.2	7.9509
800	0.30865	3659.5	4153.4	8.2834	0.27426	3658.8	4152.4	8.2284	0.24674	3658.0	4151.5	8.1791
900	0.33780	3852.1	4392.6	8.4965	0.30020	3851.5	4391.9	8.4417	0.27012	3850.9	4391.1	8.3925
1000	0.36687	4051.2	4638.2	8.6974	0.32606	4050.7	4637.6	8.6427	0.29342	4050.2	4637.1	8.5936
1100	0.39589	4256.6	4890.0	8.8878	0.35188	4256.2	4889.6	8.8331	0.31667	4255.7	4889.1	8.7842
1200	0.42488	4457.9	5147.7	9.0689	0.37766	4456.6	5147.3	9.0143	0.33989	4457.2	5147.0	8.9654
1300	0.45383	4684.8	5410.9	9.2418	0.40341	4684.5	5410.6	9.1872	0.36308	4684.2	5410.3	9.1384
P = 2.50 MPa (223.95°C)					P = 3.00 MPa (233.85°C)				P = 3.50 MPa (242.56°C)			
Sat.	0.07995	2602.1	2801.9	6.2558	0.06667	2603.2	2803.2	6.1856	0.05706	2603.0	2802.7	6.1244
225	0.08026	2604.8	2805.5	6.2629								
250	0.08705	2663.3	2880.9	6.4107	0.07063	2644.7	2856.5	6.2893	0.05876	2624.0	2829.7	6.1764
300	0.09894	2762.2	3009.6	6.6459	0.08118	2750.8	2994.3	6.5412	0.06845	2738.8	2978.4	6.4484
350	0.10979	2852.5	3127.0	6.8424	0.09056	2844.4	3116.1	6.7450	0.07680	2836.0	3104.9	6.6601
400	0.12012	2939.8	3240.1	7.0170	0.09938	2933.6	3231.7	6.9235	0.08456	2927.2	3223.2	6.8428
450	0.13015	3026.2	3351.6	7.1768	0.10789	3021.2	3344.9	7.0856	0.09198	3016.1	3338.1	7.0074
500	0.13999	3112.8	3462.8	7.3254	0.11620	3108.6	3457.2	7.2359	0.09919	3104.5	3451.7	7.1593
600	0.15931	3288.5	3686.8	7.5979	0.13245	3285.5	3682.8	7.5103	0.11325	3282.5	3678.9	7.4357
700	0.17835	3469.3	3915.2	7.8455	0.14841	3467.0	3912.2	7.7590	0.12702	3464.7	3909.3	7.6855
800	0.19722	3656.2	4149.2	8.0744	0.16420	3654.3	4146.9	7.9885	0.14061	3652.5	4144.6	7.9156
900	0.21597	3849.4	4389.3	8.2882	0.17988	3847.9	4387.5	8.2028	0.15410	3846.4	4385.7	8.1304
1000	0.23466	4049.0	4635.6	8.4897	0.19549	4047.7	4634.2	8.4045	0.16751	4046.4	4632.7	8.3324
1100	0.25330	4254.7	4887.9	8.6804	0.21105	4253.6	4886.7	8.5955	0.18087	4252.5	4885.6	8.5236
1200	0.27190	4466.3	5146.0	8.8618	0.22658	4465.3	5145.1	8.7771	0.19420	4464.4	5144.1	8.7053
1300	0.29048	4683.4	5409.5	9.0349	0.24207	4682.6	5408.5	8.9502	0.20750	4681.8	5408.0	8.8787

Tabla A-6

Vapor de agua sobrecalentado (continuación)

Vapor de agua sobrecalentado (continuación)												
T °C	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K
P = 4.0 MPa (250.33 °C)					P = 4.5 MPa (257.44 °C)				P = 5.0 MPa (263.94 °C)			
Sat.	0.04978	2601.7	2800.8	6.0696	0.04406	2599.7	2798.0	6.0198	0.03945	2597.0	2794.2	5.9737
275	0.05461	2668.9	2887.3	6.2312	0.04733	2651.4	2864.4	6.1429	0.04144	2632.3	2839.5	6.0571
300	0.05887	2726.2	2961.7	6.3639	0.05138	2713.0	2944.2	6.2854	0.04535	2699.0	2925.7	6.2111
350	0.06647	2827.4	3093.3	6.5843	0.05842	2818.6	3081.5	6.5153	0.05197	2809.5	3069.3	6.4516
400	0.07343	2920.8	3214.5	6.7714	0.06477	2914.2	3205.7	6.7071	0.05784	2907.5	3196.7	6.6483
450	0.08004	3011.0	3331.2	6.9386	0.07076	3005.8	3324.2	6.8770	0.06332	3000.6	3317.2	6.8210
500	0.08644	3100.3	3446.0	7.0922	0.07652	3096.0	3440.4	7.0323	0.06858	3091.8	3434.7	6.9781
600	0.09886	3279.4	3674.9	7.3706	0.08766	3276.4	3670.9	7.3127	0.07870	3273.3	3666.9	7.2605
700	0.11098	3462.4	3906.3	7.6214	0.09850	3460.0	3903.3	7.5647	0.08852	3457.7	3900.3	7.5136
800	0.12292	3650.6	4142.3	7.8523	0.10916	3648.8	4140.0	7.7962	0.09816	3646.9	4137.7	7.7458
900	0.13476	3844.8	4383.9	8.0675	0.11972	3843.3	4382.1	8.0118	0.10769	3841.8	4380.2	7.9619
1000	0.14653	4045.1	4631.2	8.2698	0.13020	4043.9	4629.8	8.2144	0.11715	4042.6	4628.3	8.1648
1100	0.15824	4251.4	4884.4	8.4612	0.14064	4250.4	4883.2	8.4060	0.12655	4249.3	4882.1	8.3566
1200	0.16992	4463.5	5143.2	8.6430	0.15103	4462.6	5142.2	8.5880	0.13592	4461.6	5141.3	8.5388
1300	0.18157	4680.9	5407.2	8.8164	0.16140	4680.1	5406.5	8.7616	0.14527	4679.3	5405.7	8.7124
P = 6.0 MPa (275.55 °C)					P = 7.0 MPa (285.33 °C)				P = 8.0 MPa (295.01 °C)			
Sat.	0.03245	2589.9	2784.6	5.8902	0.027378	2581.0	2772.6	5.8148	0.023525	2570.5	2758.7	5.7450
300	0.03619	2668.4	2885.6	6.0703	0.029492	2633.5	2839.9	5.9337	0.024279	2592.3	2786.5	5.7937
350	0.04225	2790.4	3043.9	6.3357	0.035262	2770.1	3016.9	6.2305	0.029975	2748.3	2988.1	6.1321
400	0.04742	2893.7	3178.3	6.5432	0.039958	2879.5	3159.2	6.4502	0.034344	2864.6	3139.4	6.3658
450	0.05217	2989.9	3302.9	6.7219	0.044187	2979.0	3288.3	6.6353	0.038194	2967.8	3273.3	6.5579
500	0.05667	3083.1	3423.1	6.8826	0.048157	3074.3	3411.4	6.8000	0.041767	3065.4	3399.5	6.7266
550	0.06102	3175.2	3541.3	7.0308	0.051966	3167.9	3531.6	6.9507	0.045172	3160.5	3521.8	6.8800
600	0.06527	3267.2	3658.8	7.1693	0.055655	3261.0	3650.6	7.0910	0.048463	3254.7	3642.4	7.0221
700	0.07355	3453.0	3894.3	7.4247	0.062850	3448.3	3888.3	7.3487	0.054829	3443.6	3882.2	7.2822
800	0.08165	3643.2	4133.1	7.6582	0.069856	3639.5	4128.5	7.5836	0.061011	3635.7	4123.8	7.5185
900	0.08964	3838.8	4376.6	7.8751	0.076750	3835.7	4373.0	7.8014	0.067082	3832.7	4369.3	7.7372
1000	0.09756	4040.1	4625.4	8.0786	0.083571	4037.5	4622.5	8.0055	0.073079	4035.0	4619.6	7.9419
1100	0.10543	4247.1	4879.7	8.2709	0.090341	4245.0	4877.4	8.1982	0.079025	4242.8	4875.0	8.1350
1200	0.11326	4459.8	5139.4	8.4534	0.097075	4457.9	5137.4	8.3810	0.084934	4456.1	5135.5	8.3181
1300	0.12107	4677.7	5404.1	8.6273	0.103781	4676.1	5402.6	8.5551	0.090817	4674.5	5401.0	8.4925
P = 9.0 MPa (303.94 °C)					P = 10.0 MPa (311.00 °C)				P = 12.5 MPa (327.81 °C)			
Sat.	0.020489	2558.5	2742.0	5.6791	0.018028	2545.2	2725.5	5.6159	0.013496	2505.6	2674.3	5.4638
325	0.023284	2647.6	2857.1	5.8738	0.019877	2611.6	2810.3	5.7596	0.016138	2624.9	2826.6	5.7130
350	0.025816	2725.0	2957.3	6.0380	0.022440	2699.6	2924.0	5.9460	0.020030	2789.6	3040.0	6.0433
400	0.029950	2849.2	3118.8	6.2876	0.026436	2833.1	3097.5	6.2141	0.023019	2913.7	3201.5	6.2749
450	0.033524	2956.3	3258.0	6.4872	0.029782	2944.5	3242.4	6.4219	0.025630	3023.2	3343.6	6.4651
500	0.036793	3056.3	3387.4	6.6603	0.032811	3047.0	3375.1	6.5995	0.028033	3126.1	3476.5	6.6317
550	0.039885	3153.0	3512.0	6.8164	0.035655	3145.4	3502.0	6.7585	0.030306	3225.8	3604.6	6.7828
600	0.042861	3248.4	3634.1	6.9604	0.038378	3242.0	3625.8	6.9045	0.032491	3324.1	3730.2	6.9227
650	0.045755	3343.4	3755.2	7.0954	0.041018	3338.0	3748.1	7.0408	0.034612	3422.0	3854.6	7.0540
700	0.048589	3438.8	3876.1	7.2229	0.043597	3434.0	3870.0	7.1693	0.038724	3618.8	4102.8	7.2967
800	0.054132	3632.0	4119.2	7.4606	0.048629	3628.2	4114.5	7.4085	0.042720	3818.9	4352.9	7.5195
900	0.059562	3829.6	4365.7	7.6802	0.053547	3826.5	4362.0	7.6290	0.046641	4023.5	4606.5	7.7269
1000	0.064919	4032.4	4616.7	7.8855	0.058391	4029.9	4613.8	7.8349	0.050510	4233.1	4864.5	7.9220
1100	0.070224	4240.7	4872.7	8.0791	0.063183	4238.5	4870.3	8.0289	0.054342	4447.7	5127.0	8.1065
1200	0.075492	4454.2	5133.6	8.2625	0.067938	4452.4	5131.7	8.2126	0.058147	4667.3	5394.1	8.2819
1300	0.080733	4672.9	5399.5	8.4371	0.072667	4671.3	5398.0	8.3874				

Tabla A-6

Vapor de agua sobrecalentado (conclusión)

T °C	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K		
P = 15.0 MPa (342.16°C)					P = 17.5 MPa (354.67°C)					P = 20.0 MPa (365.75°C)				
Sat.	0.010341	2455.7	2610.8	5.3108	0.007932	2390.7	2529.5	5.1435	0.005862	2294.8	2412.1	4.9310		
350	0.011481	2520.9	2693.1	5.4438										
400	0.015671	2740.6	2975.7	5.8819	0.012463	2684.3	2902.4	5.7211	0.009950	2617.9	2816.9	5.5526		
450	0.018477	2880.8	3157.9	6.1434	0.015204	2845.4	3111.4	6.0212	0.012721	2807.3	3061.7	5.9043		
500	0.020828	2998.4	3310.8	6.3480	0.017385	2972.4	3276.7	6.2424	0.014793	2945.3	3241.2	6.1446		
550	0.022945	3106.2	3450.4	6.5230	0.019305	3085.8	3423.6	6.4266	0.016571	3064.7	3396.2	6.3390		
600	0.024921	3209.3	3583.1	6.6796	0.021073	3192.5	3561.3	6.5890	0.018185	3175.3	3539.0	6.5075		
650	0.026804	3310.1	3712.1	6.8233	0.022742	3295.8	3693.8	6.7366	0.019695	3281.4	3675.3	6.6593		
700	0.028621	3409.8	3839.1	6.9573	0.024342	3397.5	3823.5	6.8735	0.021134	3385.1	3807.8	6.7991		
800	0.032121	3609.3	4091.1	7.2037	0.027405	3599.7	4079.3	7.1237	0.023870	3590.1	4067.5	7.0531		
900	0.035503	3811.2	4343.7	7.4288	0.030348	3803.5	4334.6	7.3511	0.026484	3795.7	4325.4	7.2829		
1000	0.038808	4017.1	4599.2	7.6378	0.033215	4010.7	4592.0	7.5616	0.029020	4004.3	4584.7	7.4950		
1100	0.042062	4227.7	4858.6	7.8339	0.036029	4222.3	4852.8	7.7588	0.031504	4216.9	4847.0	7.6933		
1200	0.045279	4443.1	5122.3	8.0192	0.038806	4438.5	5117.6	7.9449	0.033952	4433.8	5112.9	7.8802		
1300	0.048469	4663.3	5390.3	8.1952	0.041556	4659.2	5386.5	8.1215	0.036371	4655.2	5382.7	8.0574		
P = 25.0 MPa					P = 30.0 MPa					P = 35.0 MPa				
375	0.001978	1799.9	1849.4	4.0345	0.001792	1738.1	1791.9	3.9313	0.001701	1702.8	1762.4	3.8724		
400	0.005005	2428.5	2578.7	5.1400	0.002798	2068.9	2152.8	4.4758	0.002105	1914.9	1988.6	4.2144		
425	0.007886	2607.8	2805.0	5.4708	0.005299	2452.9	2611.8	5.1473	0.003434	2253.3	2373.5	4.7751		
450	0.009176	2721.2	2950.6	5.6759	0.006737	2618.9	2821.0	5.4422	0.004957	2497.5	2671.0	5.1946		
500	0.011143	2887.3	3165.9	5.9643	0.008691	2824.0	3084.8	5.7956	0.006933	2755.3	2997.9	5.6331		
550	0.012736	3020.8	3339.2	6.1816	0.010175	2974.5	3279.7	6.0403	0.008348	2925.8	3218.0	5.9093		
600	0.014140	3140.0	3493.5	6.3637	0.011445	3103.4	3446.8	6.2373	0.009523	3065.6	3399.0	6.1229		
650	0.015430	3251.9	3637.7	6.5243	0.012590	3221.7	3599.4	6.4074	0.010565	3190.9	3560.7	6.3030		
700	0.016643	3359.9	3776.0	6.6702	0.013654	3334.3	3743.9	6.5599	0.011523	3308.3	3711.6	6.4523		
800	0.018922	3570.7	4043.8	6.9322	0.015628	3551.2	4020.0	6.8301	0.013278	3531.6	3996.3	6.7409		
900	0.021075	3780.2	4307.1	7.1668	0.017473	3764.6	4288.8	7.0695	0.014904	3749.0	4270.6	6.9853		
1000	0.023150	3991.5	4570.2	7.3821	0.019240	3978.6	4555.8	7.2880	0.016450	3965.8	4541.5	7.2069		
1100	0.025172	4206.1	4835.4	7.5825	0.020954	4195.2	4823.9	7.4906	0.017942	4184.4	4812.4	7.4118		
1200	0.027157	4424.6	5103.5	7.7710	0.022630	4415.3	5094.2	7.6807	0.019398	4406.1	5085.0	7.6034		
1300	0.029115	4647.2	5375.1	7.9494	0.024279	4639.2	5367.6	7.8602	0.020827	4631.2	5360.2	7.7841		
P = 40.0 MPa					P = 50.0 MPa					P = 60.0 MPa				
375	0.001641	1677.0	1742.6	3.8290	0.001560	1638.6	1716.6	3.7642	0.001503	1609.7	1699.9	3.7149		
400	0.001911	1855.0	1931.4	4.1145	0.001731	1787.8	1874.4	4.0029	0.001633	1745.2	1843.2	3.9317		
425	0.002538	2097.5	2199.0	4.5044	0.002009	1960.3	2060.7	4.2746	0.001816	1892.9	2001.8	4.1630		
450	0.003692	2364.2	2511.8	4.9449	0.002487	2160.3	2284.7	4.5896	0.002086	2055.1	2180.2	4.4140		
500	0.005623	2681.6	2906.5	5.4744	0.003890	2528.1	2722.6	5.1762	0.002952	2393.2	2570.3	4.9356		
550	0.006985	2875.1	3154.4	5.7857	0.005118	2769.3	3025.4	5.5563	0.003955	2664.6	2901.9	5.3517		
600	0.008089	3026.8	3350.4	6.0170	0.006108	2947.1	3252.6	5.8245	0.004833	2866.8	3156.8	5.6527		
650	0.009053	3159.5	3521.6	6.2078	0.006957	3095.6	3443.5	6.0373	0.005591	3031.3	3366.8	5.8867		
700	0.009930	3282.0	3679.2	6.3740	0.007717	3228.7	3614.6	6.2179	0.006265	3175.4	3551.3	6.0814		
800	0.011521	3511.8	3972.6	6.6613	0.009073	3472.2	3925.8	6.5225	0.007456	3432.6	3880.0	6.4033		
900	0.012980	3733.3	4252.5	6.9107	0.010296	3702.0	4216.8	6.7819	0.008519	3670.9	4182.1	6.6725		
1000	0.014360	3952.9	4527.3	7.1355	0.011441	3927.4	4499.4	7.0131	0.009504	3902.0	4472.2	6.9099		
1100	0.015686	4173.7	4801.1	7.3425	0.012534	4152.2	4778.9	7.2244	0.010439	4130.9	4757.3	7.1255		
1200	0.016976	4396.9	5075.9	7.5357	0.013590	4378.6	5058.1	7.4207	0.011339	4360.5	5040.8	7.3248		
1300	0.018239	4623.3	5352.8	7.7175	0.014620	4607.5	5338.5	7.6048	0.012213	4591.8	5324.5	7.5111		

TABLA A-7

Agua líquida comprimida												
T °C	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K
P = 5 MPa (263.94°C)				P = 10 MPa (311.00°C)				P = 15 MPa (342.16°C)				
Sat.	0.0012862	1148.1	1154.5	2.9207	0.0014522	1393.3	1407.9	3.3603	0.0016572	1585.5	1610.3	3.6848
0	0.0009977	0.04	5.03	0.0001	0.0009952	0.12	10.07	0.0003	0.0009928	0.18	15.07	0.0004
20	0.0009996	83.61	88.61	0.2954	0.0009973	83.31	93.28	0.2943	0.0009951	83.01	97.93	0.2932
40	0.0010057	166.92	171.95	0.5705	0.0010035	166.33	176.37	0.5685	0.0010013	165.75	180.77	0.5666
60	0.0010149	250.29	255.36	0.8287	0.0010127	249.43	259.55	0.8260	0.0010105	248.58	263.74	0.8234
80	0.0010267	333.82	338.96	1.0723	0.0010244	332.69	342.94	1.0691	0.0010221	331.59	346.92	1.0659
100	0.0010410	417.65	422.85	1.3034	0.0010385	416.23	426.62	1.2996	0.0010361	414.85	430.39	1.2958
120	0.0010576	501.91	507.19	1.5236	0.0010549	500.18	510.73	1.5191	0.0010522	498.50	514.28	1.5148
140	0.0010769	586.80	592.18	1.7344	0.0010738	584.72	595.45	1.7293	0.0010708	582.69	598.75	1.7243
160	0.0010988	672.55	678.04	1.9374	0.0010954	670.06	681.01	1.9316	0.0010920	667.63	684.01	1.9259
180	0.0011240	759.47	765.09	2.1338	0.0011200	756.48	767.68	2.1271	0.0011160	753.58	770.32	2.1206
200	0.0011531	847.92	853.68	2.3251	0.0011482	844.32	855.80	2.3174	0.0011435	840.84	858.00	2.3100
220	0.0011868	938.39	944.32	2.5127	0.0011809	934.01	945.82	2.5037	0.0011752	929.81	947.43	2.4951
240	0.0012268	1031.6	1037.7	2.6983	0.0012192	1026.2	1038.3	2.6876	0.0012121	1021.0	1039.2	2.6774
260	0.0012755	1128.5	1134.9	2.8841	0.0012653	1121.6	1134.3	2.8710	0.0012560	1115.1	1134.0	2.8586
280					0.0013226	1221.8	1235.0	3.0565	0.0013096	1213.4	1233.0	3.0410
300					0.0013980	1329.4	1343.3	3.2488	0.0013783	1317.6	1338.3	3.2279
320									0.0014733	1431.9	1454.0	3.4263
340									0.0016311	1567.9	1592.4	3.6555
P = 20 MPa (365.75°C)				P = 30 MPa				P = 50 MPa				
Sat.	0.0020378	1785.8	1826.6	4.0146	0.0009857	0.29	29.86	0.0003	0.0009767	0.29	49.13	-0.0010
0	0.0009904	0.23	20.03	0.0005	0.0009886	82.11	111.77	0.2897	0.0009805	80.93	129.95	0.2845
20	0.0009929	82.71	102.57	0.2921	0.0009951	164.05	193.90	0.5607	0.0009872	161.90	211.25	0.5528
40	0.0009992	165.17	185.16	0.5646	0.0009951	164.05	193.90	0.5607	0.0009962	243.08	292.88	0.8055
60	0.0010084	247.75	267.92	0.8208	0.0010042	245.14	276.26	0.8156	0.0010072	324.42	374.78	1.0442
80	0.0010199	330.50	350.90	1.0627	0.0010155	328.40	358.86	1.0564	0.0010201	405.94	456.94	1.2705
100	0.0010337	413.50	434.17	1.2920	0.0010290	410.87	441.74	1.2847	0.0010349	487.69	539.43	1.4859
120	0.0010496	496.85	517.84	1.5105	0.0010445	493.66	525.00	1.5020	0.0010517	569.77	622.36	1.6916
140	0.0010679	580.71	602.07	1.7194	0.0010623	576.90	608.76	1.7098	0.0010704	652.33	705.85	1.8889
160	0.0010886	665.28	687.05	1.9203	0.0010823	660.74	693.21	1.9094	0.0010914	735.49	790.06	2.0790
180	0.0011122	750.78	773.02	2.1143	0.0011049	745.40	778.55	2.1020	0.0011149	819.45	875.19	2.2628
200	0.0011390	837.49	860.27	2.3027	0.0011304	831.11	865.02	2.2888	0.0011412	904.39	961.45	2.4414
220	0.0011697	925.77	949.16	2.4867	0.0011595	918.15	952.93	2.4707	0.0011708	990.55	1049.1	2.6156
240	0.0012053	1016.1	1040.2	2.6676	0.0011927	1006.9	1042.7	2.6491	0.0012044	1078.2	1138.4	2.7864
260	0.0012472	1109.0	1134.0	2.8469	0.0012314	1097.8	1134.7	2.8250	0.0012430	1167.7	1229.9	2.9547
280	0.0012978	1205.6	1231.5	3.0265	0.0012770	1191.5	1229.8	3.0001	0.0012879	1259.6	1324.0	3.1218
300	0.0013611	1307.2	1334.4	3.2091	0.0013322	1288.9	1328.9	3.1761	0.0013409	1354.3	1421.4	3.2888
320	0.0014450	1416.6	1445.5	3.3996	0.0014014	1391.7	1433.7	3.3588	0.0014049	1452.9	1523.1	3.4575
340	0.0015693	1540.2	1571.6	3.6086	0.0014932	1502.4	1547.1	3.5438	0.0014848	1556.5	1630.7	3.6301
360	0.0018248	1703.6	1740.1	3.8787	0.0016276	1626.8	1675.6	3.7499	0.0015884	1667.1	1746.5	3.8102
380					0.0018729	1782.0	1838.2	4.0026				

TABLA A-8

Hielo saturado. Vapor de agua												
Temp., T °C	Pres., P sat., kPa	Volumen específico, m³/kg		Energía interna, kJ/kg		Entalpía, kJ/kg		Entropía, kJ/kg · K		Hielo sat., s _i	Vapor sat., s _g	Vapor sat., s _g
		Hielo sat., v _i	Vapor sat., v _g	Hielo sat., u _i	Subl., u _g	Vapor sat., u _g	Hielo sat., h _i	Subl., h _g	Vapor sat., h _g			
0.01	0.61169	0.001091	205.99	-333.40	2707.9	2374.5	-333.40	2833.9	2500.5	-1.2202	10.374	9.154
0	0.61115	0.001091	206.17	-333.43	2707.9	2374.5	-333.43	2833.9	2500.5	-1.2204	10.375	9.154
-2	0.51772	0.001091	241.62	-337.63	2709.4	2371.8	-337.63	2834.5	2496.8	-1.2358	10.453	9.218
-4	0.43748	0.001090	283.84	-341.80	2710.8	2369.0	-341.80	2835.0	2493.2	-1.2513	10.533	9.282
-6	0.36873	0.001090	334.27	-345.94	2712.2	2366.2	-345.93	2835.4	2489.5	-1.2667	10.613	9.347
-8	0.30998	0.001090	394.66	-350.04	2713.5	2363.5	-350.04	2835.8	2485.8	-1.2821	10.695	9.413
-10	0.25990	0.001089	467.17	-354.12	2714.8	2360.7	-354.12	2836.2	2482.1	-1.2976	10.778	9.480
-12	0.21732	0.001089	554.47	-358.17	2716.1	2357.9	-358.17	2836.6	2478.4	-1.3130	10.862	9.549
-14	0.18121	0.001088	659.88	-362.18	2717.3	2355.2	-362.18	2836.9	2474.7	-1.3284	10.947	9.618
-16	0.15068	0.001088	787.51	-366.17	2718.6	2352.4	-366.17	2837.2	2471.0	-1.3439	11.033	9.689
-18	0.12492	0.001088	942.51	-370.13	2719.7	2349.6	-370.13	2837.5	2467.3	-1.3593	11.121	9.761
-20	0.10326	0.001087	1131.3	-374.06	2720.9	2346.8	-374.06	2837.7	2463.6	-1.3748	11.209	9.835
-22	0.08510	0.001087	1362.0	-377.95	2722.0	2344.1	-377.95	2837.9	2459.9	-1.3903	11.300	9.909
-24	0.06991	0.001087	1644.7	-381.82	2723.1	2341.3	-381.82	2838.1	2456.2	-1.4057	11.391	9.985
-26	0.05725	0.001087	1992.2	-385.66	2724.2	2338.5	-385.66	2838.2	2452.5	-1.4212	11.484	10.063
-28	0.04673	0.001086	2421.0	-389.47	2725.2	2335.7	-389.47	2838.3	2448.8	-1.4367	11.578	10.141
-30	0.03802	0.001086	2951.7	-393.25	2726.2	2332.9	-393.25	2838.4	2445.1	-1.4521	11.673	10.221
-32	0.03082	0.001086	3610.9	-397.00	2727.2	2330.2	-397.00	2838.4	2441.4	-1.4676	11.770	10.303
-34	0.02490	0.001085	4432.4	-400.72	2728.1	2327.4	-400.72	2838.5	2437.7	-1.4831	11.869	10.386
-36	0.02004	0.001085	5460.1	-404.40	2729.0	2324.6	-404.40	2838.4	2434.0	-1.4986	11.969	10.470
-38	0.01608	0.001085	6750.5	-408.07	2729.9	2321.8	-408.07	2838.4	2430.3	-1.5141	12.071	10.557
-40	0.01285	0.001084	8376.7	-411.70	2730.7	2319.0	-411.70	2838.3	2426.6	-1.5296	12.174	10.644

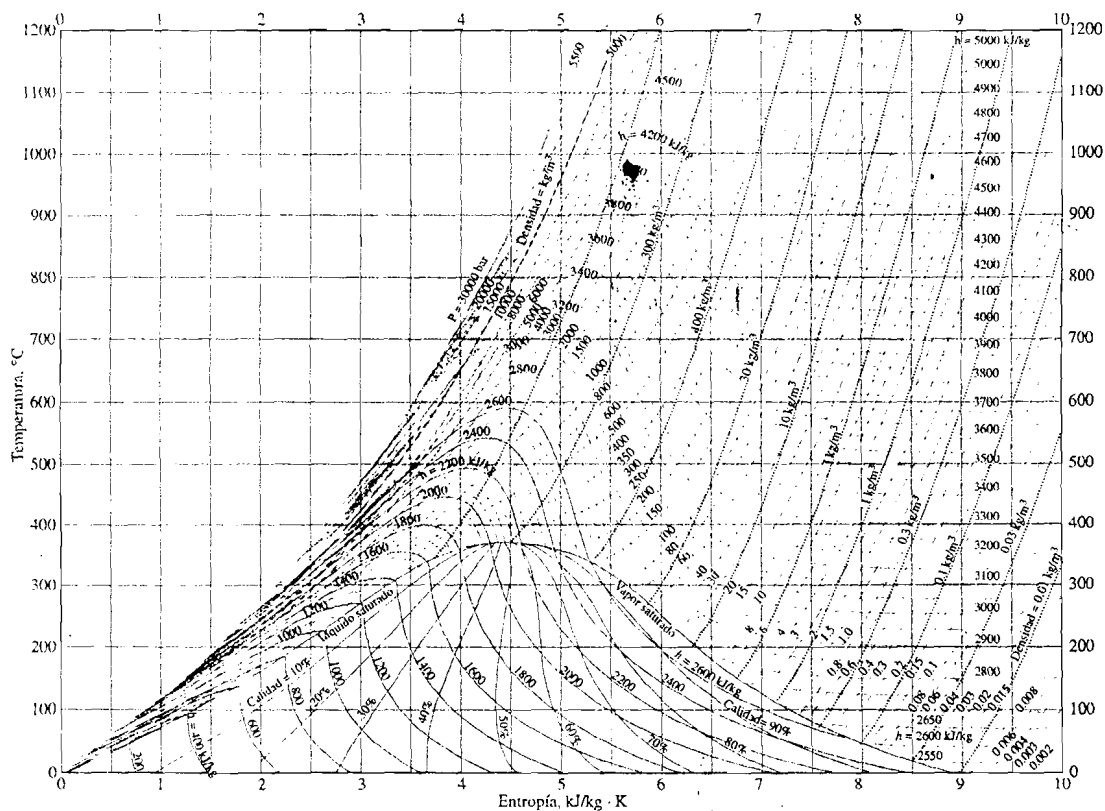


FIGURA A-9

Diagrama T-s para el agua.

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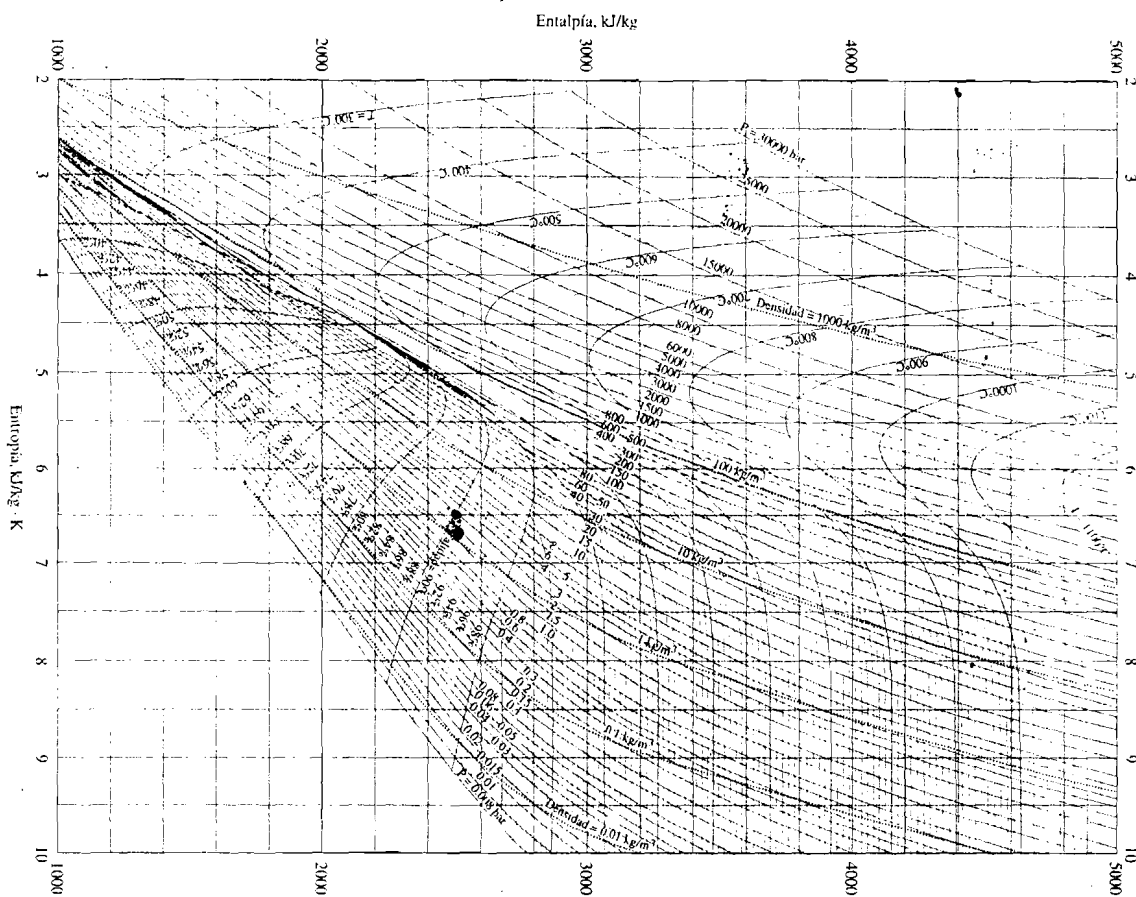


FIGURA A-10

Diagrama de Mollier para el agua.

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TABLA A-11

Refrigerante 134a saturado. Tabla de temperatura

Temp., °C	Pres. sat., kPa	Volumen específico, m³/kg		Energía interna, kJ/kg			Entalpía, kJ/kg			Entropía, kJ/kg · K		
		Líqu. sat., v_f	Vapor sat., v_g	Líqu. sat., u_f	Evap., u_{fg}	Vapor sat., u_g	Líqu. sat., h_f	Evap., h_{fg}	Vapor sat., h_g	Líqu. sat., s_f	Evap., s_{fg}	Vapor sat., s_g
-40	51.25	0.0007054	0.36081	-0.036	207.40	207.37	0.000	225.86	225.86	0.00000	0.96866	0.96866
-38	56.86	0.0007083	0.32732	2.475	206.04	208.51	2.515	224.61	227.12	0.01072	0.95511	0.96584
-36	62.95	0.0007112	0.29751	4.992	204.67	209.66	5.037	223.35	228.39	0.02138	0.94176	0.96315
-34	69.56	0.0007142	0.27090	7.517	203.29	210.81	7.566	222.09	229.65	0.03199	0.92859	0.96058
-32	76.71	0.0007172	0.24711	10.05	201.91	211.96	10.10	220.81	230.91	0.04253	0.91560	0.95813
30	84.43	0.0007203	0.22580	12.59	200.52	213.11	12.65	219.52	232.17	0.05301	0.90278	0.95579
28	92.76	0.0007234	0.20666	-15.13	199.12	214.25	15.20	218.22	233.43	0.06344	0.89012	0.95356
26	101.73	0.0007265	0.18946	17.69	197.72	215.40	17.76	216.92	234.68	0.07382	0.87762	0.95144
24	111.37	0.0007297	0.17395	20.25	196.30	216.55	20.33	215.59	235.92	0.08414	0.86527	0.94941
22	121.72	0.0007329	0.15995	22.82	194.88	217.70	22.91	214.26	237.17	0.09441	0.85307	0.94748
20	132.82	0.0007362	0.14729	25.39	193.45	218.84	25.49	212.91	238.41	0.10463	0.84101	0.94564
18	144.69	0.0007396	0.13583	27.98	192.01	219.98	28.09	211.55	239.64	0.11481	0.82908	0.94389
16	157.38	0.0007430	0.12542	30.57	190.56	221.13	30.69	210.18	240.87	0.12493	0.81729	0.94222
14	170.93	0.0007464	0.11597	33.17	189.09	222.27	33.30	208.79	242.09	0.13501	0.80561	0.94063
12	185.37	0.0007499	0.10736	35.78	187.62	223.40	35.92	207.38	243.30	0.14504	0.79406	0.93911
10	200.74	0.0007535	0.099516	38.40	186.14	224.54	38.55	205.96	244.51	0.15504	0.78263	0.93766
-8	217.08	0.0007571	0.092352	41.03	184.64	225.67	41.19	204.52	245.72	0.16498	0.77130	0.93629
6	234.44	0.0007608	0.085802	43.66	183.13	226.80	43.84	203.07	246.91	0.17489	0.76008	0.93497
4	252.85	0.0007646	0.079804	46.31	181.61	227.92	46.50	201.60	248.10	0.18476	0.74896	0.93372
-2	272.36	0.0007684	0.074304	48.96	180.08	229.04	49.17	200.11	249.28	0.19459	0.73794	0.93253
0	293.01	0.0007723	0.069255	51.63	178.53	230.16	51.86	198.60	250.45	0.20439	0.72701	0.93139
2	314.84	0.0007763	0.064612	54.30	176.97	231.27	54.55	197.07	251.61	0.21415	0.71616	0.93031
4	337.90	0.0007804	0.060338	56.99	175.39	232.38	57.25	195.51	252.77	0.22387	0.70540	0.92927
6	362.23	0.0007845	0.056398	59.68	173.80	233.48	59.97	193.94	253.91	0.23356	0.69471	0.92828
8	387.88	0.0007887	0.052762	62.39	172.19	234.58	62.69	192.35	255.04	0.24323	0.68410	0.92733
0	414.89	0.0007930	0.049403	65.10	170.55	235.67	65.43	190.73	256.16	0.25286	0.67356	0.92641
2	443.31	0.0007975	0.046295	67.83	168.92	236.75	68.18	189.09	257.27	0.26246	0.66308	0.92554
4	473.19	0.0008020	0.043417	70.57	167.26	237.83	70.95	187.42	258.37	0.27204	0.65266	0.92470
6	504.58	0.0008066	0.040748	73.32	165.58	238.90	73.73	185.73	259.46	0.28159	0.64230	0.92389
8	537.52	0.0008113	0.038271	76.08	163.88	239.96	76.52	184.01	260.53	0.29112	0.63198	0.92310

TABLA A-11

Refrigerante 134a saturado. Tabla de temperatura (conclusión)

Temp., T °C	Pres. sat., kPa	Volumen específico, m³/kg		Energía interna, kJ/kg			Entalpía, kJ/kg			Entropía, kJ/kg · K		
		Líqu. sat., v_f	Vapor sat., v_g	Líqu. sat., u_f	Evap., u_{fg}	Vapor sat., u_g	Líqu. sat., h_f	Evap., h_{fg}	Vapor sat., h_g	Líqu. sat., s_f	Evap., s_{fg}	Vapor sat., s_g
20	572.07	0.0008161	0.035969	78.86	162.16	241.02	79.32	182.27	261.59	0.30063	0.62172	0.92234
22	608.27	0.0008210	0.033828	81.64	160.42	242.06	82.14	180.49	262.64	0.31011	0.61149	0.92160
24	646.18	0.0008261	0.031834	84.44	158.65	243.10	84.98	178.69	263.67	0.31958	0.60130	0.92088
26	685.84	0.0008313	0.029976	87.26	156.87	244.12	87.83	176.85	264.68	0.32903	0.59115	0.92018
28	727.31	0.0008365	0.028242	90.09	155.05	245.14	90.69	174.99	265.68	0.33846	0.58102	0.91948
30	770.64	0.0008421	0.026622	92.93	153.22	246.14	93.58	173.08	266.66	0.34789	0.57091	0.91879
32	815.89	0.0008478	0.025108	95.79	151.35	247.14	96.48	171.14	267.62	0.35730	0.56082	0.91811
34	863.11	0.0008536	0.023691	98.66	149.46	248.12	99.40	169.17	268.57	0.36670	0.55074	0.91743
36	912.35	0.0008595	0.022364	101.55	147.54	249.08	102.33	167.16	269.49	0.37609	0.54066	0.91675
38	963.68	0.0008657	0.021119	104.45	145.58	250.04	105.29	165.10	270.39	0.38548	0.53058	0.91606
40	1017.1	0.0008720	0.019952	107.38	143.60	250.97	108.26	163.00	271.27	0.39486	0.52049	0.91536
42	1072.8	0.0008786	0.018855	110.32	141.58	251.89	111.26	160.86	272.12	0.40425	0.51039	0.91464
44	1130.7	0.0008854	0.017824	113.28	139.52	252.80	114.28	158.67	272.95	0.41363	0.50027	0.91391
46	1191.0	0.0008924	0.016853	116.26	137.42	253.68	117.32	156.43	273.75	0.42302	0.49012	0.91315
48	1253.6	0.0008996	0.015939	119.26	135.29	254.55	120.39	154.14	274.53	0.43242	0.47993	0.91236
52	1386.2	0.0009150	0.014265	125.33	130.88	256.21	126.59	149.39	275.98	0.45126	0.45941	0.91067
56	1529.1	0.0009317	0.012771	131.49	126.28	257.77	132.91	144.38	277.30	0.47018	0.43863	0.90880
60	1682.8	0.0009498	0.011434	137.76	121.46	259.22	139.36	139.10	278.46	0.48920	0.41749	0.90669
65	1891.0	0.0009750	0.009950	145.77	115.05	260.82	147.62	132.02	279.64	0.51320	0.39039	0.90359
70	2118.2	0.0010037	0.008642	154.01	108.14	262.15	156.13	124.32	280.46	0.53755	0.36227	0.89982
75	2365.8	0.0010372	0.007480	162.53	100.60	263.13	164.98	115.85	280.82	0.56241	0.33272	0.89512
80	2635.3	0.0010772	0.006436	171.40	92.23	263.63	174.24	106.35	280.59	0.58800	0.30111	0.88912
85	2928.2	0.0011270	0.005486	180.77	82.67	263.44	184.07	95.44	279.51	0.61473	0.26644	0.88117
90	3246.9	0.0011932	0.004599	190.89	71.29	262.18	194.76	82.35	277.11	0.64336	0.22674	0.87010
95	3594.1	0.0012933	0.003726	202.40	56.47	258.87	207.05	65.21	272.26	0.67578	0.17711	0.85289
100	3975.1	0.0015269	0.002630	218.72	29.19	247.91	224.79	33.58	258.37	0.72217	0.08999	0.81215

Fuente: Las tablas A-11 a A-13 se generaron utilizando el programa para resolver ecuaciones de ingeniería (EES) desarrollado por S. A. Klein y F. L. Alvarado. La rutina utilizada en los cálculos es la R134a, la cual está basada en la ecuación fundamental de estado desarrollada por R. Tillner-Roth y H. D. Baehr, "An International Standard Formulation for the Thermodynamic Properties of 1,1,1,2-Tetrafluoroethane (HFC-134a) for temperatures from 170 K to 455 K and pressures up to 70 MPa", *J. Phys. Chem. Ref. Data*, Vol. 23, No. 5, 1994. Los valores de entalpía y entropía para el líquido saturado son cero a -40°C (y -40°F).

TABLA A-12

Refrigerante 134a saturado. Tabla de presión

Pres., P kPa	Temp. sat., T_{sat} °C	Volumen específico, m^3/kg		Energía interna, kJ/kg		Entalpía, kJ/kg		Entropía, kJ/kg · K	
		Líqu. sat., v_f	Vapor sat., v_g	Líqu. sat., u_f	Vapor sat., u_g	Líqu. sat., h_f	Vapor sat., h_g	Líqu. sat., s_f	Vapor sat., s_g
60	-36.95	0.0007098	0.31121	3.798	205.32	209.12	3.841	223.95	227.79
70	-33.87	0.0007144	0.26929	7.680	203.20	210.88	7.730	222.00	229.73
80	-31.13	0.0007185	0.23753	11.15	201.30	212.46	11.21	220.25	231.46
90	-28.65	0.0007223	0.21263	14.31	199.57	213.88	14.37	218.65	233.02
100	-26.37	0.0007259	0.19254	17.21	197.98	215.19	17.28	217.16	234.44
120	-22.32	0.0007324	0.16212	22.40	195.11	217.51	22.49	214.48	236.97
140	-18.77	0.0007383	0.14014	26.98	192.57	219.54	27.08	212.08	239.16
160	-15.60	0.0007437	0.12348	31.09	190.27	221.35	31.21	209.90	241.11
180	-12.73	0.0007487	0.11041	34.83	188.16	222.99	34.97	207.90	242.86
200	-10.09	0.0007533	0.099867	38.28	186.21	224.48	38.43	206.03	244.46
240	-5.38	0.0007620	0.083897	44.48	182.67	227.14	44.66	202.62	247.28
280	-1.25	0.0007699	0.072352	49.97	179.50	229.46	50.18	199.54	249.72
320	2.46	0.0007772	0.063604	54.92	176.61	231.52	55.16	196.71	251.88
360	5.82	0.0007841	0.056738	59.44	173.94	233.38	59.72	194.08	253.81
400	8.91	0.0007907	0.051201	63.62	171.45	235.07	63.94	191.62	255.55
450	12.46	0.0007985	0.045619	68.45	168.54	237.00	68.81	188.71	257.53
500	15.71	0.0008059	0.041118	72.93	165.82	238.75	73.33	185.98	259.30
550	18.73	0.0008130	0.037408	77.10	163.25	240.35	77.54	183.38	260.92
600	21.55	0.0008199	0.034295	81.02	160.81	241.83	81.51	180.90	262.40
650	24.20	0.0008266	0.031646	84.72	158.48	243.20	85.26	178.51	263.77
700	26.69	0.0008331	0.029361	88.24	156.24	244.48	88.82	176.21	265.03
750	29.06	0.0008395	0.027371	91.59	154.08	245.67	92.22	173.98	266.20
800	31.31	0.0008458	0.025621	94.79	152.00	246.79	95.47	171.82	267.29
850	33.45	0.0008520	0.024069	97.87	149.98	247.85	98.60	169.71	268.31
900	35.51	0.0008580	0.022683	100.83	148.01	248.85	101.61	167.66	269.26
950	37.48	0.0008641	0.021438	103.69	146.10	249.79	104.51	165.64	270.15
1000	39.37	0.0008700	0.020313	106.45	144.23	250.68	107.32	163.67	270.99
1200	46.29	0.0008934	0.016715	116.70	137.11	253.81	117.77	156.10	273.87
1400	52.40	0.0009166	0.014107	125.94	130.43	256.37	127.22	148.90	276.12
1600	57.88	0.0009400	0.012123	134.43	124.04	258.47	135.93	141.93	277.86
1800	62.87	0.0009639	0.010559	142.33	117.83	260.17	144.07	135.11	279.17
2000	67.45	0.0009886	0.009288	149.78	111.73	261.51	151.76	128.33	280.09
2500	77.54	0.0010566	0.006936	166.99	96.47	263.45	169.63	111.16	280.79
3000	86.16	0.0011406	0.005275	183.04	80.22	263.26	186.46	92.63	279.09

TABLA A-13

Refrigerante 134a sobrecalentado

T °C	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg · K
P = 0.06 MPa (T _{sat} = -36.95°C)				P = 0.10 MPa (T _{sat} = -26.37°C)				P = 0.14 MPa (T _{sat} = -18.77°C)				
Sat.	0.31121	209.12	227.79	0.9644	0.19254	215.19	234.44	0.9518	0.14014	219.54	239.16	0.9446
-20	0.33608	220.60	240.76	1.0174	0.19841	219.66	239.50	0.9721				
-10	0.35048	227.55	248.58	1.0477	0.20743	226.75	247.49	1.0030	0.14605	225.91	246.36	0.9724
0	0.36476	234.66	256.54	1.0774	0.21630	233.95	255.58	1.0332	0.15263	233.23	254.60	1.0031
10	0.37893	241.92	264.66	1.1066	0.22506	241.30	263.81	1.0628	0.15908	240.66	262.93	1.0331
20	0.39302	249.35	272.94	1.1353	0.23373	248.79	272.17	1.0918	0.16544	248.22	271.38	1.0624
30	0.40705	256.95	281.37	1.1636	0.24233	256.44	280.68	1.1203	0.17172	255.93	279.97	1.0912
40	0.42102	264.71	289.97	1.1915	0.25088	264.25	289.34	1.1484	0.17794	263.79	288.70	1.1195
50	0.43495	272.64	298.74	1.2191	0.25937	272.22	298.16	1.1762	0.18412	271.79	297.57	1.1474
60	0.44883	280.73	307.66	1.2463	0.26783	280.35	307.13	1.2035	0.19025	279.95	306.59	1.1749
70	0.46269	288.99	316.75	1.2732	0.27626	288.64	316.26	1.2305	0.19635	288.28	315.77	1.2020
80	0.47651	297.41	326.00	1.2997	0.28465	297.08	325.55	1.2572	0.20242	296.75	325.09	1.2288
90	0.49032	306.00	335.42	1.3260	0.29303	305.69	334.99	1.2836	0.20847	305.38	334.57	1.2553
100	0.50410	314.74	344.99	1.3520	0.30138	314.46	344.60	1.3096	0.21449	314.17	344.20	1.2814
P = 0.18 MPa (T _{sat} = -12.73°C)				P = 0.20 MPa (T _{sat} = -10.09°C)				P = 0.24 MPa (T _{sat} = -5.38°C)				
Sat.	0.11041	222.99	242.86	0.9397	0.09987	224.48	244.46	0.9377	0.08390	227.14	247.28	0.9346
-10	0.11189	225.02	245.16	0.9484	0.09991	224.55	244.54	0.9380				
0	0.11722	232.48	253.58	0.9798	0.10481	232.09	253.05	0.9698	0.08617	231.29	251.97	0.9519
10	0.12240	240.00	262.04	1.0102	0.10955	239.67	261.58	1.0004	0.09026	238.98	260.65	0.9831
20	0.12748	247.64	270.59	1.0399	0.11418	247.35	270.18	1.0303	0.09423	246.74	269.36	1.0134
30	0.13248	255.41	279.25	1.0690	0.11874	255.14	278.89	1.0595	0.09812	254.61	278.16	1.0429
40	0.13741	263.31	288.05	1.0975	0.12322	263.08	287.72	1.0882	0.10193	262.59	287.06	1.0718
50	0.14230	271.36	296.98	1.1256	0.12766	271.15	296.68	1.1163	0.10570	270.71	296.08	1.1001
60	0.14715	279.56	306.05	1.1532	0.13206	279.37	305.78	1.1441	0.10942	278.97	305.23	1.1280
70	0.15196	287.91	315.27	1.1805	0.13641	287.73	315.01	1.1714	0.11310	287.36	314.51	1.1554
80	0.15673	296.42	324.63	1.2074	0.14074	296.25	324.40	1.1983	0.11675	295.91	323.93	1.1825
90	0.16149	305.07	334.14	1.2339	0.14504	304.92	333.93	1.2249	0.12038	304.60	333.49	1.2092
100	0.16622	313.88	343.80	1.2602	0.14933	313.74	343.60	1.2512	0.12398	313.44	343.20	1.2356
P = 0.28 MPa (T _{sat} = -1.25°C)				P = 0.32 MPa (T _{sat} = 2.45°C)				P = 0.40 MPa (T _{sat} = 8.91°C)				
Sat.	0.07235	229.46	249.72	0.9321	0.06360	231.52	251.88	0.9301	0.051201	235.07	255.55	0.9269
0	0.07282	230.44	250.83	0.9362								
10	0.07646	238.27	259.68	0.9680	0.06609	237.54	258.69	0.9544	0.051506	235.97	256.58	0.9305
20	0.07997	246.13	268.52	0.9987	0.06925	245.50	267.66	0.9856	0.054213	244.18	265.86	0.9628
30	0.08338	254.06	277.41	1.0285	0.07231	253.50	276.65	1.0157	0.056796	252.36	275.07	0.9937
40	0.08672	262.10	286.38	1.0576	0.07530	261.60	285.70	1.0451	0.059292	260.58	284.30	1.0236
50	0.09000	270.27	295.47	1.0862	0.07823	269.82	294.85	1.0739	0.061724	268.90	293.59	1.0528
60	0.09324	278.56	304.67	1.1142	0.08111	278.15	304.11	1.1021	0.064104	277.32	302.96	1.0814
70	0.09644	286.99	314.00	1.1418	0.08395	286.62	313.48	1.1298	0.066443	285.86	312.44	1.1094
80	0.09961	295.57	323.46	1.1690	0.08675	295.22	322.98	1.1571	0.068747	294.53	322.02	1.1369
90	0.10275	304.29	333.06	1.1958	0.08953	303.97	332.62	1.1840	0.071023	303.32	331.73	1.1640
100	0.10587	313.15	342.80	1.2222	0.09229	312.86	342.39	1.2105	0.073274	312.26	341.57	1.1907
110	0.10897	322.16	352.68	1.2483	0.09503	321.89	352.30	1.2367	0.075504	321.33	351.53	1.2171
120	0.11205	331.32	362.70	1.2742	0.09775	331.07	362.35	1.2626	0.077717	330.55	361.63	1.2431
130	0.11512	340.63	372.87	1.2997	0.10045	340.39	372.54	1.2882	0.079913	339.90	371.87	1.2688
140	0.11818	350.09	383.18	1.3250	0.10314	349.86	382.87	1.3135	0.082096	349.41	382.24	1.2942

TABLA A-13

Refrigerante 134a sobrecalentado (conclusión)

Refrigerante 134a sobrefundido (continued)														
T °C	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/kg · K	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/kg · K		
P = 0.50 MPa (T _{sat} = 15.71 °C)					P = 0.60 MPa (T _{sat} = 21.55 °C)					P = 0.70 MPa (T _{sat} = 26.69 °C)				
Sat.	0.041118	238.75	259.30	0.9240	0.034295	241.83	262.40	0.9218	0.029361	244.48	265.03	0.9199		
20	0.042115	242.40	263.46	0.9383										
30	0.044338	250.84	273.01	0.9703	0.035984	249.22	270.81	0.9499	0.029966	247.48	268.45	0.9313		
40	0.046456	259.26	282.48	1.0011	0.037865	257.86	280.58	0.9816	0.031696	256.39	278.57	0.9641		
50	0.048499	267.72	291.96	1.0309	0.039659	266.48	290.28	1.0121	0.033322	265.20	288.53	0.9954		
60	0.050485	276.25	301.50	1.0599	0.041389	275.15	299.98	1.0417	0.034875	274.01	298.42	1.0256		
70	0.052427	284.89	311.10	1.0883	0.043069	283.89	309.73	1.0705	0.036373	282.87	308.33	1.0549		
80	0.054331	293.64	320.80	1.1162	0.044710	292.73	319.55	1.0987	0.037829	291.80	318.28	1.0835		
90	0.056205	302.51	330.61	1.1436	0.046318	301.67	329.46	1.1264	0.039250	300.82	328.29	1.1114		
100	0.058053	311.50	340.53	1.1705	0.047900	310.73	339.47	1.1536	0.040642	309.95	338.40	1.1389		
110	0.059880	320.63	350.57	1.1971	0.049458	319.91	349.59	1.1803	0.042010	319.19	348.60	1.1658		
120	0.061687	329.89	360.73	1.2233	0.050997	329.23	359.82	1.2067	0.043358	328.55	358.90	1.1924		
130	0.063479	339.29	371.03	1.2491	0.052519	338.67	370.18	1.2327	0.044688	338.04	369.32	1.2186		
140	0.065256	348.83	381.46	1.2747	0.054027	348.25	380.66	1.2584	0.046004	347.66	379.86	1.2444		
150	0.067021	358.51	392.02	1.2999	0.055522	357.96	391.27	1.2838	0.047306	357.41	390.52	1.2699		
160	0.068775	368.33	402.72	1.3249	0.057006	367.81	402.01	1.3088	0.048597	367.29	401.31	1.2951		
P = 0.80 MPa (T _{sat} = 31.31 °C)					P = 0.90 MPa (T _{sat} = 35.51 °C)					P = 1.00 MPa (T _{sat} = 39.37 °C)				
Sat.	0.025621	246.79	267.29	0.9183	0.022683	248.85	269.26	0.9169	0.020313	250.68	270.99	0.9156		
40	0.027035	254.82	276.45	0.9480	0.023375	253.13	274.17	0.9327	0.020406	251.30	271.71	0.9179		
50	0.028547	263.86	286.69	0.9802	0.024809	262.44	284.77	0.9660	0.021796	260.94	282.74	0.9525		
60	0.029973	272.83	296.81	1.0110	0.026146	271.60	295.13	0.9976	0.023068	270.32	293.38	0.9850		
70	0.031340	281.81	306.88	1.0408	0.027413	280.72	305.39	1.0280	0.024261	279.59	303.85	1.0160		
80	0.032659	290.84	316.97	1.0698	0.028630	289.86	315.63	1.0574	0.025398	288.86	314.25	1.0458		
90	0.033941	299.95	327.10	1.0981	0.029806	299.06	325.89	1.0860	0.026492	298.15	324.64	1.0748		
100	0.035193	309.15	337.30	1.1258	0.030951	308.34	336.19	1.1140	0.027552	307.51	335.06	1.1031		
110	0.036420	318.45	347.59	1.1530	0.032068	317.70	346.56	1.1414	0.028584	316.94	345.53	1.1308		
120	0.037625	327.87	357.97	1.1798	0.033164	327.18	357.02	1.1684	0.029592	326.47	356.06	1.1580		
130	0.038813	337.40	368.45	1.2061	0.034241	336.76	367.58	1.1949	0.030581	336.11	366.69	1.1846		
140	0.039985	347.06	379.05	1.2321	0.035302	346.46	378.23	1.2210	0.031554	345.85	377.40	1.2109		
150	0.041143	356.85	389.76	1.2577	0.036349	356.28	389.00	1.2467	0.032512	355.71	388.22	1.2368		
160	0.042290	366.76	400.59	1.2830	0.037384	366.23	399.88	1.2721	0.033457	365.70	399.15	1.2623		
170	0.043427	376.81	411.55	1.3080	0.038408	376.31	410.88	1.2972	0.034392	375.81	410.20	1.2875		
180	0.044554	386.99	422.64	1.3327	0.039423	386.52	422.00	1.3221	0.035317	386.04	421.36	1.3124		
P = 1.20 MPa (T _{sat} = 45.29 °C)					P = 1.40 MPa (T _{sat} = 52.40 °C)					P = 1.60 MPa (T _{sat} = 57.83 °C)				
Sat.	0.016715	253.81	273.87	0.9130	0.014107	256.37	276.12	0.9105	0.012123	258.47	277.86	0.9078		
50	0.017201	257.63	278.27	0.9267										
60	0.018404	267.56	289.64	0.9614	0.015005	264.46	285.47	0.9389	0.012372	260.89	280.69	0.9163		
70	0.019502	277.21	300.61	0.9938	0.016060	274.62	297.10	0.9733	0.013430	271.76	293.25	0.9535		
80	0.020529	286.75	311.39	1.0248	0.017023	284.51	308.34	1.0056	0.014362	282.09	305.07	0.9875		
90	0.021506	296.26	322.07	1.0546	0.017923	294.28	319.37	1.0364	0.015215	292.17	316.52	1.0194		
100	0.022442	305.80	332.73	1.0836	0.018778	304.01	330.30	1.0661	0.016014	302.14	327.76	1.0500		
110	0.023348	315.38	343.40	1.1118	0.019597	313.76	341.19	1.0949	0.016773	312.07	338.91	1.0795		
120	0.024228	325.03	354.11	1.1394	0.020388	323.55	352.09	1.1230	0.017500	322.02	350.02	1.1081		
130	0.025086	334.77	364.88	1.1664	0.021155	333.41	363.02	1.1504	0.018201	332.00	361.12	1.1360		
140	0.025927	344.61	375.72	1.1930	0.021904	343.34	374.01	1.1773	0.018882	342.05	372.26	1.1632		
150	0.026753	354.56	386.66	1.2192	0.022636	353.37	385.07	1.2038	0.019545	352.17	383.44	1.1900		
160	0.027566	364.61	397.69	1.2449	0.023355	363.51	396.20	1.2298	0.020194	362.38	394.69	1.2163		
170	0.028367	374.78	408.82	1.2703	0.024061	373.75	407.43	1.2554	0.020830	372.69	406.02	1.2421		
180	0.029158	385.08	420.07	1.2954	0.024757	384.10	418.76	1.2807	0.021456	383.11	417.44	1.2676		

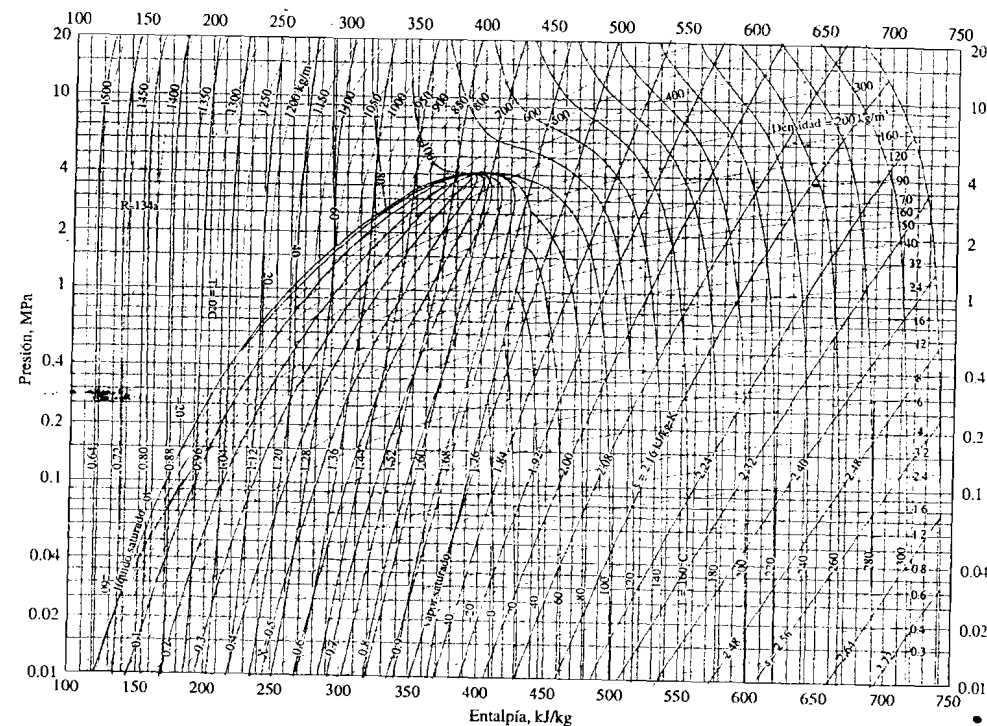


FIGURA A-14

Diagrama P - h para el refrigerante 134a.

Nota: El punto de referencia utilizado para la gráfica es diferente al empleado en las tablas de R-134a. Por lo tanto, los problemas deberán resolverse utilizando todos los datos de propiedades obtenidos, ya sea de las tablas o de la gráfica, pero no de ambas.

Reimpreso con autorización de la American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, Georgia.

TABLA A.2SI Propiedades termodinámicas del amoníaco
TABLA A.2.1SI Amoníaco saturado (unidades SI)

Temp. °C	Presión abs. kPa, <i>P</i>	Volumen específico, m ³ /kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado <i>v_f</i>	Evap. <i>v_{fg}</i>	Vapor saturado <i>v_g</i>	Líquido saturado <i>h_f</i>	Evap. <i>h_{fg}</i>	Vapor saturado <i>h_g</i>	Líquido saturado <i>s_f</i>	Evap. <i>s_{fg}</i>	Vapor saturado <i>s_g</i>
-50	40.86	0.001424	2.62524	2.62667	-43.76	1416.34	1372.57	-0.1916	6.3470	6.1553
-48	45.94	0.001429	2.35297	2.35440	-35.04	1410.95	1375.90	-0.1528	6.2666	6.1139
-46	51.52	0.001434	2.11359	2.11503	-26.31	1405.50	1379.19	-0.1142	6.1875	6.0733
-44	57.66	0.001439	1.90262	1.90406	-17.56	1400.00	1382.44	-0.0759	6.1095	6.0336
-42	64.38	0.001444	1.71625	1.71769	-8.79	1394.44	1385.65	-0.0378	6.0326	5.9948
-40	71.72	0.001450	1.55124	1.55269	0	1388.82	1388.82	0	5.9568	5.9568
-38	79.74	0.001455	1.40482	1.40627	8.81	1383.13	1391.94	0.0376	5.8820	5.9196
-36	88.48	0.001460	1.27461	1.27607	17.64	1377.39	1395.03	0.0749	5.8082	5.8831
-34	97.98	0.001465	1.15857	1.16004	26.49	1371.58	1398.07	0.1120	5.7353	5.8473
-32	108.29	0.001471	1.05496	1.05643	35.36	1365.70	1401.06	0.1489	5.6634	5.8123
-30	119.46	0.001476	0.96226	0.96374	44.26	1359.76	1404.01	0.1856	5.5924	5.7780
-28	131.54	0.001482	0.87916	0.88064	53.17	1353.74	1406.92	0.2220	5.5223	5.7443
-26	144.59	0.001487	0.80453	0.80602	62.11	1347.66	1409.77	0.2582	5.4530	5.7113
-24	158.65	0.001493	0.73738	0.73887	71.07	1341.51	1412.58	0.2942	5.3846	5.6788
-22	173.80	0.001498	0.67685	0.67835	80.05	1335.29	1415.34	0.3301	5.3170	5.6470
-20	190.08	0.001504	0.62220	0.62371	89.05	1329.00	1418.05	0.3657	5.2501	5.6158
-18	207.56	0.001510	0.57277	0.57428	98.08	1322.64	1420.71	0.4011	5.1840	5.5851
-16	226.29	0.001516	0.52800	0.52951	107.12	1316.20	1423.32	0.4363	5.1187	5.5550
-14	246.35	0.001522	0.48737	0.48889	116.19	1309.68	1425.88	0.4713	5.0541	5.5254
-12	267.79	0.001528	0.45045	0.45197	125.29	1303.09	1428.38	0.5061	4.9901	5.4963
-10	290.67	0.001534	0.41684	0.41837	134.41	1296.42	1430.83	0.5408	4.9269	5.4676
-8	315.08	0.001540	0.38621	0.38775	143.55	1289.67	1433.22	0.5753	4.8642	5.4395
-6	341.07	0.001546	0.35824	0.35979	152.72	1282.84	1435.56	0.6095	4.8023	5.4118
-4	368.72	0.001553	0.33268	0.33423	161.91	1275.93	1437.84	0.6437	4.7409	5.3846
-2	398.10	0.001559	0.30928	0.31084	171.12	1268.94	1440.06	0.6776	4.6801	5.3577

Temp. °C	Presión abs. kPa, <i>P</i>	Volumen específico, m ³ /kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado <i>v_f</i>	Evap. <i>v_{fg}</i>	Vapor saturado <i>v_g</i>	Líquido saturado <i>h_f</i>	Evap. <i>h_{fg}</i>	Vapor saturado <i>h_g</i>	Líquido saturado <i>s_f</i>	Evap. <i>s_{fg}</i>	Vapor saturado <i>s_g</i>
0	429.29	0.001566	0.28783	0.28940	180.36	1261.86	1442.22	0.7114	4.6199	5.3313
2	462.34	0.001573	0.26815	0.26972	189.63	1254.69	1444.32	0.7450	4.5603	5.3053
4	497.35	0.001579	0.25005	0.25163	198.93	1247.43	1446.35	0.7785	4.5012	5.2796
6	534.39	0.001586	0.23341	0.23499	208.25	1240.08	1448.32	0.8118	4.4426	5.2543
8	573.54	0.001593	0.21807	0.21966	217.60	1232.63	1450.23	0.8449	4.3845	5.2294
10	614.87	0.001600	0.20392	0.20553	226.97	1225.10	1452.07	0.8779	4.3269	5.2048
12	658.48	0.001608	0.19086	0.19247	236.38	1217.46	1453.84	0.9108	4.2698	5.1805
14	704.43	0.001615	0.17878	0.18040	245.81	1209.72	1455.53	0.9435	4.2131	5.1565
16	752.81	0.001623	0.16761	0.16923	255.28	1201.88	1457.16	0.9760	4.1568	5.1328
18	803.71	0.001630	0.15725	0.15888	264.77	1193.94	1458.71	1.0085	4.1009	5.1094
20	857.22	0.001638	0.14764	0.14928	274.30	1185.89	1460.18	1.0408	4.0455	5.0863
22	913.41	0.001646	0.13872	0.14037	283.85	1177.73	1461.58	1.0730	3.9904	5.0634
24	972.38	0.001654	0.13043	0.13208	293.44	1169.45	1462.89	1.1050	3.9357	5.0407
26	1034.21	0.001663	0.12272	0.12438	303.07	1161.06	1464.13	1.1370	3.8813	5.0182
28	1099.00	0.001671	0.11553	0.11720	312.72	1152.55	1465.27	1.1688	3.8272	4.9960
30	1166.83	0.001680	0.10883	0.11051	322.42	1143.92	1466.33	1.2005	3.7735	4.9740
32	1237.80	0.001688	0.10258	0.10427	332.14	1135.16	1467.30	1.2321	3.7200	4.9521
34	1312.00	0.001697	0.09675	0.09845	341.91	1126.27	1468.17	1.2635	3.6669	4.9304
36	1389.52	0.001707	0.09129	0.09300	351.71	1117.25	1468.95	1.2949	3.6140	4.9089
38	1470.46	0.001716	0.08619	0.08790	361.55	1108.09	1469.64	1.3262	3.5613	4.8875
40	1554.92	0.001725	0.08141	0.08313	371.43	1098.79	1470.22	1.3574	3.5088	4.8662
42	1642.98	0.001735	0.07693	0.07866	381.35	1089.34	1470.69	1.3885	3.4566	4.8451
44	1734.75	0.001745	0.07272	0.07447	391.31	1079.75	1471.06	1.4195	3.4045	4.8240
46	1830.33	0.001755	0.06878	0.07053	401.32	1070.00	1471.32	1.4504	3.3526	4.8030
48	1929.82	0.001766	0.06507	0.06684	411.38	1060.09	1471.46	1.4813	3.3009	4.7822
50	2033.32	0.001777	0.06159	0.06336	421.48	1050.01	1471.49	1.5121	3.2493	4.7613

TABLA A.2.2SI Amoníaco sobrecalentado (unidades SI)

Presión abs. kPa, (T saturación)		Temperatura, °C											
		-20	-10	0	10	20	30	40	50	60	70	80	100
50 (-46.53)	v	2.4463	2.5471	2.6474	2.7472	2.8466	2.9458	3.0447	3.1435	3.2421	3.3406	3.4390	—
	h	1434.6	1455.7	1476.9	1498.1	1519.3	1540.6	1562.0	1583.5	1605.1	1626.9	1648.8	—
	s	6.3187	6.4006	6.4795	6.5556	6.6293	6.7008	6.7703	6.8379	6.9038	6.9682	7.0312	—
75 (-39.16)	v	1.6222	1.6905	1.7582	1.8255	1.8924	1.9591	2.0255	2.0917	2.1577	2.2237	2.2895	—
	h	1431.7	1453.3	1474.8	1496.2	1517.7	1539.2	1560.7	1582.4	1604.1	1626.0	1648.0	—
	s	6.1120	6.1954	6.2756	6.3527	6.4272	6.4993	6.5693	6.6373	6.7036	6.7683	6.8315	—
100 (-33.59)	v	1.2101	1.2621	1.3136	1.3647	1.4153	1.4657	1.5158	1.5658	1.6156	1.6652	1.7148	1.8137
	h	1428.8	1450.8	1472.6	1494.4	1516.1	1537.7	1559.5	1581.2	1603.1	1625.1	1647.1	1691.7
	s	5.9626	6.0477	6.1291	6.2073	6.2826	6.3553	6.4258	6.4943	6.5609	6.6258	6.6892	6.8120
125 (-29.06)	v	0.9627	1.0051	1.0468	1.0881	1.1290	1.1696	1.2100	1.2502	1.2903	1.3302	1.3700	1.4494
	h	1425.9	1448.3	1470.5	1492.5	1514.4	1536.3	1558.2	1580.1	1602.1	1624.1	1646.3	1691.0
	s	5.8446	5.9314	6.0141	6.0933	6.1694	6.2428	6.3138	6.3827	6.4496	6.5149	6.5785	6.7017
150 (-25.21)	v	0.7977	0.8336	0.8689	0.9037	0.9381	0.9723	1.0062	1.0398	1.0734	1.1068	1.1401	1.2065
	h	1422.9	1445.7	1468.3	1490.6	1512.8	1534.8	1556.9	1578.9	1601.0	1623.2	1645.4	1690.2
	s	5.7465	5.8349	5.9189	5.9992	6.0761	6.1502	6.2217	6.2910	6.3583	6.4238	6.4877	6.6112
200 (-18.85)	v	—	0.6193	0.6465	0.6732	0.6995	0.7255	0.7513	0.7769	0.8023	0.8275	0.8527	0.9028
	h	—	1440.6	1463.8	1486.8	1509.4	1531.9	1554.3	1576.6	1598.9	1621.3	1643.7	1688.8
	s	—	5.6791	5.7659	5.8484	5.9270	6.0025	6.0751	6.1453	6.2133	6.2794	6.3437	6.4679
250 (-13.65)	v	—	0.4905	0.5129	0.5348	0.5563	0.5774	0.5983	0.6190	0.6396	0.6600	0.6803	0.7206
	h	—	1435.3	1459.3	1482.9	1506.0	1529.0	1551.7	1574.3	1596.8	1619.4	1641.9	1687.3
	s	—	5.5544	5.6441	5.7288	5.8093	5.8861	5.9599	6.0309	6.0997	6.1663	6.2312	6.3561
300 (-9.22)	v	—	—	0.4238	0.4425	0.4608	0.4787	0.4964	0.5138	0.5311	0.5483	0.5653	0.5992
	h	—	—	1454.7	1478.9	1502.6	1525.9	1549.0	1571.9	1594.7	1617.5	1640.2	1685.8
	s	—	—	5.5420	5.6290	5.7113	5.7896	5.8645	5.9365	6.0060	6.0732	6.1385	6.2642

Presión abs. kPa. (T saturación)		Temperatura, °C											
		-20	-10	0	10	20	30	40	50	60	70	80	100
350 (-5.34)	v	—	—	0.3601	0.3765	0.3925	0.4081	0.4235	0.4386	0.4536	0.4685	0.4832	0.5124
	h	—	—	1449.9	1474.9	1499.1	1522.9	1546.3	1569.5	1592.6	1615.5	1638.4	1684.3
	s	—	—	5.4532	5.5427	5.6270	5.7068	5.7828	5.8557	5.9259	5.9938	6.0596	6.1860
400 (-1.87)	v	—	—	0.3123	0.3270	0.3413	0.3552	0.3688	0.3823	0.3955	0.4086	0.4216	0.4473
	h	—	—	1445.1	1470.7	1495.6	1519.8	1543.6	1567.1	1590.4	1613.6	1636.7	1682.8
	s	—	—	5.3741	5.4663	5.5525	5.6338	5.7111	5.7850	5.8560	5.9244	5.9907	6.1179
450 (1.27)	v	—	—	—	0.2885	0.3014	0.3140	0.3263	0.3384	0.3503	0.3620	0.3737	0.3967
	h	—	—	—	1466.5	1492.0	1516.7	1540.9	1564.7	1588.2	1611.6	1634.9	1681.3
	s	—	—	—	5.3972	5.4855	5.5685	5.6470	5.7219	5.7936	5.8627	5.9295	6.0575
		20	30	40	50	60	70	80	100	120	140	160	180
500 (4.15)	v	0.2695	0.2810	0.2923	0.3033	0.3141	0.3248	0.3353	0.3562	0.3768	0.3972	—	—
	h	1488.3	1513.5	1538.1	1562.3	1586.1	1609.6	1633.1	1679.8	1726.6	1773.8	—	—
	s	5.4244	5.5090	5.5889	5.6647	5.7373	5.8070	5.8744	6.0031	6.1253	6.2422	—	—
600 (9.29)	v	0.2215	0.2315	0.2412	0.2506	0.2598	0.2689	0.2778	0.2955	0.3128	0.3300	—	—
	h	1480.8	1507.1	1532.5	1557.3	1581.6	1605.7	1629.5	1676.8	1724.0	1771.5	—	—
	s	5.3156	5.4037	5.4862	5.5641	5.6383	5.7094	5.7778	5.9081	6.0314	6.1491	—	—
700 (13.81)	v	0.1872	0.1961	0.2046	0.2129	0.2210	0.2289	0.2367	0.2521	0.2671	0.2819	—	—
	h	1473.0	1500.4	1526.7	1552.2	1577.1	1601.6	1625.8	1673.7	1721.4	1769.2	—	—
	s	5.2196	5.3115	5.3968	5.4770	5.5529	5.6254	5.6949	5.8268	5.9512	6.0698	—	—
800 (17.86)	v	0.1614	0.1695	0.1772	0.1846	0.1919	0.1990	0.2059	0.2195	0.2328	0.2459	0.2589	—
	h	1464.9	1493.5	1520.8	1547.0	1572.5	1597.5	1622.1	1670.6	1718.7	1766.9	1815.3	—
	s	5.1328	5.2287	5.3171	5.3996	5.4774	5.5513	5.6219	5.7555	5.8811	6.0006	6.1150	—
900 (21.53)	v	—	0.1487	0.1558	0.1626	0.1692	0.1756	0.1819	0.1942	0.2061	0.2179	0.2295	—
	h	—	1486.5	1514.7	1541.7	1567.9	1593.3	1618.4	1667.5	1716.1	1764.5	1813.2	—
	s	—	5.1530	5.2447	5.3296	5.4093	5.4847	5.5565	5.6919	5.8187	5.9389	6.0541	—
1000 (24.91)	v	—	0.1321	0.1387	0.1450	0.1511	0.1570	0.1627	0.1739	0.1848	0.1955	0.2060	0.2164
	h	—	1479.1	1508.5	1536.3	1563.1	1589.1	1614.6	1664.3	1713.4	1762.2	1811.2	1860.5
	s	—	5.0826	5.1778	5.2654	5.3471	5.4240	5.4971	5.6342	5.7622	5.8834	5.9992	6.1105

TABLA A.2.2SI (Continuación) Amoníaco sobrecalentado (unidades SI)

Presión abs. kPa, (<i>T</i> saturación)		Temperatura, °C											
		40	50	60	70	80	100	120	140	160	180	200	220
1200 (30.95)	<i>v</i>	0.1129	0.1185	0.1238	0.1289	0.1339	0.1435	0.1527	0.1618	0.1707	0.1795	—	—
	<i>h</i>	1495.4	1525.1	1553.3	1580.5	1606.8	1658.0	1708.0	1757.5	1807.1	1856.9	—	—
	<i>s</i>	5.0564	5.1497	5.2357	5.3159	5.3916	5.5325	5.6631	5.7860	5.9031	6.0156	—	—
1400 (36.26)	<i>v</i>	0.0943	0.0994	0.1042	0.1088	0.1132	0.1217	0.1299	0.1378	0.1455	0.1532	—	—
	<i>h</i>	1481.6	1513.4	1543.1	1571.5	1598.8	1651.4	1702.5	1752.8	1802.9	1853.2	—	—
	<i>s</i>	4.9463	5.0462	5.1370	5.2209	5.2994	5.4443	5.5775	5.7023	5.8208	5.9343	—	—
1600 (41.03)	<i>v</i>	—	0.0851	0.0895	0.0937	0.0977	0.1054	0.1127	0.1197	0.1266	0.1334	—	—
	<i>h</i>	—	1501.0	1532.5	1562.3	1590.7	1644.8	1696.9	1748.0	1798.7	1849.5	—	—
	<i>s</i>	—	4.9510	5.0472	5.1351	5.2167	5.3659	5.5018	5.6286	5.7485	5.8631	—	—
1800 (45.37)	<i>v</i>	—	0.0738	0.0780	0.0819	0.0857	0.0927	0.0993	0.1057	0.1119	0.1180	—	—
	<i>h</i>	—	1487.9	1521.4	1552.7	1582.2	1638.0	1691.2	1743.1	1794.5	1845.7	—	—
	<i>s</i>	—	4.8614	4.9637	5.0561	5.1410	5.2948	5.4337	5.5624	5.6838	5.7995	—	—
2000 (49.36)	<i>v</i>	—	0.0647	0.0687	0.0725	0.0760	0.0825	0.0886	0.0945	0.1002	0.1057	—	—
	<i>h</i>	—	1473.9	1509.8	1542.7	1573.5	1631.1	1685.5	1738.2	1790.2	1842.0	—	—
	<i>s</i>	—	4.7754	4.8848	4.9821	5.0707	5.2294	5.3714	5.5022	5.6251	5.7420	—	—

TABLA A.3SI Propiedades termodinámicas del refrigerante-12 (diclorodifluorometano)

TABLA A.3.1SI R-12 saturado (unidades SI)

Temp. °C	Presión abs., MPa, P	Volumen específico, m³/kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado v_f	Evap. v_{fg}	Vapor saturado v_g	Líquido saturado h_f	Evap. h_{fg}	Vapor saturado h_g	Líquido saturado s_f	Evap. s_{fg}	Vapor saturado s_g
-90	0.00284	0.000608	4.414937	4.415545	-43.284	189.748	146.464	-0.20863	1.03593	0.82730
-85	0.00424	0.000612	3.036704	3.037316	-39.005	187.737	148.731	-0.18558	0.99771	0.81213
-80	0.00617	0.000617	2.137728	2.138345	-34.721	185.740	151.018	-0.16312	0.96155	0.79843
-75	0.00879	0.000622	1.537030	1.537651	-30.430	183.751	153.321	-0.14119	0.92725	0.78606
-70	0.01227	0.000627	1.126654	1.127280	-26.128	181.764	155.636	-0.11977	0.89465	0.77489
-65	0.01680	0.000632	0.840534	0.841166	-21.814	179.774	157.960	-0.09880	0.86361	0.76480
-60	0.02262	0.000637	0.637274	0.637911	-17.485	177.775	160.289	-0.07827	0.83397	0.75570
-55	0.02998	0.000642	0.490358	0.491000	-13.141	175.762	162.621	-0.05815	0.80563	0.74748
-50	0.03915	0.000648	0.382457	0.383105	-8.779	173.730	164.951	-0.03841	0.77848	0.74007
-45	0.05044	0.000654	0.302029	0.302682	-4.400	171.676	167.276	-0.01903	0.75241	0.73338
-40	0.06417	0.000659	0.241251	0.241910	0	169.595	169.595	0	0.72735	0.72735
-35	0.08071	0.000666	0.194732	0.195398	4.420	167.482	171.903	0.01871	0.70322	0.72193
-30	0.10041	0.000672	0.158703	0.159375	8.862	165.335	174.197	0.03711	0.67993	0.71704
-25	0.12368	0.000679	0.130487	0.131166	13.327	163.149	176.476	0.05522	0.65742	0.71264
-20	0.15093	0.000685	0.108162	0.108847	17.816	160.920	178.736	0.07306	0.63563	0.70869
-15	0.18260	0.000693	0.090326	0.091018	22.331	158.643	180.974	0.09063	0.61450	0.70513
-10	0.21912	0.000700	0.075946	0.076646	26.874	156.314	183.188	0.10796	0.59397	0.70194
-5	0.26096	0.000708	0.064255	0.064963	31.446	153.928	185.375	0.12506	0.57400	0.69907
0	0.30861	0.000716	0.054673	0.055389	36.052	151.479	187.531	0.14196	0.55453	0.69649
5	0.36255	0.000724	0.046761	0.047485	40.694	148.961	189.654	0.15865	0.53551	0.69416
10	0.42330	0.000733	0.040180	0.040914	45.375	146.365	191.740	0.17517	0.51689	0.69206
15	0.49137	0.000743	0.034671	0.035413	50.100	143.684	193.784	0.19154	0.49862	0.69015
20	0.56729	0.000752	0.030028	0.030780	54.874	140.909	195.783	0.20777	0.48064	0.68841
25	0.65162	0.000763	0.026091	0.026854	59.702	138.028	197.730	0.22388	0.46292	0.68680
30	0.74490	0.000774	0.022734	0.023508	64.592	135.028	199.620	0.23991	0.44539	0.68530
35	0.84772	0.000786	0.019855	0.020641	69.551	131.896	201.446	0.25587	0.42800	0.68387
40	0.96065	0.000798	0.017373	0.018171	74.587	128.613	203.200	0.27179	0.41068	0.68248
45	1.08432	0.000811	0.015220	0.016032	79.712	125.160	204.872	0.28771	0.39338	0.68109
50	1.21932	0.000826	0.013344	0.014170	84.936	121.514	206.450	0.30366	0.37601	0.67967
55	1.36630	0.000841	0.011701	0.012542	90.274	117.645	207.920	0.31967	0.35849	0.67817
60	1.52592	0.000858	0.010253	0.011111	95.743	113.521	209.264	0.33580	0.34073	0.67653
65	1.69884	0.000877	0.008971	0.009847	101.362	109.099	210.460	0.35209	0.32262	0.67471

TABLA A.3SI (Continuación) Propiedades termodinámicas del refrigerante-12 (diclorodifluorometano)

Temp. °C	Presión abs. MPa. P	Volumen específico, m ³ /kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado v_f	Evap. v_{fg}	Vapor saturado v_g	Líquido saturado h_f	Evap. h_{fg}	Vapor saturado h_g	Líquido saturado s_f	Evap. s_{fg}	Vapor saturado s_g
70	1.88578	0.000897	0.007828	0.008725	107.155	104.326	211.481	0.36861	0.30401	0.67262
75	2.08745	0.000920	0.006802	0.007723	113.153	99.136	212.288	0.38543	0.28474	0.67017
80	2.30460	0.000946	0.005875	0.006821	119.394	93.437	212.832	0.40265	0.26457	0.66722
85	2.53802	0.000976	0.005029	0.006005	125.932	87.107	213.039	0.42040	0.24320	0.66361
90	2.78850	0.001012	0.004246	0.005258	132.841	79.961	212.802	0.43887	0.22018	0.65905
95	3.05689	0.001056	0.003508	0.004563	140.235	71.707	211.942	0.45833	0.19477	0.65310
100	3.34406	0.001113	0.002790	0.003903	148.314	61.810	210.124	0.47928	0.16564	0.64492
105	3.65093	0.001197	0.002045	0.003242	157.521	49.047	206.568	0.50285	0.12970	0.63254
110	3.97846	0.001364	0.001098	0.002462	169.550	28.444	197.995	0.53334	0.07423	0.60758
112	4.11548	0.001792	0	0.001792	183.418	0	183.418	0.56888	0	0.56888

TABLA A.3.2SI (Continuación) Refrigerante-12 sobrecalentado (unidades SI)

Temp. °C	0.05 MPa			0.10 MPa			0.15 MPa		
	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K
-20	0.341859	181.170	0.79172	0.167702	179.987	0.74064	—	—	—
-10	0.356228	186.889	0.81388	0.175223	185.839	0.76331	0.114826	184.753	0.73240
0	0.370509	192.705	0.83557	0.182648	191.765	0.78541	0.119980	190.800	0.75495
10	0.384717	198.614	0.85681	0.189995	197.770	0.80700	0.125051	196.906	0.77660
20	0.398864	204.617	0.87764	0.197277	203.855	0.82812	0.130053	203.077	0.79832
30	0.412960	210.710	0.89808	0.204507	210.018	0.84879	0.135000	209.314	0.81924
40	0.427014	216.891	0.91814	0.211692	216.262	0.86905	0.139900	215.621	0.83971
50	0.441031	223.160	0.93784	0.218839	222.583	0.88892	0.144761	221.993	0.85975
60	0.455018	229.512	0.95720	0.225956	228.982	0.90842	0.149539	228.446	0.87940
70	0.468980	235.946	0.97623	0.233045	235.457	0.92757	0.154391	234.963	0.89867
80	0.482919	242.460	0.99494	0.240112	242.007	0.94638	0.159168	241.549	0.91759
90	0.496839	249.050	1.01334	0.247160	248.629	0.96487	0.163926	248.204	0.93617

Temp. °C	0.20 MPa			0.25 MPa			0.30 MPa		
	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K
0	0.088609	189.805	0.73249	0.069752	188.779	0.71437	0.057150	187.718	0.69894
10	0.092550	196.020	0.75484	0.073024	195.109	0.73713	0.059984	194.173	0.72215
20	0.096419	202.281	0.77657	0.076219	201.468	0.75920	0.062735	200.636	0.74458
30	0.100229	208.597	0.79775	0.079351	207.866	0.78066	0.065419	207.119	0.76633
40	0.103990	214.971	0.81843	0.082432	214.309	0.80157	0.068049	213.635	0.78747
50	0.107710	221.405	0.83866	0.085470	220.803	0.82198	0.070636	220.191	0.80808
60	0.111397	227.902	0.85846	0.088474	227.351	0.84193	0.073186	226.793	0.82820
70	0.115056	234.462	0.87786	0.091449	233.956	0.86147	0.075706	233.444	0.84787
80	0.118691	241.087	0.89689	0.094399	240.620	0.88061	0.078200	240.147	0.86712
90	0.122305	247.775	0.91556	0.097328	247.341	0.89937	0.080673	246.904	0.88599
100	0.125902	254.525	0.93390	0.100239	254.122	0.91779	0.083127	253.716	0.90449
110	0.129484	261.338	0.95191	0.103135	260.962	0.93588	0.085566	260.582	0.92265
Temp. °C	0.40 MPa			0.50 MPa			0.60 MPa		
	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K
20	0.045837	198.906	0.72043	0.035646	197.077	0.70043	—	—	—
30	0.047971	205.577	0.74281	0.037464	203.963	0.72352	0.030422	202.263	0.70679
40	0.050046	212.250	0.76447	0.039215	210.810	0.74574	0.031966	209.307	0.72965
50	0.052072	218.939	0.78549	0.040912	217.643	0.76722	0.033450	216.300	0.75163
60	0.054059	225.653	0.80595	0.042566	224.479	0.78806	0.034887	223.268	0.77287
70	0.056014	232.401	0.82591	0.044185	231.330	0.80832	0.036286	230.231	0.79346
80	0.057941	239.188	0.84540	0.045775	238.206	0.82807	0.037653	237.201	0.81348
90	0.059846	246.017	0.86447	0.047341	245.112	0.84735	0.038996	244.188	0.83299
100	0.061731	252.892	0.88315	0.048886	252.054	0.86621	0.040316	251.200	0.85214
110	0.063601	259.815	0.90145	0.050415	259.035	0.88467	0.041619	258.242	0.87066
120	0.065456	266.786	0.91941	0.051929	266.057	0.90276	0.042907	265.318	0.88888
130	0.067299	273.806	0.93704	0.053430	273.123	0.92050	0.044181	272.431	0.90675
Temp. °C	0.70 MPa			0.80 MPa			0.90 MPa		
	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K
40	0.026761	207.732	0.71529	0.022830	206.074	0.70210	0.019744	204.320	0.68972
50	0.028100	214.903	0.73783	0.024068	213.446	0.72527	0.020912	211.921	0.71361
60	0.029387	222.017	0.75951	0.025247	220.720	0.74744	0.022012	219.373	0.73633
70	0.030632	229.099	0.78045	0.026380	227.934	0.76878	0.023062	226.730	0.75808
80	0.031843	236.171	0.80076	0.027477	235.114	0.78940	0.024073	234.028	0.77905
90	0.033028	243.244	0.82051	0.028545	242.279	0.80941	0.025057	241.290	0.79932

TABLA A.3.2SI (Continuación) Refrigerante-12 sobrecalentado (unidades SI)

Temp. °C	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K
0.70 MPa			0.80 MPa			0.90 MPa			
100	0.034189	250.330	0.83976	0.029588	249.443	0.82887	0.026905	248.537	0.81901
110	0.035332	257.436	0.85855	0.030612	256.616	0.84784	0.026937	255.781	0.83817
120	0.036459	264.568	0.87693	0.031619	263.806	0.86636	0.027852	263.032	0.85685
130	0.037572	271.730	0.89492	0.032612	271.019	0.88448	0.028751	270.298	0.87510
140	0.038673	278.925	0.91254	0.033592	278.259	0.90221	0.029639	277.585	0.89295
150	0.039765	286.155	0.92984	0.034563	285.529	0.91960	0.030515	284.896	0.91043
1.00 MPa			1.20 MPa			1.40 MPa			
50	0.018366	210.317	0.70259	0.014483	206.813	0.68165	—	—	—
60	0.019410	217.970	0.72591	0.015463	214.964	0.70649	0.012579	211.613	0.68806
70	0.020397	225.485	0.74814	0.016368	222.851	0.72982	0.013448	219.984	0.71281
80	0.021341	232.910	0.76946	0.017221	230.568	0.75198	0.014247	228.059	0.73601
90	0.022251	240.278	0.79004	0.018032	238.171	0.77321	0.014997	235.940	0.75802
100	0.023133	247.612	0.80996	0.018812	245.699	0.79366	0.015710	243.692	0.77907
110	0.023993	254.931	0.82931	0.019567	253.180	0.81344	0.016393	251.355	0.79934
120	0.024835	262.246	0.84816	0.020301	260.632	0.83265	0.017053	258.961	0.81893
130	0.025661	269.567	0.86655	0.021018	268.072	0.85133	0.017695	266.530	0.83795
140	0.026474	276.902	0.88452	0.021721	275.509	0.86955	0.018321	274.078	0.85644
150	0.027275	284.255	0.90211	0.022412	282.952	0.88735	0.018934	281.618	0.87447
160	0.028068	291.632	0.91933	0.023093	290.408	0.90477	0.019535	289.158	0.89208
1.60 MPa			1.80 MPa			2.00 MPa			
70	0.011208	216.810	0.69641	0.009406	213.208	0.67992	—	—	—
80	0.011984	225.344	0.72092	0.010187	222.363	0.70622	0.008704	219.024	0.69143
90	0.012698	233.563	0.74387	0.010884	231.007	0.73036	0.009406	228.226	0.71713
100	0.013366	241.575	0.76564	0.011525	239.332	0.75297	0.010035	236.936	0.74079
110	0.014000	249.448	0.78646	0.012126	247.446	0.77443	0.010615	245.336	0.76300
120	0.014608	257.225	0.80649	0.012697	255.417	0.79497	0.011159	253.528	0.78411
130	0.015195	264.937	0.82586	0.013244	263.288	0.81474	0.011676	261.577	0.80433
140	0.015765	272.606	0.84465	0.013772	271.090	0.83385	0.012172	269.526	0.82380
150	0.016320	280.250	0.86293	0.014284	278.847	0.85240	0.012651	277.405	0.84265

Temp. °C	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K
	1.60 MPa			1.80 MPa			2.00 MPa		
160	0.016864	287.880	0.88076	0.014784	286.574	0.87045	0.013116	285.237	0.86094
170	0.017398	295.506	0.89816	0.015272	294.284	0.88805	0.013570	293.037	0.87874
180	0.017923	303.136	0.91519	0.015752	301.988	0.90524	0.014013	300.819	0.89611
	2.50 MPa			3.00 MPa			3.50 MPa		
90	0.006595	219.736	0.68284	—	—	—	—	—	—
100	0.007264	230.029	0.71081	0.005231	220.723	0.67755	—	—	—
110	0.007837	239.453	0.73573	0.005886	232.256	0.70806	0.004324	222.360	0.67559
120	0.008351	248.379	0.75873	0.006419	242.398	0.73420	0.004959	235.086	0.70840
130	0.008827	256.986	0.78035	0.006887	251.825	0.75788	0.005456	245.865	0.73548
140	0.009273	265.377	0.80091	0.007313	260.818	0.77991	0.005884	255.728	0.75965
150	0.009697	273.616	0.82062	0.007709	269.521	0.80072	0.006270	265.053	0.78195
160	0.010104	281.748	0.83961	0.008083	278.024	0.82059	0.006626	274.027	0.80291
170	0.010497	289.802	0.85799	0.008439	286.384	0.83967	0.006961	282.759	0.82284
180	0.010879	297.802	0.87584	0.008782	294.640	0.85809	0.007279	291.319	0.84194
190	0.011250	305.764	0.89322	0.009114	302.820	0.87594	0.007584	299.752	0.86035
200	0.011614	313.701	0.91018	0.009436	310.946	0.89330	0.007878	308.092	0.87816
	4.00 MPa			5.00 MPa					
120	0.003736	225.180	0.67769	0.001369	176.303	0.54710			
130	0.004325	238.691	0.71164	0.002501	216.458	0.64811			
140	0.004781	249.930	0.73918	0.003139	235.004	0.69359			
150	0.005172	260.124	0.76357	0.003585	248.416	0.72568			
160	0.005522	269.710	0.78596	0.003950	259.910	0.75253			
170	0.005845	278.903	0.80694	0.004268	270.400	0.77648			
180	0.006147	287.825	0.82685	0.004555	280.276	0.79851			
190	0.006434	296.552	0.84590	0.004821	289.740	0.81917			
200	0.006708	305.136	0.86424	0.005071	298.916	0.83877			
210	0.006972	313.614	0.88197	0.005308	307.882	0.85753			
220	0.007228	322.013	0.89917	0.005535	316.690	0.87557			
230	0.007477	330.352	0.91592	0.005753	325.380	0.89301			

TABLA A.4SI Propiedades termodinámicas del refrigerante-22 (clorodifluorometano)
TABLA A.4.1SI Refrigerante-22 saturado (unidades SI)

Temp. °C	Presión abs. MPa, P	Volumen específico, m ³ /kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado v_f	Evap. v_{fg}	Vapor saturado v_g	Líquido saturado h_f	Evap. h_{fg}	Vapor saturado h_g	Líquido saturado s_f	Evap. s_{fg}	Vapor saturado s_g
-70	0.0205	0.000670	0.940268	0.940938	-30.607	249.425	218.818	-0.1401	1.2277	1.0876
-65	0.0280	0.000676	0.704796	0.705472	-25.658	246.925	221.267	-0.1161	1.1862	1.0701
-60	0.0375	0.000682	0.536470	0.537152	-20.652	244.354	223.702	-0.0924	1.1463	1.0540
-55	0.0495	0.000689	0.414138	0.414827	-15.585	241.703	226.117	-0.0689	1.1079	1.0390
-50	0.0644	0.000695	0.323862	0.324557	-10.456	238.965	228.509	-0.0457	1.0708	1.0251
-45	0.0827	0.000702	0.256288	0.256990	-5.262	236.132	230.870	-0.0227	1.0349	1.0122
-40	0.1049	0.000709	0.205036	0.205745	0	233.198	233.197	0	1.0002	1.0002
-35	0.1317	0.000717	0.165683	0.166400	5.328	230.156	235.484	0.0225	0.9664	0.9889
-30	0.1635	0.000725	0.135120	0.135844	10.725	227.001	237.726	0.0449	0.9335	0.9784
-25	0.2010	0.000733	0.111126	0.111859	16.191	223.727	239.918	0.0670	0.9015	0.9685
-20	0.2448	0.000741	0.092102	0.092843	21.728	220.327	242.055	0.0890	0.8703	0.9593
-15	0.2957	0.000750	0.076876	0.077625	27.334	216.798	244.132	0.1107	0.8398	0.9505
-10	0.3543	0.000759	0.064581	0.065340	33.012	213.132	246.144	0.1324	0.8099	0.9422
-5	0.4213	0.000768	0.054571	0.055339	38.762	209.323	248.085	0.1538	0.7806	0.9344
0	0.4976	0.000778	0.046357	0.047135	44.586	205.364	249.949	0.1751	0.7518	0.9269
5	0.5838	0.000789	0.039567	0.040356	50.485	201.246	251.731	0.1963	0.7235	0.9197
10	0.6807	0.000800	0.033914	0.034714	56.463	196.960	253.423	0.2173	0.6956	0.9129
15	0.7891	0.000812	0.029176	0.029987	62.523	192.495	255.018	0.2382	0.6680	0.9062
20	0.9099	0.000824	0.025179	0.026003	68.670	187.836	256.506	0.2590	0.6407	0.8997
25	1.0439	0.000838	0.021787	0.022624	74.910	182.968	257.877	0.2797	0.6137	0.8934
30	1.1919	0.000852	0.018890	0.019742	81.250	177.869	259.119	0.3004	0.5867	0.8871
35	1.3548	0.000867	0.016401	0.017269	87.700	172.516	260.216	0.3210	0.5598	0.8809
40	1.5335	0.000884	0.014251	0.015135	94.272	166.877	261.149	0.3417	0.5329	0.8746
45	1.7290	0.000902	0.012382	0.013284	100.982	160.914	261.896	0.3624	0.5058	0.8682
50	1.9423	0.000922	0.010747	0.011669	107.851	154.576	262.428	0.3832	0.4783	0.8615
55	2.1744	0.000944	0.009308	0.010252	114.905	147.800	262.705	0.4042	0.4504	0.8546
60	2.4266	0.000969	0.008032	0.009001	122.180	140.497	262.678	0.4255	0.4217	0.8472
65	2.6999	0.000997	0.006890	0.007887	129.729	132.547	262.276	0.4472	0.3920	0.8391

Temp. °C	Presión abs. MPa, P	Volumen específico, m ³ /kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado v_f	Evap. v_{fg}	Vapor saturado v_g	Líquido saturado h_f	Evap. h_{fg}	Vapor saturado h_g	Líquido saturado s_f	Evap. s_{fg}	Vapor saturado s_g
70	2.9959	0.001030	0.005859	0.006889	137.625	123.772	261.397	0.4695	0.3607	0.8302
75	3.3161	0.001069	0.004914	0.005983	145.986	113.902	259.888	0.4927	0.3272	0.8198
80	3.6623	0.001118	0.004031	0.005149	155.011	102.475	257.486	0.5173	0.2902	0.8075
85	4.0368	0.001183	0.003175	0.004358	165.092	88.598	253.690	0.5445	0.2474	0.7918
90	4.4425	0.001282	0.002282	0.003564	177.204	70.037	247.241	0.5767	0.1929	0.7695
95	4.8835	0.001521	0.001030	0.002551	196.359	34.925	231.284	0.6273	0.0949	0.7222
96.006	4.9773	0.001906	0	0.001906	212.546	0	212.546	0.6708	0	0.6708

TABLA A.4.2SI Refrigerante-22 sobrecalentado (unidades SI)

Temp. °C	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K
	0.05 MPa			0.10 MPa			0.15 MPa		
-40	0.440633	234.724	1.07616	0.216331	233.337	1.00523	—	—	—
-30	0.460641	240.602	1.10084	0.226754	239.359	1.03052	0.148723	238.078	0.98773
-20	0.480543	246.586	1.12495	0.237064	245.466	1.05513	0.155851	244.319	1.01288
-10	0.500357	252.676	1.14855	0.247279	251.665	1.07914	0.162879	250.631	1.03733
0	0.520095	258.874	1.17166	0.257415	257.956	1.10261	0.169823	257.022	1.06116
10	0.539771	265.180	1.19433	0.267485	264.345	1.12558	0.176699	263.496	1.08444
20	0.559393	271.594	1.21659	0.277500	270.831	1.14809	0.183516	270.057	1.10721
30	0.578970	278.115	1.23846	0.287467	277.416	1.17017	0.190284	276.709	1.12952
40	0.598507	284.743	1.25998	0.297394	284.101	1.19187	0.197011	283.452	1.15140
50	0.618011	291.478	1.28114	0.307287	290.887	1.21320	0.203702	290.289	1.17289
60	0.637485	298.319	1.30199	0.317149	297.772	1.23418	0.210362	297.220	1.19402
70	0.656935	305.265	1.32253	0.326986	304.757	1.25484	0.216997	304.246	1.21479
80	0.676362	312.314	1.34278	0.336801	311.842	1.27519	0.223608	311.368	1.23525
90	0.695771	319.465	1.36275	0.346596	319.026	1.29524	0.230200	318.584	1.25540
	0.20 MPa			0.25 MPa			0.30 MPa		
-20	0.115203	243.140	0.98184	—	—	—	—	—	—
-10	0.120647	249.574	1.00676	0.095280	248.492	0.98231	0.078344	247.382	0.96170
0	0.126003	256.069	1.03098	0.099689	255.097	1.00695	0.082128	254.104	0.98677
10	0.131286	262.633	1.05458	0.104022	261.755	1.03089	0.085832	260.861	1.01106

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TABLA A.4.2SI Refrigerante-22 sobrecalentado (unidades SI)

Temp. °C	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K
0.20 MPa			0.25 MPa			0.30 MPa			
20	0.136509	269.273	1.07763	0.108292	268.476	1.05421	0.089469	267.667	1.03468
30	0.141681	275.992	1.10016	0.112508	275.267	1.07699	0.093051	274.531	1.05771
40	0.146809	282.796	1.12224	0.116681	282.132	1.09927	0.096588	281.460	1.08019
50	0.151902	289.686	1.14390	0.120815	289.076	1.12109	0.100085	288.460	1.10220
60	0.156963	296.664	1.16516	0.124918	296.102	1.14250	0.103550	295.535	1.12376
70	0.161997	303.731	1.18607	0.128993	303.212	1.16353	0.106986	302.689	1.14491
80	0.167008	310.890	1.20663	0.133044	310.409	1.18420	0.110399	309.924	1.16569
90	0.171999	318.139	1.22687	0.137075	317.692	1.20454	0.113790	317.241	1.18612
100	0.176972	325.480	1.24681	0.141089	325.063	1.22456	0.117164	324.643	1.20623
110	0.181931	332.912	1.26646	0.145086	332.522	1.24428	0.120522	332.129	1.22603
0.40 MPa			0.50 MPa			0.60 MPa			
0	0.060131	252.051	0.95359	—	—	—	—	—	—
10	0.063060	259.023	0.97866	0.049355	257.108	0.95223	0.040180	255.109	0.92945
20	0.065915	266.010	1.00291	0.051751	264.295	0.97717	0.042280	262.517	0.95517
30	0.068710	273.029	1.02646	0.054081	271.483	1.00128	0.044307	269.888	0.97989
40	0.071455	280.092	1.04938	0.056358	278.690	1.02467	0.046276	277.250	1.00378
50	0.074160	287.209	1.07175	0.058590	285.930	1.04743	0.048198	284.622	1.02695
60	0.076830	294.386	1.09362	0.060786	293.215	1.06963	0.050081	292.020	1.04950
70	0.079470	301.630	1.11504	0.062951	300.552	1.09133	0.051931	299.456	1.07149
80	0.082085	308.944	1.13605	0.065090	307.949	1.11257	0.053754	306.938	1.09298
90	0.084679	316.332	1.15668	0.067206	315.410	1.13340	0.055553	314.475	1.11403
100	0.087254	323.796	1.17695	0.069303	322.939	1.15386	0.057332	322.071	1.13466
110	0.089813	331.339	1.19690	0.071384	330.539	1.17395	0.059094	329.731	1.15492
120	0.092358	338.961	1.21654	0.073450	338.213	1.19373	0.060842	337.458	1.17482
130	0.094890	346.664	1.23588	0.075503	345.963	1.21319	0.062576	345.255	1.19441
0.70 MPa			0.80 MPa			0.90 MPa			
20	0.035487	260.667	0.93565	0.030366	258.737	0.91787	0.026355	256.713	0.90132
30	0.037305	268.240	0.96105	0.032034	266.533	0.94402	0.027915	264.760	0.92831
40	0.039059	275.769	0.98549	0.033632	274.243	0.96905	0.029397	272.670	0.95398

Temp. °C	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K
0.70 MPa			0.80 MPa			0.90 MPa			
50	0.040763	283.282	1.00910	0.035175	281.907	0.99314	0.030819	280.497	0.97859
60	0.042424	290.800	1.03201	0.036674	289.553	1.01644	0.032193	288.278	1.00230
70	0.044052	298.339	1.05431	0.038136	297.202	1.03906	0.033528	296.042	1.02526
80	0.045650	305.912	1.07606	0.039568	304.868	1.06108	0.034832	303.807	1.04757
90	0.047224	313.527	1.09732	0.040974	312.565	1.08257	0.036108	311.590	1.06930
100	0.048778	321.192	1.11815	0.042359	320.303	1.10359	0.037363	319.401	1.09062
110	0.050313	328.914	1.13856	0.043725	328.087	1.12417	0.038598	327.251	1.11128
120	0.051834	336.696	1.15861	0.045076	335.925	1.14437	0.039817	335.147	1.13162
130	0.053341	344.541	1.17832	0.046413	343.821	1.16420	0.041022	343.094	1.15158
140	0.054836	352.454	1.19770	0.047738	351.778	1.18369	0.042215	351.097	1.17119
150	0.056321	360.435	1.21679	0.049052	359.799	1.20288	0.043398	359.159	1.19047
1.00 MPa			1.20 MPa			1.40 MPa			
30	0.024600	262.912	0.91358	—	—	—	—	—	—
40	0.025995	271.042	0.93996	0.020851	267.602	0.91411	0.017120	263.861	0.89010
50	0.027323	279.046	0.96512	0.022051	276.011	0.94055	0.018247	272.766	0.91809
60	0.028601	286.973	0.98928	0.023191	284.263	0.96570	0.019299	281.430	0.94441
70	0.029836	294.859	1.01260	0.024282	292.415	0.98981	0.020295	289.858	0.96942
80	0.031038	302.727	1.03520	0.025336	300.508	1.01305	0.021248	298.202	0.99339
90	0.032213	310.599	1.05718	0.026359	308.570	1.03556	0.022167	306.473	1.01649
100	0.033364	318.488	1.07861	0.027357	316.623	1.05744	0.023058	314.703	1.03884
110	0.034495	326.405	1.09955	0.028334	324.682	1.07875	0.023926	322.916	1.06056
120	0.035609	334.360	1.12004	0.029292	332.762	1.09957	0.024775	331.128	1.08172
130	0.036709	342.360	1.14014	0.030236	340.871	1.11994	0.025608	339.354	1.10238
140	0.037797	350.410	1.15986	0.031166	349.019	1.13990	0.026426	347.603	1.12259
150	0.038873	358.514	1.17924	0.032084	357.210	1.15949	0.027233	355.885	1.14240
160	0.039940	366.677	1.19831	0.032993	365.450	1.17873	0.028029	364.206	1.16183
1.60 MPa			1.80 MPa			2.00 MPa			
50	0.015351	269.262	0.89689	0.013052	265.423	0.87625	—	—	—
60	0.016351	278.358	0.92461	0.014028	275.097	0.90573	0.012135	271.563	0.88729
70	0.017284	287.171	0.95068	0.014921	284.331	0.93304	0.013008	281.310	0.91612
80	0.018167	295.797	0.97546	0.015755	293.282	0.95876	0.013811	290.640	0.94292
90	0.019011	304.301	0.99920	0.016546	302.046	0.98323	0.014563	299.697	0.96821
100	0.019825	312.725	1.02209	0.017303	310.683	1.00669	0.015277	308.571	0.99292

TABLA A.4.2SI (Continuación) Refrigerante-22 sobrecalentado (unidades SI)

Temp. °C	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K
1.60 MPa			1.80 MPa			2.00 MPa			
110	0.020614	321.103	1.04424	0.018032	319.239	1.02932	0.015960	317.322	1.01546
120	0.021382	329.457	1.06576	0.018738	327.745	1.05123	0.016619	325.991	1.03780
130	0.022133	337.805	1.08673	0.019427	336.224	1.07253	0.017258	334.610	1.05944
140	0.022869	346.162	1.10721	0.020099	344.695	1.09329	0.017881	343.201	1.08049
150	0.023592	354.540	1.12724	0.020759	353.172	1.11356	0.018490	351.783	1.10102
160	0.024305	362.945	1.14688	0.021407	361.666	1.13340	0.019087	360.369	1.12107
170	0.025008	371.386	1.16614	0.022045	370.186	1.15284	0.019673	368.970	1.14070
180	0.025703	379.869	1.18507	0.022675	378.738	1.17193	0.020251	377.595	1.15995
2.50 MPa			3.00 MPa			3.50 MPa			
70	0.009459	272.677	0.87476	—	—	—	—	—	—
80	0.010243	283.332	0.90537	0.007747	274.530	0.86780	0.005765	262.739	0.82489
90	0.010948	293.338	0.93332	0.008465	286.042	0.89995	0.006597	277.268	0.86548
100	0.011598	302.935	0.95939	0.009098	296.663	0.92881	0.007257	289.504	0.89872
110	0.012208	312.261	0.98405	0.009674	306.744	0.95547	0.007829	300.640	0.92818
120	0.012788	321.400	1.00760	0.010211	316.470	0.98053	0.008346	311.129	0.95520
130	0.013343	330.412	1.03023	0.010717	325.955	1.00435	0.008825	321.196	0.98049
140	0.013880	339.336	1.05210	0.011200	335.270	1.02718	0.009276	330.976	1.00445
150	0.014400	348.205	1.07331	0.011665	344.467	1.04918	0.009704	340.554	1.02736
160	0.014907	357.040	1.09395	0.012114	353.584	1.07047	0.010114	349.989	1.04940
170	0.015402	365.860	1.11408	0.012550	362.647	1.09116	0.010510	359.324	1.07071
180	0.015887	374.679	1.13376	0.012976	371.679	1.11131	0.010894	368.590	1.09138
190	0.016364	383.508	1.15303	0.013392	380.695	1.13099	0.011268	377.810	1.11151
200	0.016834	392.354	1.17192	0.013801	389.708	1.15024	0.011634	387.004	1.13115
4.00 MPa			5.00 MPa			6.00 MPa			
90	0.005037	265.629	0.82544	—	—	—	—	—	—
100	0.005804	280.997	0.86721	0.003334	253.042	0.78005	—	—	—
110	0.006405	293.748	0.90094	0.004255	275.919	0.84064	0.002432	243.278	0.74674
120	0.006924	305.273	0.93064	0.004851	291.362	0.88045	0.003333	272.385	0.82185
130	0.007391	316.080	0.95778	0.005335	304.469	0.91337	0.003899	290.253	0.86675

Temp. °C	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K
	4.00 MPa			5.00 MPa			6.00 MPa		
140	0.007822	326.422	0.98312	0.005757	316.379	0.94256	0.004345	304.757	0.90230
150	0.008226	336.446	1.00710	0.006139	327.563	0.96931	0.004728	317.633	0.93310
160	0.008610	346.246	1.02999	0.006493	338.266	0.99431	0.005071	329.553	0.96094
170	0.008978	355.885	1.05199	0.006826	348.633	1.01797	0.005386	340.849	0.98673
180	0.009332	365.409	1.07324	0.007142	358.760	1.04057	0.005680	351.715	1.01098
190	0.009675	374.853	1.09386	0.007444	368.713	1.06230	0.005958	362.271	1.03402
200	0.010009	384.240	1.11391	0.007735	378.537	1.08328	0.006222	372.602	1.05609
210	0.010335	393.593	1.13347	0.008018	388.268	1.10363	0.006477	382.764	1.07734
220	0.010654	402.925	1.15259	0.008292	397.932	1.12343	0.006722	392.801	1.09790

TABLA A.6SI Propiedades termodinámicas del nitrógeno
TABLA A.6.1SI Nitrógeno saturado (unidades SI)

Temp. K	Presión abs. MPa P	Volumen específico, m ³ /kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado ν_f	Evap. ν_{fg}	Vapor saturado ν_g	Líquido saturado h_f	Evap. h_{fg}	Vapor saturado h_g	Líquido saturado s_f	Evap. s_{fg}	Vapor saturado s_g
63.148	0.01252	0.001150	1.480099	1.481249	-150.911	215.392	64.482	2.4234	3.4108	5.8342
65	0.01741	0.001160	1.092665	1.093825	-147.172	213.384	66.212	2.4816	3.2829	5.7646
70	0.03858	0.001191	0.525015	0.526206	-137.088	207.788	70.700	2.6307	2.9683	5.5991
75	0.07610	0.001223	0.280499	0.281722	-126.949	201.816	74.867	2.7700	2.6909	5.4609
77.348	0.101325	0.001240	0.215145	0.216385	-122.150	198.839	76.689	2.8326	2.5707	5.4033
80	0.13699	0.001259	0.162485	0.163744	-116.689	195.319	78.630	2.9014	2.4415	5.3429
85	0.22903	0.001299	0.100204	0.101503	-106.252	188.149	81.898	3.0266	2.2136	5.2401
90	0.36066	0.001343	0.064803	0.066146	-95.577	180.137	84.560	3.1466	2.0016	5.1482
95	0.54082	0.001393	0.043398	0.044792	-84.593	171.075	86.482	3.2627	1.8009	5.0636
100	0.77881	0.001452	0.029764	0.031216	-73.199	160.691	87.493	3.3761	1.6070	4.9831
105	1.08423	0.001522	0.020673	0.022195	-61.238	148.597	87.359	3.4883	1.4153	4.9036
110	1.46717	0.001610	0.014342	0.015952	-48.446	134.165	85.719	3.6017	1.2197	4.8215
115	1.93875	0.001729	0.009717	0.011445	-34.308	116.212	81.904	3.7204	1.0106	4.7310
120	2.51248	0.001915	0.006083	0.007998	-17.605	91.930	74.324	3.8536	0.7661	4.6197
125	3.20886	0.002353	0.002530	0.004883	6.677	48.762	55.438	4.0395	0.3901	4.4296
126.193	3.39780	0.003194	0	0.003194	29.791	0	29.791	4.2193	0	4.2193

TABLA A.6.2SI Nitrógeno sobrecalentado (unidades SI)

Presión abs. MPa		Temperatura, K								
		100	125	150	175	200	225	250	275	300
0.1	v	0.291030	0.367236	0.442612	0.517577	0.592311	0.666904	0.741404	0.815839	0.890229
	h	101.938	128.423	154.695	180.860	206.967	233.039	259.090	285.128	311.160
	s	5.6944	5.9308	6.1225	6.2838	6.4232	6.5461	6.6559	6.7551	6.8457
0.2	v	0.142521	0.181711	0.220007	0.257878	0.295515	0.333008	0.370408	0.407743	0.445033
	h	100.238	127.294	153.876	180.236	206.476	232.644	258.766	284.861	310.938
	s	5.4775	5.7191	5.9130	6.0755	6.2157	6.3390	6.4491	6.5486	6.6393
0.5	v	0.053062	0.070328	0.086429	0.102059	0.117442	0.132677	0.147817	0.162892	0.177921
	h	94.460	123.776	151.376	178.349	204.998	231.458	257.799	284.063	310.276
	s	5.1660	5.4282	5.6296	5.7959	5.9383	6.0629	6.1740	6.2741	6.3653
1.0	v	—	0.033064	0.041876	0.050120	0.058093	0.065911	0.073631	0.081285	0.088893
	h	—	117.397	147.062	175.156	202.522	229.482	256.194	282.743	309.182
	s	—	5.1872	5.4039	5.5772	5.7234	5.8504	5.9630	6.0642	6.1562
2.0	v	—	0.014030	0.019541	0.024153	0.028436	0.032548	0.036558	0.040500	0.044395
	h	—	101.541	137.779	168.584	197.528	225.543	253.014	280.140	307.034
	s	—	4.8887	5.1541	5.3443	5.4989	5.6310	5.7467	5.8502	5.9438
4.0	v	—	—	0.008231	0.011185	0.013650	0.015912	0.018063	0.020145	0.022179
	h	—	—	115.595	154.672	187.417	217.740	246.800	275.098	302.898
	s	—	—	4.8379	5.0797	5.2548	5.3978	5.5203	5.6282	5.7250

TABLA A.6.2SI (Continuación) Nitrógeno sobrecalentado (unidades SI)

Presión abs. MPa		Temperatura, K								
		150	175	200	225	250	275	300	350	400
6.0	v	0.004421	0.006909	0.008771	0.010412	0.011937	0.013393	0.014803	0.017532	0.020187
	h	87.298	139.945	177.293	210.125	240.822	270.294	298.988	354.951	409.83
	s	4.5685	4.8956	5.0955	5.2503	5.3797	5.4921	5.5920	5.7646	5.9112
8.0	v	0.002914	0.004861	0.006387	0.007701	0.008905	0.010042	0.011135	0.013236	0.015264
	h	61.924	125.326	167.469	202.833	235.145	265.761	295.318	352.511	408.237
	s	4.3522	4.7460	4.9717	5.1385	5.2748	5.3916	5.4945	5.6709	5.8197
10.0	v	0.002388	0.003752	0.005014	0.006112	0.007113	0.008053	0.008952	0.01067	0.01232
	h	48.659	112.363	158.353	196.022	229.841	261.532	291.902	350.260	406.790
	s	4.2290	4.6233	4.8697	5.0474	5.1901	5.3109	5.4167	5.5967	5.7477
15.0	v	0.001955	0.002598	0.003365	0.004109	0.004804	0.005461	0.006088	0.007280	0.008416
	h	36.805	91.928	140.599	181.908	218.586	252.470	284.565	345.466	403.791
	s	4.0790	4.4191	4.6796	4.8745	5.0292	5.1585	5.2702	5.4581	5.6139
20.0	v	0.001782	0.002187	0.002687	0.003213	0.003729	0.004226	0.004704	0.005617	0.006487
	h	33.644	83.317	130.168	172.324	210.434	245.699	279.007	341.856	401.649
	s	3.9960	4.3024	4.5529	4.7517	4.9124	5.0469	5.1629	5.3568	5.5166

TABLA A.7SI Propiedades termodinámicas del metano
TABLA A.7.1SI Metano saturado (unidades SI)

Temp. K	Presión abs. MPa P	Volumen específico, m ³ /kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado	Evap.	Vapor saturado	Líquido saturado	Evap.	Vapor saturado	Líquido saturado	Evap.	Vapor saturado
		v_f	v_{fg}	v_g	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g
90.685	0.01169	0.00221	3.97955	3.98176	-358.1	543.1	185.1	4.226	5.989	10.216
95	0.01983	0.00224	2.44824	2.45048	-343.7	537.2	193.4	4.381	5.654	10.035
100	0.03441	0.00228	1.47657	1.47885	-326.8	529.8	202.9	4.554	5.298	9.851
105	0.05643	0.00231	0.93791	0.94022	-309.7	521.8	212.2	4.721	4.970	9.691
110	0.08820	0.00235	0.62219	0.62454	-292.3	513.3	221.0	4.882	4.666	9.548
115	0.13232	0.00239	0.42808	0.43048	-274.7	504.1	229.4	5.037	4.384	9.421
120	0.19158	0.00244	0.30371	0.30615	-257.0	494.2	237.2	5.187	4.118	9.305
125	0.26896	0.00249	0.22110	0.22359	-239.0	483.4	244.5	5.332	3.868	9.200
130	0.36760	0.00254	0.16448	0.16702	-220.7	471.7	251.0	5.473	3.629	9.102
135	0.49072	0.00259	0.12457	0.12717	-202.1	458.9	256.8	5.611	3.399	9.011
140	0.64165	0.00265	0.09574	0.09839	-183.2	444.8	261.7	5.746	3.177	8.924
145	0.82379	0.00272	0.07444	0.07716	-163.7	429.4	265.7	5.879	2.961	8.841
150	1.04065	0.00279	0.05838	0.06117	-143.7	412.3	268.5	6.011	2.748	8.759
155	1.29580	0.00288	0.04604	0.04892	-123.1	393.3	270.2	6.141	2.537	8.679
160	1.59296	0.00297	0.03638	0.03935	-101.6	372.0	270.3	6.272	2.325	8.597
165	1.93607	0.00309	0.02868	0.03176	-79.1	347.8	268.7	6.405	2.108	8.512
170	2.32936	0.00322	0.02241	0.02563	-55.2	320.0	264.8	6.540	1.882	8.422
175	2.77762	0.00339	0.01718	0.02058	-29.3	287.2	257.9	6.681	1.641	8.322
180	3.28655	0.00362	0.01266	0.01628	-0.5	246.8	246.2	6.833	1.371	8.204
185	3.86361	0.00398	0.00845	0.01243	33.8	192.1	225.9	7.009	1.038	8.048
190	4.52082	0.00499	0.00298	0.00796	92.2	79.8	172.0	7.305	0.420	7.725
190.551	4.59920	0.00615	0	0.00615	129.7	0	129.7	7.500	0	7.500

TABLA A.7.2SI Metano sobrecalentado (unidades SI)

Presión abs. MPa		Temperatura, K									
		150	175	200	225	250	275	300	350	400	450
0.05	v	1.5433	1.8054	2.0665	2.3270	2.5872	2.8472	3.1069	3.6262	4.1451	—
	h	308.5	360.8	413.2	465.8	518.9	572.9	628.1	742.9	865.4	—
	s	10.5170	10.8399	11.1196	11.3674	11.5914	11.7972	11.9891	12.3429	12.6697	—
0.10	v	0.7659	0.8984	1.0299	1.1609	1.2915	1.4219	1.5521	1.8123	2.0721	—
	h	306.8	359.6	412.2	465.0	518.3	572.4	627.6	742.6	865.1	—
	s	10.1504	10.4759	10.7570	11.0058	11.2303	11.4365	11.6286	11.9829	12.3099	—
0.50	v	0.1433	0.1726	0.2006	0.2280	0.2550	0.2817	0.3083	0.3611	0.4137	—
	h	292.3	349.1	404.1	458.5	512.9	567.8	623.7	739.6	862.8	—
	s	9.2515	9.6021	9.8959	10.1520	10.3812	10.5906	10.7850	11.1422	11.4710	—
1.00	v	0.0643	0.0815	0.0968	0.1113	0.1254	0.1392	0.1528	0.1798	0.2064	—
	h	270.6	334.9	393.5	450.1	506.0	562.0	618.8	735.9	860.0	—
	s	8.7902	9.1871	9.5006	9.7672	10.0028	10.2164	10.4138	10.7748	11.1059	—
1.50	v	—	0.0508	0.0621	0.0724	0.0822	0.0917	0.1010	0.1193	0.1373	—
	h	—	318.8	382.3	441.4	499.0	556.2	613.8	732.3	857.2	—
	s	—	8.9121	9.2514	9.5303	9.7730	9.9911	10.1916	10.5565	10.8899	—
2.00	v	—	0.0350	0.0446	0.0529	0.0606	0.0680	0.0751	0.0891	0.1027	—
	h	—	300.0	370.2	432.4	491.8	550.3	608.9	728.6	854.3	—
	s	—	8.6839	9.0596	9.3532	9.6036	9.8266	10.0303	10.3992	10.7349	—

TABLA A.7.2SI (Continuación) Metano sobrecalentado (unidades SI)

Presión abs. MPa		Temperatura, K									
		100	125	200	225	250	275	300	350	400	450
3.00	v	—	—	0.0269	0.0333	0.0390	0.0442	0.0492	0.0589	0.0682	0.0774
	h	—	—	342.7	413.3	477.1	538.3	598.8	721.2	848.8	983.5
	s	—	—	8.7492	9.0823	9.3512	9.5848	9.7954	10.1726	10.5130	10.8303
4.00	v	—	—	0.0176	0.0235	0.0281	0.0324	0.0363	0.0438	0.0510	0.0580
	h	—	—	308.2	392.4	461.6	526.1	588.7	713.9	843.2	979.2
	s	—	—	8.4675	8.8653	9.1574	9.4031	9.6212	10.0071	10.3523	10.6725
5.00	v	—	—	0.0114	0.0175	0.0216	0.0252	0.0286	0.0348	0.0406	0.0463
	h	—	—	258.3	369.3	445.6	513.6	578.6	706.7	837.8	975.0
	s	—	—	8.1459	8.6728	8.9945	9.2540	9.4802	9.8751	10.2251	10.5483
6.00	v	—	—	0.0061	0.0135	0.0173	0.0205	0.0234	0.0288	0.0338	0.0386
	h	—	—	160.3	343.7	428.8	500.9	568.4	699.5	832.4	970.9
	s	—	—	7.6125	8.4907	8.8502	9.1253	9.3601	9.7643	10.1192	10.4453
8.00	v	—	—	0.0041	0.0085	0.0120	0.0147	0.0171	0.0213	0.0252	0.0289
	h	—	—	88.5	285.0	393.9	475.4	548.1	685.4	822.0	962.9
	s	—	—	7.2069	8.1344	8.5954	8.9064	9.1598	9.5831	9.9477	10.2796
10.00	v	—	—	0.0038	0.0059	0.0089	0.0113	0.0133	0.0169	0.0201	0.0231
	h	—	—	72.2	229.3	358.6	450.1	528.4	671.8	811.9	955.3
	s	—	—	7.0862	7.8245	8.3716	8.7210	8.9936	9.4362	9.8104	10.1480

Table A.4

Thermodynamic Properties of Oxygen^a Propiedades Termodinámicas del OXIGENO

Table A.4.1

Saturated Oxygen Oxígeno: Vapor Saturado o Húmedo

Temp. K	Press. MPa P	Specific Volume m ³ /kg			Enthalpy kJ/kg			Entropy kJ/kg K		
		Sat. Liquid v_f	Evap. v_g	Sat. Vapor v_g	Sat. Liquid h_f	Evap. h_g	Sat. Vapor h_g	Sat. Liquid s_f	Evap. s_g	Sat. Vapor s_g
54.3507	0.00015	0.000 765	92.9658	92.9666	-193.432	242.553	49.121	2.0938	4.4514	6.5452
60	0.00078	0.000 780	21.3461	21.3469	-184.029	238.265	54.236	2.2585	3.9686	6.2271
70	0.00623	0.000 808	2.9085	2.9093	-167.372	230.527	63.155	2.5151	3.2936	5.8087
80	0.03006	0.000 840	0.681 04	0.681 88	-150.646	222.289	71.643	2.7382	2.7779	5.5161
90	0.09943	0.000 876	0.226 49	0.227 36	-133.758	213.070	79.312	2.9364	2.3663	5.3027
100	0.25425	0.000 917	0.094 645	0.095 562	-116.557	202.291	85.734	3.1161	2.0222	5.1383
110	0.54339	0.000 966	0.045 855	0.046 821	-98.829	189.320	90.491	3.2823	1.7210	5.0033
120	1.0215	0.001 027	0.024 336	0.025 363	-80.219	173.310	93.091	3.4401	1.4445	4.8846
130	1.7478	0.001 108	0.013 488	0.014 596	-60.093	152.887	92.794	3.5948	1.1766	4.7714
140	2.7866	0.001 230	0.007 339	0.008 569	-37.045	125.051	88.006	3.7567	0.8935	4.6502
150	4.2190	0.001 480	0.003 180	0.004 660	-7.038	79.459	72.421	3.9498	0.5301	4.4799
154.576	5.0427	0.002 293	0.000 000	0.002 293	32.257	0.000	32.257	4.1977	0.0000	4.1977

Table A.4.2

Superheated Oxygen

Oxígeno: Vapor Sobrecalentado

Temp. K	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K	v m ³ /kg	h kJ/kg	s kJ/kg K
0.10 MPa				0.20 MPa			0.50 MPa		
100	0.253 503	88.828	5.4016	0.123 394	86.864	5.2083	0.060 674	107.093	5.1650
125	0.320 717	112.214	5.6107	0.158 268	110.988	5.4241	0.075 039	131.788	5.3448
150	0.386 914	135.301	5.7787	0.192 016	134.440	5.5947	0.088 842	155.643	5.4919
175	0.452 645	158.255	5.9202	0.225 276	157.609	5.7376	0.102 371	179.105	5.6175
200	0.518 127	181.145	6.0427	0.258 282	180.638	5.8609	0.115 746	202.359	5.7268
225	0.583 465	204.007	6.1502	0.291 140	203.596	5.9688	0.129 025	225.506	5.8246
250	0.648 711	226.869	6.2468	0.323 906	226.529	6.0657	0.142 242	248.621	5.9156
275	0.713 895	249.769	6.3369	0.356 610	249.483	6.1560	0.155 415	271.740	5.9932
300	0.779 036	272.720	6.4140	0.389 271	272.475	6.2332			
1.00 MPa				2.00 MPa			4.00 MPa		
125	0.027 869	99.653	4.9431	0.016 270	116.476	4.9130	0.005 526	81.481	4.5475
150	0.035 976	127.112	5.1433	0.020 544	145.112	5.0899	0.009 029	128.618	4.8414
175	0.043 341	152.269	5.2986	0.024 395	171.150	5.2293	0.011 376	159.715	5.0080
200	0.050 394	176.508	5.4283	0.028 051	196.052	5.3464	0.013 444	187.333	5.1380
225	0.057 282	200.280	5.5401	0.031 597	220.348	5.4491	0.015 378	213.374	5.2480
250	0.064 068	223.795	5.6394	0.035 073	244.309	5.5433	0.017 233	238.560	5.3469
275	0.070 790	247.185	5.7314	0.038 502	268.076	5.6263	0.019 039	263.234	5.4300
300	0.077 467	270.516	5.8098						
6.00 MPa				8.00 MPa			10.00 MPa		
175	0.005 051	107.496	4.6431	0.003 002	79.513	4.4384	0.002 020	52.661	4.2573
200	0.007 027	147.232	4.8565	0.004 864	133.760	4.7308	0.003 603	119.767	4.6189
225	0.008 589	178.304	5.0029	0.006 181	169.069	4.8973	0.004 757	159.686	4.8072
250	0.009 991	206.340	5.1214	0.007 316	199.317	5.0251	0.005 730	192.401	4.9455
275	0.011 306	232.848	5.2253	0.008 360	227.219	5.1344	0.006 606	221.685	5.0572
300	0.012 570	258.464	5.3116	0.009 351	253.797	5.2240	0.007 432	249.262	5.1533
20.00 MPa									
175	0.001 343	24.551	4.0086						
200	0.001 727	75.318	4.2798						
225	0.002 236	122.595	4.5024						
250	0.002 755	163.109	4.6739						
275	0.003 241	198.021	4.8069						
300	0.003 700	229.655	4.9174						

0.0002

$$h = h_a + \omega h_g$$

Diagrama Sicrométrico
de Aire a 101.35 kPa

