TABLAS Y FIGURAS DE

PROPIEDADES TERMODINÁMICAS DE SUSTANCIAS PURAS.

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Las presentes tablas de propiedades termodinámicas están disponibles en formato digital en la siguiente dirección:

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Aquel que no sabe y sabe que no sabe es un idiota; evítalo. Aquel que no sabe y no sabe que no sabe es un niño; edúcalo. Aquel que sabe y no sabe que sabe está dormido; despiértalo. Aquel que sabe y sabe que sabe es un sabio; síguelo.

Proverbio persa.

CONTENIDO.

PRESENTACIÓN.

Modificaciones introducidas en las tablas de propiedades termodinámicas presentadas en este anexo con respecto a las tablas de propiedades termodinámicas del texto original.

1.- Se ha incluido un índice de tablas, con el objeto de facilitar la búsqueda de propiedades termodinámicas para una sustancia en particular.

2.- Uniformidad en la presentación de los datos.

a.- En la tabla de saturación del agua, se presentan las propiedades termodinámicas para la diferencia del volumen específico durante la evaporación (v_{fg}), de la misma forma como es presentada esta propiedad en las tablas de Amoniaco, Refrigerante-12, Refrigerante-22, Refrigerante-134a, Nitrógeno y Metano.

b.- Las tablas de vapor sobrecalentado para el Amoniaco, Nitrógeno y Metano se presentan en el mismo formato que las de Agua, Refrigerante-12, Refrigerante-22 y Refrigerante-134a.

3.- Se incluyó la tabla de presiones de saturación para el amoniaco, refrigerante 12, refrigerante 22, refrigerante 134a y propano.

4.- Se incluyó la tabla del refrigerante 134a con la misma referencia para la entalpía que para el amoniaco, refrigerante 12, refrigerante 22 y propano ($h_f = 0$ a –40ºC).

5.- Se ha incluido la energía interna para el Amoniaco, Refrigerante-12, Refrigerante-22, Refrigerante-134a, Nitrógeno y Metano tanto en las tablas de saturación (para el líquido saturado, el vapor saturado y la evaporación) como en las tablas de sobrecalentamiento. Anteriormente este dato debía ser estimado mediante la ecuación $u = h - Pv$

Como ejemplo, para el amoniaco saturado, a 40ºF, la energía interna del líquido saturado y del vapor saturado se obtenían mediante:

Líquido saturado: $u_f = h_f - Pv_f$

$$u_f = 86.41\,\text{Btu/lb}_m - 73.703\,\text{lb}_f / \text{pulg}^2 \times 0.02532\,\text{ft}^3/\text{lb}_m$$

$$u_f = 86.41\,\text{Btu/lb}_m - 1.866160\,(\text{lb}_f/\text{pulg}^2)(\text{ft}^3/\text{lb}_m)$$

Al utilizar la tabla de factores de conversión:

$$u_f = 86.41\,\text{Btu/lb}_m - 1.866160\,(\text{lb}_f/\text{pulg}^2)(\text{ft}^3/\text{lb}_m) \times \left(\frac{9.478169 \times 10^{-4}\,\text{Btu}}{5.125919 \times 10^{-3}\,\text{ft}^3.(\text{lb}_f/\text{pulg}^2)}\right)$$

$$u_f = 86.41\,\text{Btu/lb}_m - 0.3451\,\text{Btu/lb}_m$$

$$u_f = 86.07\,\text{Btu/lb}_m$$

Vapor saturado: $u_g = h_g - Pv_g$

$$u_g = 622.01\,\text{Btu/lb}_m - 73.703\,\text{lb}_f/\text{pulg}^2 \times 3.970\,\text{ft}^3/\text{lb}_m$$

$$u_g = 622.01\,\text{Btu/lb}_m - 292.60\,(\text{lb}_f/\text{pulg}^2)(\text{ft}^3/\text{lb}_m)$$

Al utilizar la tabla de factores de conversión:

$$u_g = 622.01\,\text{Btu/lb}_m - 292.60\,(\text{lb}_f/\text{pulg}^2)(\text{ft}^3/\text{lb}_m) \times \left(\frac{9.478169 \times 10^{-4}\,\text{Btu}}{5.125919 \times 10^{-3}\,\text{ft}^3.(\text{lb}_f/\text{pulg}^2)}\right)$$

$$u_g = 622.01\,\text{Btu/lb}_m - 54.10\,\text{Btu/lb}_m$$

$$u_g = 568.12\,\text{Btu/lb}_m$$

La diferencia entre estos dos valores:

Evaporación: $u_{fg} = u_g - u_f$

$$u_{fg} = 568.12\,\text{Btu/lb}_m - 86.07\,\text{Btu/lb}_m$$

$$u_{fg} = 482.06\,\text{Btu/lb}_m$$

Mientras que para el refrigerante-12 sobrecalentado a 100.00 lbf/pulg^2 y 200ºF, era necesario aplicar:

$$u = h - Pv$$

$$u = 105.633\,\text{Btu/lb}_m - 100.00\,\text{lb}_f/\text{pulg}^2 \times 0.54413\,\text{ft}^3/\text{lb}_m$$

$$u = 105.633\,\text{Btu/lb}_m - 54.413\,(\text{lb}_f/\text{pulg}^2)(\text{ft}^3/\text{lb}_m)$$

Al utilizar la tabla de factores de conversión:

$$u = 105.633\,\text{Btu/lb}_m - 54.413\,(\text{lb}_f/\text{pulg}^2)(\text{ft}^3/\text{lb}_m) \times \left(\frac{9.478169 \times 10^{-4}\,\text{Btu}}{5.125919 \times 10^{-3}\,\text{ft}^3.(\text{lb}_f/\text{pulg}^2)}\right)$$

$u = 105.633 \, \text{Btu/lb}_m - 10.061 \, \text{Btu/lb}_m$

$u = 95.557 \, \text{Btu/lb}_m$

Con los datos proporcionados, no es necesario el cálculo de la energía interna, pues estos datos están disponibles en las tablas actuales.

6.- Se ha incluido la entalpía específica, energía interna específica y entropía específica de diversas sustancias como gas ideal en función de la temperatura, en contraste con la entalpía molar, energía interna molar y entropía molar disponibles en las tablas anexas en los textos de Termodinámica.

7.- Se han resaltado en colores los datos de presión (azul), temperatura (rojo), nombre y fórmula química de las sustancias (verde), los títulos de cada tabla (violeta) y las referencias o fuentes (anaranjado).

8.- Se han sombreado lineas alternadas para la lectura más fácil de los datos.

Tabla A.1 I Propiedades termodinámicas del Agua.
Tabla A.1.1 I Agua saturada: Tabla de Temperaturas.

Temp.ºF T	Presión lb$_f$/pulg^2, P	Volumen específico, ft^3/lb$_m$			Energía interna, Btu/lb$_m$			Entalpía, Btu/lb$_m$			Entropía, Btu/lb$_m$.ºR		
		Líquido saturado v$_f$	Evap v$_{fg}$	Vapor saturado v$_g$	Líquido saturado u$_f$	Evap u$_{fg}$	Vapor saturado u$_g$	Líquido saturado h$_f$	Evap h$_{fg}$	Vapor saturado h$_g$	Líquido saturado s$_f$	Evap s$_{fg}$	Vapor saturado s$_g$
32	0.08867	0.016022	3301.8840	3301.9	0.00	1021.2	1021.2	0.00	1075.4	1075.4	0.00000	2.1869	2.1869
35	0.09993	0.016021	2947.4840	2947.5	2.99	1019.2	1022.2	2.99	1073.7	1076.7	0.00607	2.1703	2.1764
40	0.12167	0.016020	2445.0840	2445.1	8.01	1015.8	1023.8	8.01	1070.9	1078.9	0.01617	2.1429	2.1591
45	0.14756	0.016021	2036.9840	2037.0	13.03	1012.5	1025.5	13.03	1068.1	1081.1	0.02617	2.1161	2.1423
50	0.17805	0.016024	1703.9840	1704.0	18.05	1009.2	1027.2	18.05	1065.3	1083.3	0.03606	2.0898	2.1259
60	0.2563	0.016034	1206.6840	1206.7	28.08	1002.3	1030.4	28.08	1059.6	1087.7	0.05554	2.0388	2.0943
70	0.3632	0.016051	867.5839	867.60	38.09	995.6	1033.7	38.09	1053.9	1092.0	0.07462	1.9896	2.0642
80	0.5074	0.016072	632.6739	632.69	48.08	988.9	1037.0	48.08	1048.3	1096.4	0.09331	1.9423	2.0356
90	0.6989	0.016099	467.5839	467.60	58.06	982.1	1040.2	58.06	1042.6	1100.7	0.11163	1.8967	2.0083
100	0.9504	0.016130	349.9639	349.98	68.04	975.5	1043.5	68.04	1037.0	1105.0	0.12962	1.8526	1.9822
110	1.2765	0.016166	265.0538	265.07	78.01	968.7	1046.7	78.01	1031.3	1109.3	0.14728	1.8101	1.9574
120	1.6947	0.016205	203.0138	203.03	87.99	961.9	1049.9	87.99	1025.5	1113.5	0.16464	1.7690	1.9336
130	2.2254	0.016247	157.1438	157.16	97.96	955.0	1053.0	97.97	1019.7	1117.7	0.18171	1.7292	1.9109
140	2.892	0.016293	122.8537	122.87	107.95	948.3	1056.2	107.96	1013.9	1121.9	0.19850	1.6907	1.8892
150	3.722	0.016343	96.9607	96.977	117.94	941.4	1059.3	117.95	1008.2	1126.1	0.21502	1.6533	1.8683
160	4.745	0.016395	77.2076	77.224	127.94	934.4	1062.3	127.95	1002.2	1130.1	0.23129	1.6171	1.8484
170	5.997	0.016450	61.9986	62.015	137.94	927.5	1065.4	137.96	996.2	1134.2	0.24731	1.5819	1.8292
180	7.515	0.016509	50.1825	50.199	147.96	920.3	1068.3	147.98	990.2	1138.2	0.26309	1.5478	1.8109
190	9.344	0.016570	40.9254	40.942	157.99	913.3	1071.3	158.02	984.1	1142.1	0.27865	1.5146	1.7932
200	11.530	0.016634	33.6144	33.631	168.03	906.2	1074.2	168.07	977.8	1145.9	0.29399	1.4822	1.7762
210	14.126	0.016702	27.7963	27.813	178.09	898.9	1077.0	178.13	971.6	1149.7	0.30912	1.4508	1.7599
212	14.699	0.016715	26.7803	26.797	180.10	897.5	1077.6	180.15	970.4	1150.5	0.31212	1.4446	1.7567
220	17.189	0.016772	23.1322	23.149	188.16	891.6	1079.8	188.21	965.3	1153.5	0.32404	1.4201	1.7441
230	20.780	0.016845	19.3682	19.385	198.25	884.4	1082.6	198.31	958.8	1157.1	0.33878	1.3901	1.7289
240	24.968	0.016922	16.3091	16.326	208.36	876.9	1085.3	208.43	952.3	1160.7	0.35333	1.3609	1.7142
250	29.823	0.017001	13.8080	13.825	218.48	869.4	1087.9	218.58	945.6	1164.2	0.36771	1.3324	1.7001
260	35.422	0.017084	11.7499	11.767	228.64	861.9	1090.5	228.75	938.9	1167.6	0.38191	1.3045	1.6864
270	41.848	0.017170	10.0478	10.065	238.81	854.1	1092.9	238.95	932.0	1170.9	0.39596	1.2771	1.6731
280	49.189	0.017259	8.6327	8.650	249.02	846.4	1095.4	249.17	924.9	1174.1	0.40985	1.2504	1.6602
290	57.535	0.017352	7.4486	7.466	259.25	838.5	1097.7	259.43	917.8	1177.2	0.42359	1.2241	1.6477
300	66.985	0.017448	6.4536	6.471	269.51	830.5	1100.0	269.73	910.5	1180.2	0.43719	1.1984	1.6356
310	77.641	0.017548	5.6135	5.631	279.80	822.3	1102.1	280.06	902.9	1183.0	0.45065	1.1732	1.6238
320	89.609	0.017652	4.9013	4.919	290.13	814.1	1104.2	290.43	895.4	1185.8	0.46399	1.1482	1.6122
330	103.00	0.017760	4.2942	4.312	300.50	805.7	1106.2	300.84	887.6	1188.4	0.47720	1.1238	1.6010
340	117.94	0.017871	3.7741	3.792	310.90	797.1	1108.0	311.29	879.5	1190.8	0.49030	1.0997	1.5900
350	134.54	0.017987	3.3280	3.346	321.35	788.5	1109.8	321.80	871.3	1193.1	0.50328	1.0760	1.5793
360	152.93	0.018108	2.9429	2.961	331.83	779.6	1111.4	332.35	862.9	1195.2	0.51616	1.0526	1.5688

Tabla A.1.1 I Agua saturada: Tabla de Temperaturas.

Temp.ºF T	Presión lb$_f$/pulg^2, P	Volumen específico, ft^3/lb$_m$			Energía interna, Btu/lb$_m$			Entalpía, Btu/lb$_m$			Entropía, Btu/lb$_m$.ºR		
		Líquido saturado v$_f$	Evap v$_{fg}$	Vapor saturado v$_g$	Líquido saturado u$_f$	Evap u$_{fg}$	Vapor saturado u$_g$	Líquido saturado h$_f$	Evap h$_{fg}$	Vapor saturado h$_g$	Líquido saturado s$_f$	Evap s$_{fg}$	Vapor saturado s$_g$
370	173.24	0.018233	2.6098	2.628	342.37	770.5	1112.9	342.95	854.3	1197.2	0.52893	1.0295	1.5584
380	195.61	0.018363	2.3206	2.339	352.95	761.4	1114.3	353.61	845.4	1199.0	0.54161	1.0067	1.5483
390	220.17	0.018498	2.0685	2.087	363.58	751.9	1115.5	364.33	836.3	1200.6	0.55420	0.9841	1.5383
400	247.08	0.018638	1.84736	1.8660	374.26	742.3	1116.6	375.11	826.8	1201.9	0.56671	0.9617	1.5284
410	276.48	0.018784	1.65372	1.6725	385.00	732.6	1117.6	385.96	817.1	1203.1	0.57914	0.9396	1.5187
420	308.52	0.018936	1.48336	1.5023	395.80	722.5	1118.3	396.89	807.2	1204.1	0.59150	0.9175	1.5090
430	343.37	0.019094	1.33291	1.3520	406.67	712.2	1118.9	407.89	796.9	1204.8	0.60380	0.8957	1.4995
440	381.18	0.019260	1.19984	1.2191	417.61	701.7	1119.3	418.97	786.3	1205.3	0.61604	0.8740	1.4900
450	422.13	0.019433	1.08167	1.1011	428.63	690.9	1119.5	430.15	775.4	1205.5	0.62823	0.8523	1.4805
460	466.38	0.019613	0.97649	0.9961	439.73	679.8	1119.5	441.42	764.1	1205.5	0.64038	0.8307	1.4711
470	514.11	0.019803	0.88260	0.9024	450.92	668.5	1119.4	452.80	752.4	1205.2	0.65250	0.8093	1.4618
480	565.50	0.020002	0.79860	0.8186	462.21	656.7	1118.9	464.30	740.3	1204.6	0.66460	0.7878	1.4524
490	620.74	0.020211	0.72332	0.74353	473.60	644.7	1118.3	475.92	727.8	1203.7	0.67669	0.7663	1.4430
500	680.02	0.020432	0.65562	0.67605	485.11	632.3	1117.4	487.68	714.7	1202.4	0.68877	0.7447	1.4335
520	811.48	0.020911	0.53951	0.56042	508.53	606.3	1114.8	511.67	687.2	1198.9	0.71299	0.7014	1.4144
540	961.51	0.021452	0.44434	0.46579	532.56	578.4	1111.0	536.38	657.4	1193.8	0.73736	0.6576	1.3950
560	1131.9	0.022068	0.36557	0.38764	557.35	548.5	1105.8	561.97	625.0	1187.0	0.76203	0.6129	1.3749
580	1324.4	0.022782	0.29972	0.32250	583.05	515.9	1098.9	588.63	589.4	1178.0	0.78714	0.5668	1.3539
600	1541.1	0.023625	0.24403	0.26765	609.91	480.1	1090.0	616.64	549.7	1166.3	0.81294	0.5188	1.3317
620	1784.5	0.024646	0.19625	0.22090	638.26	440.2	1078.5	646.40	505.0	1151.4	0.83975	0.4678	1.3075
640	2057.2	0.025934	0.15451	0.18044	668.68	394.5	1063.2	678.55	453.4	1131.9	0.86808	0.4122	1.2803
660	2362.6	0.027665	0.11691	0.14457	702.24	340.1	1042.3	714.34	391.2	1105.5	0.89896	0.3493	1.2483
680	2705.1	0.030313	0.08094	0.11125	741.70	269.3	1011.0	756.87	309.7	1066.6	0.93947	0.2673	1.2068
700	3090.5	0.036648	0.03770	0.07435	801.66	145.9	947.6	822.61	167.5	990.1	0.99006	0.1444	1.1345
705.44	3203.8	0.050531	0	0.05053	872.56	0	872.6	902.52	0	902.5	1.05801	0	1.0580

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 821 – 822, tabla A.1.1I.

Tabla A.1.2 I Agua saturada: Tabla de Presiones.

Presión lb$_f$/pulg^2, P	Temp.ºF T	Volumen específico, ft^3/lb$_m$			Energía interna, Btu/lb$_m$			Entalpía, Btu/lb$_m$			Entropía, Btu/lb$_m$.ºR		
		Líquido saturado v$_f$	Evap v$_{fg}$	Vapor saturado v$_g$	Líquido saturado u$_f$	Evap u$_{fg}$	Vapor saturado u$_g$	Líquido saturado h$_f$	Evap h$_{fg}$	Vapor saturado h$_g$	Líquido saturado s$_f$	Evap s$_{fg}$	Vapor saturado s$_g$
1	101.70	0.016136	333.5639	333.58	69.73	974.3	1044.0	69.73	1036.0	1105.7	0.13264	1.8453	1.9779
2	126.03	0.016230	173.7338	173.75	94.01	957.8	1051.8	94.01	1022.1	1116.1	0.17497	1.7448	1.9198
3	141.43	0.016300	118.7037	118.72	109.37	947.2	1056.6	109.38	1013.1	1122.5	0.20087	1.6852	1.8861
4	152.92	0.016358	90.6236	90.64	120.86	939.3	1060.2	120.88	1006.4	1127.3	0.21981	1.6426	1.8624
5	162.20	0.016407	73.5136	73.53	130.14	932.9	1063.0	130.15	1000.9	1131.0	0.23484	1.6093	1.8441
6	170.02	0.016450	61.9686	61.985	137.97	927.4	1065.4	137.98	996.2	1134.2	0.24734	1.5819	1.8292
8	182.83	0.016526	47.3305	47.347	150.80	918.4	1069.2	150.83	988.5	1139.3	0.26752	1.5383	1.8058
10	193.19	0.016590	38.4074	38.424	161.19	911.0	1072.2	161.22	982.1	1143.3	0.28356	1.5041	1.7877
14.696	211.99	0.016715	26.7863	26.803	180.09	897.5	1077.6	180.13	970.4	1150.5	0.31210	1.4446	1.7567
15	213.02	0.016723	26.2783	26.295	181.13	896.8	1077.9	181.18	969.7	1150.9	0.31365	1.4414	1.7550
20	227.96	0.016830	20.0742	20.091	196.18	885.8	1082.0	196.25	960.2	1156.4	0.33578	1.3962	1.7320
25	240.07	0.016922	16.2891	16.306	208.43	876.9	1085.3	208.51	952.2	1160.7	0.35344	1.3607	1.7141
30	250.34	0.017004	13.7310	13.748	218.83	869.2	1088.0	218.92	945.4	1164.3	0.36819	1.3314	1.6996
35	259.29	0.017078	11.8829	11.900	227.92	862.4	1090.3	228.03	939.4	1167.4	0.38091	1.3064	1.6873
40	267.26	0.017146	10.4839	10.501	236.02	856.3	1092.3	236.15	933.9	1170.0	0.39212	1.2846	1.6767
45	274.45	0.017209	9.3858	9.403	243.35	850.7	1094.0	243.50	928.8	1172.3	0.40216	1.2651	1.6673
50	281.03	0.017268	8.5007	8.518	250.07	845.5	1095.6	250.23	924.2	1174.4	0.41127	1.2476	1.6589
55	287.09	0.017325	7.7717	7.789	256.27	840.7	1097.0	256.45	919.9	1176.3	0.41961	1.2317	1.6513
60	292.73	0.017378	7.1596	7.177	262.04	836.3	1098.3	262.24	915.8	1178.0	0.42731	1.2171	1.6444
65	298.00	0.017429	6.6396	6.657	267.45	832.1	1099.5	267.66	911.9	1179.6	0.43448	1.2035	1.6380
70	302.95	0.017477	6.1905	6.208	272.55	828.1	1100.6	272.77	908.2	1181.0	0.44118	1.1908	1.6320
75	307.63	0.017524	5.8005	5.818	277.36	824.2	1101.6	277.60	904.8	1182.4	0.44747	1.1790	1.6265
80	312.06	0.017569	5.4564	5.474	281.93	820.7	1102.6	282.19	901.4	1183.6	0.45342	1.1680	1.6214
85	316.28	0.017613	5.1524	5.170	286.29	817.1	1103.4	286.57	898.2	1184.8	0.45905	1.1575	1.6165
90	320.31	0.017655	4.8803	4.898	290.45	813.9	1104.3	290.75	895.1	1185.8	0.46440	1.1475	1.6119
95	324.16	0.017696	4.6363	4.654	294.44	810.6	1105.0	294.75	892.2	1186.9	0.46950	1.1380	1.6075
100	327.85	0.017736	4.4163	4.434	298.27	807.5	1105.8	298.60	889.2	1187.8	0.47437	1.1290	1.6034
110	334.82	0.017813	4.0332	4.051	305.51	801.6	1107.1	305.87	883.7	1189.6	0.48352	1.1122	1.5957
120	341.30	0.017886	3.7121	3.730	312.26	796.0	1108.3	312.66	878.4	1191.1	0.49199	1.0966	1.5886
130	347.37	0.017957	3.4390	3.457	318.59	790.7	1109.3	319.03	873.5	1192.5	0.49987	1.0822	1.5821
140	353.08	0.018024	3.2030	3.221	324.57	785.7	1110.3	325.04	868.8	1193.8	0.50725	1.0688	1.5760
150	358.47	0.018089	2.9979	3.016	330.23	781.0	1111.2	330.73	864.2	1194.9	0.51420	1.0562	1.5704
160	363.59	0.018152	2.8178	2.836	335.61	776.4	1112.0	336.15	859.9	1196.0	0.52076	1.0442	1.5650
170	368.47	0.018213	2.6578	2.676	340.75	772.0	1112.7	341.32	855.6	1196.9	0.52698	1.0330	1.5600
180	373.12	0.018273	2.5147	2.533	345.67	767.7	1113.4	346.27	851.5	1197.8	0.53290	1.0224	1.5553
190	377.58	0.018331	2.3867	2.405	350.38	763.6	1114.0	351.03	847.6	1198.6	0.53855	1.0122	1.5507
200	381.86	0.018387	2.2706	2.289	354.92	759.7	1114.6	355.60	843.7	1199.3	0.54396	1.0024	1.5464
250	401.03	0.018653	1.8261	1.8448	375.37	741.3	1116.7	376.23	825.9	1202.1	0.56800	0.9594	1.5274

Tabla A.1.2 I Agua saturada: Tabla de Presiones.

Presión lb$_f$/pulg^2, P	Temp.ºF T	Volumen específico, ft^3/lb$_m$			Energía interna, Btu/lb$_m$			Entalpía, Btu/lb$_m$			Entropía, Btu/lb$_m$.ºR		
		Líquido saturado v$_f$	Evap v$_{fg}$	Vapor saturado v$_g$	Líquido saturado u$_f$	Evap u$_{fg}$	Vapor saturado u$_g$	Líquido saturado h$_f$	Evap h$_{fg}$	Vapor saturado h$_g$	Líquido saturado s$_f$	Evap s$_{fg}$	Vapor saturado s$_g$
300	417.42	0.018896	1.5252	1.5441	393.01	725.1	1118.1	394.06	809.8	1203.9	0.58832	0.9232	1.5115
350	431.81	0.019124	1.3076	1.3267	408.65	710.4	1119.0	409.89	795.0	1204.9	0.60602	0.8918	1.4978
400	444.69	0.019340	1.1426	1.1619	422.77	696.6	1119.4	424.21	781.3	1205.5	0.62177	0.8638	1.4856
450	456.39	0.019547	1.0131	1.0326	435.71	683.9	1119.6	437.34	768.3	1205.6	0.63600	0.8385	1.4745
500	467.12	0.019748	0.9085	0.92828	447.69	671.7	1119.4	449.51	755.8	1205.3	0.64901	0.8155	1.4645
550	477.06	0.019942	0.8224	0.84230	458.88	660.2	1119.1	460.91	743.9	1204.8	0.66104	0.7941	1.4551
600	486.33	0.020133	0.7500	0.77016	469.40	649.1	1118.5	471.64	732.5	1204.1	0.67225	0.7742	1.4464
700	503.22	0.020505	0.6353	0.65579	488.85	628.2	1117.0	491.50	710.5	1202.0	0.69266	0.7378	1.4305
800	518.36	0.020870	0.5482	0.56906	506.58	608.4	1115.0	509.67	689.6	1199.3	0.71099	0.7050	1.4160
900	532.11	0.021231	0.4797	0.50093	523.00	589.6	1112.6	526.54	669.5	1196.0	0.72772	0.6750	1.4027
1000	544.74	0.021590	0.4243	0.44591	538.37	571.5	1109.9	542.36	650.0	1192.4	0.74318	0.6471	1.3903
1200	567.36	0.022318	0.3400	0.36232	566.69	536.8	1103.5	571.64	612.3	1183.9	0.77120	0.5961	1.3673
1400	587.25	0.023070	0.2785	0.30156	592.63	503.4	1096.0	598.61	575.5	1174.1	0.79640	0.5497	1.3461
1600	605.05	0.023863	0.2313	0.25515	616.91	470.5	1087.4	623.98	538.9	1162.9	0.81960	0.5062	1.3258
1800	621.20	0.024715	0.1936	0.21831	640.02	437.7	1077.7	648.26	502.1	1150.4	0.84140	0.4645	1.3059
2000	635.99	0.025648	0.1625	0.18813	662.38	404.2	1066.6	671.87	464.4	1136.3	0.86224	0.4239	1.2861
2500	668.30	0.028602	0.1020	0.13059	717.62	313.4	1031.0	730.85	360.6	1091.4	0.91302	0.3196	1.2326
3000	695.52	0.03430	0.0497	0.08402	783.37	185.4	968.8	802.41	213.0	1015.4	0.97312	0.1844	1.1575
3203.6	705.44	0.050531	0	0.05053	872.56	0	872.6	902.52	0	902.5	1.05801	0	1.0580

Tabla A.1.3 I Vapor de Agua sobrecalentado.

Temp.ºF T	P = 1.00 lb_f/pulg² (101.70ºF)				P = 5.00 lb_f/pulg² (162.20ºF)				P = 10.0 lb_f/pulg² (193.19ºF)			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)
Sat	333.58	1044.0	1105.7	1.9779	73.531	1063.0	1131.0	1.8441	38.424	1072.2	1143.3	1.7877
200	392.51	1077.5	1150.1	2.0507	78.147	1076.2	1148.6	1.8715	38.848	1074.7	1146.6	1.7927
240	416.42	1091.2	1168.3	2.0775	83.001	1090.3	1167.1	1.8987	41.320	1089.0	1165.5	1.8205
280	440.32	1105.0	1186.5	2.1028	87.831	1104.3	1185.5	1.9244	43.768	1103.3	1184.3	1.8467
320	464.19	1118.9	1204.8	2.1269	92.645	1118.3	1204.0	1.9487	46.200	1117.6	1203.0	1.8713
360	488.05	1132.9	1223.2	2.1499	97.447	1132.4	1222.6	1.9719	48.620	1131.8	1221.8	1.8948
400	511.91	1147.0	1241.7	2.1720	102.24	1146.6	1241.2	1.9941	51.032	1146.1	1240.5	1.9171
440	535.76	1161.2	1260.4	2.1932	107.03	1160.9	1259.9	2.0154	53.438	1160.5	1259.3	1.9385
500	571.53	1182.8	1288.5	2.2235	114.21	1182.5	1288.2	2.0458	57.039	1182.2	1287.7	1.9690
600	631.13	1219.3	1336.1	2.2706	126.15	1219.1	1335.8	2.0930	63.027	1218.8	1335.5	2.0164
700	690.72	1256.7	1384.5	2.3142	138.09	1256.5	1384.3	2.1367	69.006	1256.3	1384.0	2.0601
800	750.30	1294.9	1433.7	2.3549	150.01	1294.7	1433.5	2.1774	74.978	1294.6	1433.3	2.1009
1000	869.45	1373.9	1534.8	2.4294	173.86	1373.8	1534.7	2.2520	86.912	1373.7	1534.6	2.1755
1200	988.60	1456.7	1639.6	2.4967	197.70	1456.6	1639.5	2.3192	98.837	1456.5	1639.4	2.2428
1400	1107.74	1543.1	1747.1	2.5584	221.54	1543.1	1748.1	2.3809	110.759	1543.0	1748.0	2.3045

Temp.ºF T	P = 14.696 lb_f/pulg² (211.99ºF)				P = 20 lb_f/pulg² (227.96ºF)				P = 40 lb_f/pulg² (267.26ºF)			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)
Sat	26.803	1077.6	1150.5	1.7567	20.091	1082.0	1156.4	1.7320	10.501	1092.3	1170.0	1.6767
240	27.999	1087.9	1164.0	1.7764	20.475	1086.5	1162.3	1.7405	-	-	-	-
280	29.687	1102.4	1183.1	1.8030	21.734	1101.4	1181.8	1.7676	10.711	1097.3	1176.6	1.6857
320	31.358	1116.8	1202.1	1.8280	22.976	1116.0	1201.0	1.7929	11.360	1112.8	1196.9	1.7124
360	33.018	1131.2	1221.0	1.8516	24.206	1130.6	1220.1	1.8168	11.996	1128.0	1216.8	1.7373
400	34.668	1145.6	1239.9	1.8741	25.427	1145.1	1239.2	1.8395	12.623	1143.0	1236.4	1.7606
440	36.313	1160.0	1258.8	1.8956	26.642	1159.6	1258.2	1.8611	13.242	1157.8	1255.8	1.7827
500	38.772	1181.8	1287.3	1.9262	28.456	1181.5	1286.8	1.8919	14.164	1180.1	1284.9	1.8140
600	42.857	1218.6	1335.2	1.9737	31.466	1218.3	1134.8	1.9395	15.685	1217.3	1333.4	1.8621
700	46.932	1256.1	1383.8	2.0175	34.466	1255.9	1383.5	1.9834	17.196	1255.1	1382.4	1.9063
800	51.001	1294.4	1433.1	2.0584	37.460	1294.3	1432.9	2.0243	18.701	1293.7	1432.1	1.9474
1000	59.128	1373.6	1534.4	2.1330	43.437	1373.5	1534.3	2.0989	21.700	1373.1	1533.7	2.0222
1200	67.247	1456.5	1639.3	2.2003	49.406	1456.4	1639.2	2.1663	24.690	1456.1	1638.9	2.0897
1400	75.361	1543.0	1747.9	2.2620	55.371	1542.9	1747.8	2.2280	27.677	1542.7	1747.6	2.1515
1600	83.473	1633.2	1860.2	2.3194	61.333	1633.1	1860.1	2.2854	30.660	1633.0	1859.9	2.2089

Tabla A.1.3 I Vapor de Agua sobrecalentado.

Temp.ºF T	P = 60 lb$_f$/pulg^2 (292.73ºF)				P = 80 lb$_f$/pulg^2 (312.06ºF)				P = 100 lb$_f$/pulg^2 (327.86ºF)			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
Sat	7.177	1098.3	1178.0	1.6444	5.474	1102.6	1183.6	1.6214	4.434	1105.8	1187.8	1.6035
320	7.485	1109.5	1192.6	1.6633	5.544	1105.9	1188.0	1.6270	-	-	-	-
360	7.924	1125.3	1213.3	1.6893	5.886	1122.5	1209.7	1.6541	4.662	1119.7	1205.9	1.6259
400	8.353	1140.8	1233.5	1.7134	6.217	1138.5	1230.6	1.6790	4.934	1136.2	1227.5	1.6517
440	8.775	1156.0	1253.4	1.7360	6.541	1154.1	1251.0	1.7022	5.199	1152.2	1248.5	1.6755
500	9.399	1178.6	1283.0	1.7678	7.017	1177.2	1281.1	1.7346	5.587	1175.7	1279.1	1.7085
600	10.425	1216.3	1332.1	1.8165	7.794	1215.3	1330.7	1.7838	6.216	1214.2	1329.3	1.7582
700	11.440	1254.4	1381.4	1.8609	8.561	1253.6	1380.3	1.8285	6.834	1252.8	1379.2	1.8033
800	12.448	1293.0	1431.2	1.9022	9.321	1292.4	1430.4	1.8700	7.445	1291.8	1429.6	1.8449
1000	14.454	1372.7	1533.2	1.9773	10.831	1372.3	1532.6	1.9453	8.657	1371.9	1532.1	1.9204
1200	16.452	1455.8	1638.5	2.0448	12.333	1455.5	1638.1	2.0129	9.861	1455.2	1637.7	1.9882
1400	18.445	1542.5	1747.3	2.1067	13.830	1542.3	1747.0	2.0749	11.060	1542.0	1746.7	2.0502
1600	20.436	1632.8	1859.7	2.1641	15.324	1632.6	1859.5	2.1323	12.257	1632.4	1859.3	2.1076
1800	22.426	1726.7	1975.7	2.2178	16.818	1726.5	1975.5	2.1861	13.452	1726.4	1975.3	2.1614
2000	24.415	1824.0	2095.1	2.2685	18.310	1823.9	2094.9	2.2367	14.647	1823.7	2094.8	2.2120

Temp.ºF T	P = 120 lb$_f$/pulg^2 (341.30ºF)				P = 140 lb$_f$/pulg^2 (353.08ºF)				P = 160 lb$_f$/pulg^2 (363.59ºF)			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
Sat	3.730	1108.3	1191.1	1.5886	3.221	1110.3	1193.8	1.5760	2.836	1112.0	1196.0	1.5650
360	3.844	1116.6	1202.0	1.6021	3.259	1113.5	1197.9	1.5812	-	-	-	-
400	4.079	1133.8	1224.4	1.6287	3.466	1131.4	1221.2	1.6088	3.007	1128.8	1217.8	1.5910
450	4.360	1154.3	1251.2	1.6590	3.713	1152.4	1248.6	1.6399	3.228	1150.5	1246.1	1.6230
500	4.633	1174.2	1277.1	1.6868	3.952	1172.7	1275.1	1.6682	3.440	1171.1	1273.0	1.6518
550	4.900	1193.8	1302.6	1.7127	4.184	1192.5	1300.9	1.6944	3.646	1191.2	1299.2	1.6784
600	5.164	1213.2	1327.8	1.7371	4.412	1212.1	1326.4	1.7191	3.848	1211.0	1325.0	1.7033
700	5.682	1252.0	1378.2	1.7825	4.860	1251.2	1377.1	1.7648	4.243	1250.4	1376.0	1.7494
800	6.195	1291.2	1428.7	1.8243	5.301	1290.5	1427.9	1.8068	4.631	1289.9	1427.0	1.7916
1000	7.208	1371.5	1531.5	1.9000	6.173	1371.0	1531.0	1.8827	5.397	1370.6	1530.4	1.8677
1200	8.213	1454.9	1637.3	1.9679	7.036	1454.6	1636.9	1.9507	6.154	1454.3	1636.5	1.9358
1400	9.214	1541.8	1746.4	2.0300	7.895	1541.6	1746.1	2.0128	6.906	1541.4	1745.8	1.9980
1600	10.212	1632.3	1859.0	2.0875	8.752	1632.1	1858.8	2.0704	7.656	1631.9	1858.6	2.0556
1800	11.209	1726.2	1975.1	2.1412	9.607	1726.1	1975.0	2.1242	8.405	1725.9	1974.8	2.1094
2000	12.205	1823.6	2094.6	2.1919	10.461	1823.5	2094.5	2.1748	9.153	1823.3	2094.3	2.1601

Tabla A.1.3 I Vapor de Agua sobrecalentado.

Temp.ºF T	P = 180 lb$_f$/pulg^2 (373.12ºF)				P = 200 lb$_f$/pulg^2 (381.86ºF)				P = 225 lb$_f$/pulg^2 (391.86ºF)			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
Sat	2.533	1113.4	1197.8	1.5553	2.289	1114.6	1199.3	1.5464	2.043	1115.8	1200.8	1.5364
400	2.648	1126.2	1214.4	1.5749	2.361	1123.5	1210.8	1.5600	2.073	1119.9	1206.2	1.5427
450	2.850	1148.5	1243.4	1.6078	2.548	1146.4	1240.7	1.5938	2.245	1143.8	1237.3	1.5779
500	3.042	1169.6	1270.9	1.6372	2.724	1168.0	1268.8	1.6238	2.405	1165.9	1266.1	1.6087
550	3.228	1190.0	1297.5	1.6641	2.893	1188.6	1295.7	1.6512	2.558	1187.0	1293.5	1.6366
600	3.409	1210.0	1323.5	1.6893	3.058	1208.9	1322.0	1.6767	2.707	1207.5	1320.2	1.6624
700	3.763	1249.6	1374.9	1.7357	3.379	1248.8	1373.8	1.7234	2.995	1247.7	1372.4	1.7095
800	4.110	1289.3	1426.2	1.7781	3.693	1288.6	1425.3	1.7659	3.276	1287.8	1424.2	1.7523
900	4.453	1329.4	1477.7	1.8175	4.003	1328.9	1477.0	1.8055	3.553	1328.3	1476.2	1.7920
1000	4.793	1370.2	1529.8	1.8544	4.310	1369.8	1529.3	1.8425	3.827	1369.2	1528.6	1.8292
1200	5.467	1454.0	1636.1	1.9227	4.918	1453.7	1635.7	1.9109	4.369	1453.4	1635.2	1.8977
1400	6.137	1541.2	1745.6	1.9849	5.521	1540.9	1745.3	1.9732	4.906	1540.7	1744.9	1.9600
1600	6.804	1631.7	1858.4	2.0425	6.123	1631.6	1858.1	2.0308	5.441	1631.3	1857.9	2.0177
1800	7.470	1725.8	1974.6	2.0963	6.722	1725.6	1974.4	2.0847	5.975	1725.4	1974.2	2.0716
2000	8.135	1823.2	2094.1	2.1470	7.321	1823.0	2094.0	2.1354	6.507	1822.8	2093.8	2.1223

Temp.ºF T	P = 250 lb$_f$/pulg^2 (401.03ºF)				P = 275 lb$_f$/pulg^2 (409.52ºF)				P = 300 lb$_f$/pulg^2 (417.42ºF)			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
Sat	1.8448	1116.7	1202.1	1.5274	1.6813	1117.5	1203.1	1.5191	1.5441	1118.1	1203.9	1.5115
450	2.0018	1141.1	1233.7	1.5632	1.8026	1138.3	1230.0	1.5494	1.6361	1135.4	1226.2	1.5365
500	2.1498	1163.8	1263.3	1.5948	1.9407	1161.7	1260.4	1.5820	1.7662	1159.5	1257.5	1.5701
550	2.2903	1185.3	1291.3	1.6233	2.0708	1183.6	1289.0	1.6110	1.8878	1181.8	1286.5	1.5997
600	2.4258	1206.1	1318.3	1.6494	2.1958	1204.7	1316.4	1.6375	2.0041	1203.2	1314.5	1.6266
650	2.5581	1226.5	1344.8	1.6739	2.3174	1225.3	1343.2	1.6623	2.1168	1224.1	1341.6	1.6516
700	2.6879	1246.7	1371.1	1.6970	2.4365	1245.7	1369.7	1.6856	2.2269	1244.6	1368.3	1.6751
800	2.9426	1287.0	1423.2	1.7401	2.6696	1286.2	1422.1	1.7289	2.4421	1285.4	1421.0	1.7187
900	3.1929	1327.6	1475.3	1.7799	2.8983	1327.0	1474.5	1.7689	2.6528	1326.3	1473.6	1.7589
1000	3.4402	1368.7	1527.9	1.8172	3.1239	1368.2	1527.2	1.8063	2.8604	1367.7	1526.4	1.7964
1200	3.9291	1453.0	1634.8	1.8858	3.5696	1452.6	1634.3	1.8751	3.2700	1452.2	1633.8	1.8653
1400	4.4136	1540.4	1744.6	1.9483	4.0108	1540.1	1744.2	1.9376	3.6751	1539.8	1743.8	1.9279
1600	4.8957	1631.1	1857.6	2.0060	4.4495	1630.9	1857.3	1.9954	4.0777	1630.7	1857.0	1.9857
1800	5.3763	1725.2	1974.0	2.0599	4.8868	1725.0	1973.7	2.0493	4.4790	1724.8	1973.5	2.0396
2000	5.8562	1822.7	2093.6	2.1106	5.3234	1822.5	2093.4	2.1000	4.8794	1822.3	2093.2	2.0904

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 827 – 828, tabla A.1.3I.

Tabla A.1.3 I Vapor de Agua sobrecalentado.

Temp.ºF T	P = 350 lbf/pulg² (431.81ºF)				P = 400 lbf/pulg² (444.69ºF)				P = 450 lbf/pulg² (456.39ºF)			
	v (ft³/lbm)	u (Btu/lbm)	h (Btu/lbm)	s (Btu/lbm.ºR)	v (ft³/lbm)	u (Btu/lbm)	h (Btu/lbm)	s (Btu/lbm.ºR)	v (ft³/lbm)	u (Btu/lbm)	h (Btu/lbm)	s (Btu/lbm.ºR)
Sat	1.3267	1119.0	1204.9	1.4978	1.1619	1119.4	1205.5	1.4856	1.0326	1119.6	1205.6	1.4745
450	1.3733	1129.2	1218.2	1.5125	1.1745	1122.6	1209.6	1.4901	-	-	-	-
500	1.4913	1154.9	1251.5	1.5481	1.2843	1150.1	1245.2	1.5282	1.1226	1145.0	1238.5	1.5097
550	1.5998	1178.3	1281.9	1.5790	1.3834	1174.6	1277.0	1.5605	1.2146	1170.7	1271.9	1.5436
600	1.7025	1200.3	1310.6	1.6068	1.4760	1197.3	1306.6	1.5892	1.2996	1194.3	1302.5	1.5732
650	1.8013	1221.6	1338.3	1.6323	1.5646	1219.1	1334.9	1.6153	1.3803	1216.6	1331.5	1.6000
700	1.8975	1242.5	1365.4	1.6562	1.6503	1240.4	1362.5	1.6396	1.4580	1238.2	1359.6	1.6248
800	2.0846	1283.8	1418.8	1.7004	1.8163	1282.1	1416.6	1.6844	1.6077	1280.5	1414.4	1.6700
900	2.2670	1325.0	1471.8	1.7409	1.9776	1323.7	1470.1	1.7252	1.7524	1322.4	1468.3	1.7113
1000	2.4463	1366.6	1525.0	1.7787	2.1357	1365.5	1523.6	1.7632	1.8941	1364.4	1522.2	1.7495
1200	2.7993	1451.5	1632.8	1.8478	2.4462	1450.7	1631.8	1.8327	2.1715	1450.0	1630.8	1.8192
1400	3.1476	1539.3	1743.0	1.9106	2.7520	1538.7	1742.4	1.8956	2.4443	1538.1	1741.7	1.8823
1600	3.4935	1630.2	1856.5	1.9685	3.0553	1629.8	1855.9	1.9535	2.7146	1629.3	1855.4	1.9403
1800	3.8380	1724.5	1973.0	2.0225	3.3573	1724.1	1972.6	2.0076	2.9834	1723.7	1972.1	1.9944
2000	4.1817	1822.0	2092.8	2.0732	3.6585	1821.6	2092.4	2.0584	3.2515	1821.3	2092.0	2.0452

Temp.ºF T	P = 500 lbf/pulg² (467.12ºF)				P = 600 lbf/pulg² (486.33ºF)				P = 700 lbf/pulg² (503.22ºF)			
	v (ft³/lbm)	u (Btu/lbm)	h (Btu/lbm)	s (Btu/lbm.ºR)	v (ft³/lbm)	u (Btu/lbm)	h (Btu/lbm)	s (Btu/lbm.ºR)	v (ft³/lbm)	u (Btu/lbm)	h (Btu/lbm)	s (Btu/lbm.ºR)
Sat	0.9283	1119.4	1205.3	1.4645	0.7702	1118.5	1204.1	1.4464	0.6558	1117.0	1202.0	1.4305
500	0.9924	1139.7	1231.5	1.4922	0.7947	1128.0	1216.2	1.4592	0.7275	1149.0	1243.2	1.4723
550	1.0792	1166.7	1266.6	1.5279	0.8749	1157.2	1255.4	1.4990	0.7929	1177.5	1280.2	1.5081
600	1.1583	1191.1	1298.3	1.5585	0.9456	1184.5	1289.5	1.5320	0.8520	1203.0	1313.4	1.5387
650	1.2327	1214.0	1328.0	1.5860	1.0109	1208.6	1320.9	1.5609	0.9073	1226.9	1344.4	1.5660
700	1.3040	1236.0	1356.7	1.6112	1.0728	1231.5	1350.6	1.5871	1.0109	1272.0	1402.9	1.6145
800	1.4407	1278.8	1412.1	1.6571	1.1900	1275.4	1407.6	1.6343	1.1089	1315.6	1459.3	1.6575
900	1.5723	1321.0	1466.5	1.6986	1.3021	1318.4	1462.9	1.6766	1.2036	1358.9	1514.9	1.6970
1000	1.7008	1363.3	1520.7	1.7371	1.4108	1361.2	1517.8	1.7155	1.2960	1402.4	1570.2	1.7337
1100	1.8271	1406.0	1575.1	1.7731	1.5173	1404.2	1572.7	1.7519	1.3868	1446.1	1625.8	1.7682
1200	1.9518	1449.2	1629.8	1.8071	1.6222	1447.7	1627.8	1.7861	1.5632	1535.3	1738.1	1.8321
1400	2.1981	1537.6	1741.0	1.8704	1.8289	1536.4	1739.5	1.8497	1.7409	1627.1	1852.6	1.8905
1600	2.4419	1628.9	1854.8	1.9285	2.0330	1628.0	1853.7	1.9080	1.9152	1721.8	1969.9	1.9449
1800	2.6843	1723.3	1971.7	1.9826	2.2357	1722.6	1970.8	1.9622	2.0887	1819.5	2090.1	1.9958
2000	2.9259	1820.9	2091.6	2.0335	2.4375	1820.2	2090.8	2.0131	-	-	-	-

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 828 – 829, tabla A.1.3I.

Tabla A.1.3 I Vapor de Agua sobrecalentado.

Temp.ºF T	P = 800 lb_f/pulg² (518.36ºF)				P = 1000 lb_f/pulg² (544.74ºF)				P = 1250 lb_f/pulg² (572.56ºF)			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)
Sat	0.5691	1115.0	1199.3	1.4160	0.4459	1109.9	1192.4	1.3903	0.3454	1101.7	1181.6	1.3619
550	0.6154	1138.8	1229.9	1.4469	0.4534	1114.8	1198.7	1.3965	-	-	-	-
600	0.6776	1170.1	1270.4	1.4861	0.5140	1153.7	1248.8	1.4450	0.3786	1129.0	1216.6	1.3954
650	0.7324	1197.2	1305.6	1.5186	0.5637	1184.7	1289.1	1.4822	0.4267	1167.2	1266.0	1.4409
700	0.7829	1222.1	1338.0	1.5471	0.6080	1212.0	1324.5	1.5135	0.4670	1198.4	1306.4	1.4766
750	0.8306	1245.7	1368.6	1.5729	0.6490	1237.2	1357.3	1.5412	0.5030	1226.1	1342.4	1.5070
800	0.8764	1268.5	1398.2	1.5969	0.6878	1261.2	1388.5	1.5664	0.5364	1251.8	1375.8	1.5341
900	0.9640	1312.9	1455.6	1.6408	0.7610	1307.3	1448.1	1.6120	0.5984	1300.0	1438.4	1.5819
1000	1.0482	1356.7	1511.9	1.6807	0.8305	1352.2	1505.9	1.6530	0.6563	1346.4	1498.2	1.6244
1100	1.1300	1400.5	1567.8	1.7178	0.8976	1396.8	1562.9	1.6908	0.7116	1392.0	1556.6	1.6631
1200	1.2102	1444.6	1623.8	1.7525	0.9630	1441.5	1619.7	1.7260	0.7652	1437.5	1614.5	1.6990
1400	1.3674	1534.2	1736.6	1.8167	1.0905	1531.9	1733.7	1.7909	0.8690	1529.0	1730.0	1.7647
1600	1.5218	1626.2	1851.5	1.8754	1.2152	1624.4	1849.3	1.8499	0.9699	1622.1	1846.5	1.8242
1800	1.6749	1721.0	1969.0	1.9298	1.3384	1719.5	1967.2	1.9046	1.0693	1717.6	1964.9	1.8791
2000	1.8271	1818.8	2089.3	1.9808	1.4608	1817.4	2087.7	1.9557	1.1678	1815.7	2085.8	1.9304

Temp.ºF T	P = 1500 lb_f/pulg² (596.38ºF)				P = 1750 lb_f/pulg² (617.30ºF)				P = 2000 lb_f/pulg² (635.99ºF)			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)
Sat	0.2769	1091.8	1168.7	1.3358	0.2268000	1080.2	1153.7	1.3109	0.1881	1066.6	1136.3	1.2861
600	0.2816	1096.6	1174.8	1.3416	-	-	-	-	-	-	-	-
650	0.3329	1147.0	1239.3	1.4012	0.2627	1122.5	1207.6	1.3603	0.2057	1091.1	1167.2	1.3141
700	0.3716	1183.4	1286.6	1.4429	0.3022	1166.7	1264.6	1.4106	0.2487	1147.7	1239.8	1.3782
750	0.4049	1214.1	1326.5	1.4766	0.3341	1201.3	1309.5	1.4485	0.2803	1187.3	1291.1	1.4216
800	0.4350	1241.8	1362.5	1.5058	0.3622	1231.3	1348.6	1.4801	0.3071	1220.1	1333.8	1.4562
850	0.4631	1267.7	1396.2	1.5321	0.3878	1258.8	1384.4	1.5080	0.3312	1249.5	1372.0	1.4860
900	0.4897	1292.5	1428.5	1.5562	0.4119	1284.8	1418.2	1.5334	0.3534	1276.8	1407.6	1.5126
1000	0.5400	1340.4	1490.3	1.6001	0.4569	1334.3	1482.3	1.5789	0.3945	1328.1	1474.1	1.5598
1100	0.5876	1387.2	1550.3	1.6398	0.4990	1382.2	1543.8	1.6197	0.4325	1377.2	1537.2	1.6017
1200	0.6334	1433.4	1609.3	1.6765	0.5392	1429.3	1603.9	1.6570	0.4685	1425.2	1598.6	1.6398
1400	0.7213	1526.1	1726.3	1.7431	0.6158	1523.1	1722.6	1.7245	0.5368	1520.2	1718.8	1.7082
1600	0.8064	1619.9	1843.7	1.8031	0.6896	1617.6	1840.9	1.7850	0.6020	1615.4	1838.2	1.7692
1800	0.8899	1715.7	1962.7	1.8582	0.7617	1713.8	1960.5	1.8404	0.6656	1712.0	1958.3	1.8248
2000	0.9725	1814.0	2093.9	1.9096	0.8330	1812.3	2082.0	1.8919	0.7284	1810.6	2080.1	1.8765

Tabla A.1.3 I Vapor de Agua sobrecalentado.

Temp.ºF T	P = 2500 lb_f/pulg² (668.30ºF)				P = 3000 lb_f/pulg² (695.52ºF)				P = 3500 lb_f/pulg²			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)
Sat	0.13059	1031.0	1091.4	1.2326	0.08402	968.8	1015.4	1.1575	-	-	-	-
650	-	-	-	-	-	-	-	-	0.02491	663.5	679.6	0.8629
700	0.16840	1098.7	1176.6	1.3073	0.09772	1003.9	1058.1	1.1944	0.03058	759.5	779.3	0.9506
750	0.20302	1155.2	1249.1	1.3686	0.14831	1114.7	1197.1	1.3122	0.10460	1058.4	1126.1	1.2440
800	0.22907	1195.7	1301.7	1.4112	0.17572	1167.6	1265.2	1.3675	0.13626	1134.7	1123.0	1.3226
850	0.25126	1229.5	1345.8	1.4456	0.19731	1207.6	1317.2	1.4080	0.15819	1183.4	1285.9	1.3716
900	0.27118	1259.9	1385.4	1.4752	0.21598	1241.8	1361.7	1.4413	0.17625	1222.4	1336.5	1.4095
950	0.28960	1288.2	1422.2	1.5018	0.23284	1272.7	1402.0	1.4705	0.19214	1256.4	1380.8	1.4416
1000	0.30694	1315.2	1457.2	1.5262	0.24847	1301.7	1439.6	1.4967	0.20663	1287.6	1421.4	1.4699
1100	0.33933	1366.8	1523.8	1.5704	0.27720	1356.2	1510.0	1.5434	0.23282	1345.2	1496.0	1.5193
1200	0.36958	1416.7	1587.7	1.6101	0.30365	1408.0	1576.6	1.5847	0.25657	1399.1	1565.3	1.5624
1300	0.39836	1465.7	1650.0	1.6465	0.32855	1458.5	1640.8	1.6223	0.27871	1451.1	1631.6	1.6012
1400	0.42609	1514.2	1711.3	1.6804	0.35236	1508.1	1703.7	1.6571	0.29972	1501.9	1696.1	1.6368
1600	0.47947	1610.8	1832.6	1.7424	0.39782	1606.3	1827.1	1.7201	0.33953	1601.7	1821.6	1.7010
1800	0.53116	1708.2	1954.0	1.7986	0.44156	1704.5	1949.6	1.7769	0.37759	1700.8	1945.4	1.7583

Temp.ºF T	P = 4000 lb_f/pulg²				P = 5000 lb_f/pulg²				P = 6000 lb_f/pulg²			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)
650	0.02447	657.7	675.8	0.8574	0.02377	648.0	670.0	0.8482	0.02322	640.0	665.8	0.8404
700	0.02867	742.1	763.3	0.9345	0.02676	721.8	746.5	0.9156	0.02563	708.1	736.5	0.9028
750	0.06332	960.7	1007.6	1.1395	0.03364	821.4	852.6	1.0049	0.02978	788.6	821.7	0.9746
800	0.10523	1095.0	1172.9	1.2740	0.05933	987.2	1042.1	1.1583	0.03942	896.9	940.6	1.0708
850	0.12833	1156.5	1251.5	1.3352	0.08556	1092.7	1171.9	1.2596	0.05828	1018.8	1083.4	1.1820
900	0.14623	1201.5	1309.7	1.3789	0.10385	1155.1	1251.1	1.3190	0.07588	1102.9	1187.2	1.2599
950	0.16152	1239.2	1358.8	1.4143	0.11853	1202.2	1311.8	1.3629	0.09009	1162.0	1262.0	1.3140
1000	0.17520	1272.9	1402.6	1.4449	0.13120	1242.0	1363.4	1.3988	0.10207	1209.1	1322.4	1.3561
1100	0.19954	1333.9	1481.6	1.4973	0.15302	1310.6	1452.2	1.4577	0.12219	1286.4	1422.1	1.4222
1200	0.22129	1390.1	1553.9	1.5423	0.17199	1371.6	1530.8	1.5066	0.13928	1352.7	1507.3	1.4752
1300	0.24137	1443.7	1622.4	1.5823	0.18919	1428.6	1603.7	1.5493	0.15453	1413.3	1584.9	1.5206
1400	0.26029	1495.7	1688.4	1.6188	0.20517	1483.2	1673.0	1.5876	0.16854	1470.5	1657.6	1.5608
1600	0.29856	1597.1	1816.1	1.6841	0.23480	1587.9	1805.2	1.6551	0.19421	1578.7	1794.3	1.6307
1800	0.32964	1697.1	1941.1	1.7420	0.26261	1689.7	1932.7	1.7142	0.21801	1682.4	1924.5	1.6910
2000	0.36251	1797.3	2065.6	1.7948	0.28947	1790.8	2058.6	1.7676	0.24087	1784.3	2051.7	1.7450

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 830 – 831, tabla A.1.3I.

Tabla A.1.4 I Agua líquida comprimida.

Temp.ºF T	P = 500 lb$_f$/pulg^2 (467.12ºF)				P = 1000 lb$_f$/pulg^2 (544.74ºF)				P = 1500 lb$_f$/pulg^2 (596.39ºF)			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
Sat	0.019748	447.69	449.51	0.64901	0.021590	538.37	542.36	0.74318	0.023461	604.95	611.46	0.80821
32	0.015994	0.00	1.48	0.00000	0.015967	0.02	2.98	0.00004	0.015939	0.04	4.47	0.00006
50	0.015998	18.02	19.50	0.03599	0.015971	17.98	20.94	0.03592	0.015946	17.95	22.37	0.03583
100	0.016106	67.87	69.36	0.12931	0.016081	67.70	70.67	0.12900	0.016057	67.53	71.99	0.12869
150	0.016318	117.66	119.17	0.21455	0.016293	117.37	120.39	0.21409	0.016268	117.10	121.61	0.21362
200	0.016607	167.64	169.18	0.29339	0.016580	167.25	170.32	0.29279	0.016554	166.86	171.46	0.29220
250	0.016978	217.99	219.56	0.36700	0.016941	217.46	220.60	0.36626	0.016910	216.95	221.65	0.36553
300	0.017416	268.91	270.52	0.43640	0.017379	268.24	271.45	0.43550	0.017343	267.57	272.39	0.43462
350	0.017954	320.7	322.36	0.50247	0.017909	319.83	323.14	0.50139	0.017865	318.97	323.93	0.50032
400	0.018608	373.68	375.40	0.56603	0.018549	382.55	375.98	0.56471	0.018493	371.45	376.58	0.56341
450	0.019420	428.39	430.19	0.62797	0.019340	426.89	430.47	0.62630	0.019264	425.43	430.78	0.62468
500	-	-	-	-	0.020357	483.77	487.54	0.68736	0.020245	481.76	487.38	0.68524
550	-	-	-	-	-	-	-	-	0.021579	542.08	548.07	0.74686

Temp.ºF T	P = 2000 lb$_f$/pulg^2 (635.99ºF)				P = 3000 lb$_f$/pulg^2 (695.52ºF)				P = 5000 lb$_f$/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
Sat.	0.025648	662.38	671.87	0.86224	0.034300	783.37	802.41	0.97312	-	-	-	-
32	0.015912	0.06	5.95	0.00008	0.015859	0.09	8.89	0.00009	0.015755	0.11	14.69	-0.00002
50	0.015920	17.91	23.80	0.03574	0.015870	17.83	26.64	0.03555	0.015773	17.66	32.26	0.03507
100	0.016034	67.36	73.30	0.12838	0.015987	67.03	75.91	0.12776	0.015897	66.40	81.11	0.12650
200	0.016527	166.48	172.60	0.29161	0.016476	165.74	174.88	0.29044	0.016376	164.31	179.49	0.28817
300	0.017308	266.92	273.33	0.43374	0.017240	265.65	275.22	0.43203	0.017110	263.24	279.07	0.42874
400	0.018439	370.38	377.20	0.56214	0.018334	368.31	378.49	0.55969	0.018141	364.46	381.24	0.55504
450	0.019191	424.03	431.13	0.62312	0.019052	421.35	431.93	0.6201	0.018802	416.44	433.83	0.61449
500	0.020139	479.84	487.29	0.6832	0.019944	476.24	487.31	0.67935	0.019603	469.80	487.93	0.67238
550	0.021407	539.24	547.16	0.74400	0.021103	534.07	545.79	0.73874	0.020602	525.24	544.30	0.72963
600	0.023302	605.37	613.99	0.80856	0.022736	596.99	609.62	0.80041	0.021914	583.96	604.23	0.78555

Tabla A.1.5 I **Agua** sólido saturado - vapor saturado.

Temp.ºF T	Presión lb$_f$/pulg^2, P	Volumen específico, ft^3/lb$_m$			Energía interna, Btu/lb$_m$			Entalpía, Btu/lb$_m$			Entropía, Btu/lb$_m$.ºR		
		Sólido saturado v_i	Sublim v_{ig}	Vapor saturado v_g	Sólido saturado u_i	Sublim u_{ig}	Vapor saturado u_g	Sólido saturado h_i	Sublim h_{ig}	Vapor saturado h_g	Sólido saturado s_i	Sublim s_{ig}	Vapor saturado s_g
32.02	0.08866	0.017473	3301.9825	3302	-143.34	1164.5	1021.2	-143.34	1218.7	1075.4	-0.2916	2.4785	2.1869
32	0.08859	0.01747	3304.9825	3305	-143.35	1164.6	1021.2	-143.35	1218.8	1075.4	-0.2917	2.4787	2.1870
30	0.08083	0.01747	3606.9825	3607	-144.35	1164.9	1020.5	-144.35	1218.9	1074.5	-0.2938	2.4891	2.1953
25	0.06406	0.01746	4504.9825	4505	-146.84	1165.7	1018.9	-146.84	1219.1	1072.3	-0.2990	2.5154	2.2164
20	0.05051	0.01745	5654.9826	5655	-149.31	1166.5	1017.2	-149.31	1219.4	1070.1	-0.3042	2.5422	2.2380
15	0.03963	0.01745	7132.9826	7133	-151.75	1167.4	1015.6	-151.75	1219.7	1067.9	-0.3093	2.5694	2.2601
10	0.03093	0.01744	9042.9826	9043	-154.16	1168.1	1013.9	-154.16	1219.9	1065.7	-0.3145	2.5972	2.2827
5	0.02402	0.01743	11521.983	11522	-156.56	1168.8	1012.2	-156.56	1220.1	1063.5	-0.3197	2.6256	2.3059
0	0.01855	0.01742	14760.983	14761	-158.93	1169.5	1010.6	-158.93	1220.1	1061.2	-0.3248	2.6544	2.3296
-5	0.01424	0.01742	19018.983	19019	-161.27	1170.2	1008.9	-161.27	1220.3	1059.0	-0.3300	2.6839	2.3539
-10	0.01086	0.01741	24656.983	24657	-163.59	1170.9	1007.3	-163.59	1220.4	1056.8	-0.3351	2.7139	2.3788
-15	0.00823	0.01740	32168.983	32169	-165.89	1171.5	1005.6	-165.89	1220.5	1054.6	-0.3403	2.7447	2.4044
-20	0.00620	0.01740	42237.983	42238	-168.16	1172.1	1003.9	-168.16	1220.6	1052.4	-0.3455	2.7762	2.4307
-25	0.00464	0.01739	55781.983	55782	-170.40	1172.7	1002.3	-170.40	1220.6	1050.2	-0.3506	2.8081	2.4575
-30	0.00346	0.01738	74045.983	74046	-172.63	1173.2	1000.6	-172.63	1220.6	1048.0	-0.3557	2.8406	2.4849
-35	0.00256	0.01737	98889.983	98890	-174.82	1173.7	998.9	-174.82	1220.5	1045.7	-0.3608	2.8737	2.5129
-40	0.00187	0.01737	134016.98	134017	-177.00	1174.3	997.3	-177.00	1220.5	1043.5	-0.3659	2.9084	2.5425

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 833, tabla A.1.5I.

Tabla A.2 I Propiedades termodinámicas del Amoniaco.
Tabla A.2.1 I Amoniaco saturado: Tabla de Temperaturas.

Temp.ºF T	Presión lb$_f$/pulg^2, P	Volumen específico, ft^3/lb$_m$			Energía interna, Btu/lb$_m$			Entalpía, Btu/lb$_m$			Entropía, Btu/lb$_m$.ºR		
		Líquido saturado v$_f$	Evap v$_{fg}$	Vapor saturado v$_g$	Líquido saturado u$_f$	Evap u$_{fg}$	Vapor saturado u$_g$	Líquido saturado h$_f$	Evap h$_{fg}$	Vapor saturado h$_g$	Líquido saturado s$_f$	Evap s$_{fg}$	Vapor saturado s$_g$
-60	5.547	0.02277	44.7332	44.756	-20.91	564.24	543.33	-20.89	610.19	589.30	-0.0510	1.5268	1.4758
-55	6.535	0.02288	38.3791	38.402	-15.72	560.54	544.82	-15.69	606.98	591.29	-0.0380	1.4999	1.4619
-50	7.664	0.02299	33.0680	33.091	-10.51	556.81	546.30	-10.48	603.74	593.26	-0.0252	1.4737	1.4485
-45	8.946	0.02311	28.6089	28.632	-5.29	553.05	547.76	-5.25	600.44	595.19	-0.0126	1.4480	1.4354
-40	**10.403**	**0.02322**	**24.8488**	**24.872**	**-0.04**	**549.21**	**549.17**	**0**	**597.08**	**597.08**	**0**	**1.4228**	**1.4228**
-35	12.046	0.02334	21.6627	21.686	5.21	545.37	550.58	5.26	593.69	598.95	0.0124	1.3981	1.4105
-30	13.894	0.02345	18.9536	18.977	10.48	541.47	551.95	10.54	590.23	600.77	0.0248	1.3737	1.3985
-25	15.967	0.02357	16.6394	16.663	15.77	537.52	553.29	15.84	586.72	602.56	0.0370	1.3499	1.3869
-20	18.282	0.02369	14.6563	14.68	21.07	533.54	554.61	21.15	583.16	604.31	0.0492	1.3264	1.3756
-15	20.861	0.02382	12.9502	12.974	26.40	529.51	555.91	26.49	579.54	606.03	0.0612	1.3033	1.3645
-10	23.725	0.02394	11.4771	11.501	31.73	525.44	557.17	31.84	575.86	607.70	0.0731	1.2807	1.3538
-5	26.896	0.02407	10.2009	10.225	37.09	521.31	558.41	37.21	572.12	609.33	0.0850	1.2584	1.3434
0	30.397	0.02420	9.0918	9.116	42.46	517.14	559.61	42.60	568.32	610.92	0.0967	1.2365	1.3332
5	34.251	0.02433	8.1247	8.149	47.85	512.94	560.79	48.00	564.47	612.47	0.1084	1.2148	1.3232
10	38.483	0.02446	7.2785	7.303	43.26	518.67	561.93	43.43	570.54	613.97	0.1200	1.1935	1.3135
15	43.120	0.02460	6.5364	6.561	58.68	504.36	563.04	58.88	556.55	615.43	0.1315	1.1725	1.3040
20	48.186	0.02474	5.8833	5.908	64.12	500.01	564.13	64.34	552.51	616.85	0.1429	1.1519	1.2948
25	53.709	0.02488	5.3071	5.332	69.58	495.60	565.18	69.83	548.38	618.21	0.1542	1.1315	1.2857
30	59.717	0.02502	4.7980	4.823	75.05	491.14	566.20	75.33	544.20	619.53	0.1654	1.1115	1.2769
35	66.239	0.02517	4.3458	4.371	80.55	486.64	567.19	80.86	539.94	620.80	0.1766	1.0916	1.2682
40	73.303	0.02532	3.9447	3.970	86.07	482.06	568.12	86.41	535.60	622.01	0.1877	1.0720	1.2597
45	80.940	0.02547	3.5865	3.612	91.60	477.44	569.03	91.98	531.19	623.17	0.1987	1.0526	1.2513
50	89.180	0.02564	3.2664	3.292	97.16	472.76	569.92	97.58	526.70	624.28	0.2097	1.0334	1.2431
55	98.055	0.02580	2.9802	3.006	102.73	468.01	570.74	103.20	522.12	625.32	0.2206	1.0145	1.2351
60	107.596	0.02597	2.7230	2.749	108.32	463.22	571.54	108.84	517.47	626.31	0.2314	0.9958	1.2272
65	117.836	0.02614	2.4929	2.519	113.94	458.34	572.28	114.51	512.73	627.24	0.2422	0.9772	1.2194
70	128.808	0.02631	2.2847	2.311	119.58	453.40	572.98	120.21	507.89	628.10	0.2529	0.9589	1.2118
75	140.546	0.02649	2.0965	2.123	125.24	448.41	573.65	125.93	502.97	628.90	0.2636	0.9406	1.2042
80	153.084	0.02668	1.9263	1.953	130.92	443.34	574.27	131.68	497.95	629.63	0.2741	0.9227	1.1968

Tabla A.2.1 I Amoniaco saturado: Tabla de Temperaturas.

Temp.ºF T	Presión lbf/pulg², P	Volumen específico, ft³/lbm			Energía interna, Btu/lbm			Entalpía, Btu/lbm			Entropía, Btu/lbm.ºR		
		Líquido saturado v_f	Evap v_{fg}	Vapor saturado v_g	Líquido saturado u_f	Evap u_{fg}	Vapor saturado u_g	Líquido saturado h_f	Evap h_{fg}	Vapor saturado h_g	Líquido saturado s_f	Evap s_{fg}	Vapor saturado s_g
85	166.457	0.02687	1.7721	1.799	136.62	438.22	574.84	137.45	492.84	630.29	0.2846	0.9049	1.1895
90	180.700	0.02706	1.6329	1.660	142.35	432.97	575.32	143.26	487.61	630.87	0.2951	0.8871	1.1822
95	195.850	0.02726	1.5057	1.533	148.11	427.66	575.77	149.10	482.27	631.37	0.3055	0.8695	1.1750
100	211.943	0.02747	1.3895	1.417	153.89	422.30	576.19	154.97	476.83	631.80	0.3159	0.8520	1.1679
105	229.016	0.02768	1.2833	1.311	159.70	416.85	576.54	160.87	471.27	632.14	0.3263	0.8346	1.1609
110	247.107	0.02790	1.1871	1.215	165.52	411.28	576.80	166.80	465.60	632.40	0.3366	0.8173	1.1539
115	266.254	0.02813	1.0979	1.126	171.39	405.65	577.04	172.78	459.78	632.56	0.3468	0.8001	1.1469
120	286.496	0.02836	1.0166	1.045	177.29	399.91	577.19	178.79	453.84	632.63	0.3571	0.7829	1.1400
125	307.872	0.02860	0.9424	0.971	183.21	394.03	577.24	184.84	447.76	632.60	0.3676	0.7655	1.1331

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 834 – 835, tabla A.2.1I.

La línea sombreada corresponde al estado de referencia para la entalpía y la entropía del líquido saturado.

Tabla A.2.2 I Amoniaco sobrecalentado.

Temp.ºF T	P = 10 lb_f/pulg² (-41.32ºF)				P = 15 lb_f/pulg² (-27.26ºF)				P = 20 lb_f/pulg² (-16.61ºF)			
	v (ft³/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft³/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft³/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
0	28.567	565.0	617.9	1.475	18.909	563.7	616.2	1.425	14.077	562.4	614.5	1.388
20	29.881	572.8	628.1	1.496	19.804	571.7	626.7	1.447	14.763	570.6	625.3	1.411
40	31.185	580.6	638.3	1.517	20.688	579.7	637.2	1.468	15.439	578.7	635.9	1.433
60	32.481	588.5	648.6	1.537	21.564	587.6	647.5	1.889	16.105	586.9	646.5	1.454
80	33.770	596.3	658.8	1.557	22.434	595.6	657.9	1.508	16.765	594.9	657.0	1.473
100	35.055	604.2	669.1	1.575	23.298	603.6	668.3	1.527	17.420	603.0	667.5	1.492
120	36.336	612.1	679.4	1.593	24.16	611.6	678.7	1.545	18.071	611.1	678.0	1.511
140	37.613	620.2	689.8	1.611	25.02	619.6	689.1	1.563	18.719	619.2	688.5	1.529
160	38.889	628.2	700.2	1.628	25.87	627.7	699.6	1.580	19.364	627.4	699.1	1.546
180	40.162	636.3	710.7	1.645	26.73	636.0	710.2	1.597	20.007	635.6	709.7	1.563
200	41.434	644.6	721.3	1.661	27.58	644.2	720.8	1.613	20.649	643.9	720.4	1.579
220	-	-	-	-	-	-	-	-	21.290	652.3	731.1	1.595

Temp.ºF T	P = 25 lb_f/pulg² (-7.93ºF)				P = 30 lb_f/pulg² (-0.54ºF)				P = 35 lb_f/pulg² (5.92ºF)			
	v (ft³/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft³/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft³/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
0	11.177	561.1	612.8	1.359	9.242	559.8	611.1	1.335	-	-	-	-
20	11.738	569.6	623.9	1.383	9.721	568.4	622.4	1.359	8.279	567.2	620.9	1.339
40	12.288	577.8	634.7	1.405	10.187	576.9	633.5	1.382	8.686	575.9	632.2	1.362
60	12.829	586.1	645.5	1.426	10.645	585.3	644.4	1.403	9.084	584.4	643.3	1.384
80	13.363	594.2	656.1	1.446	11.095	593.6	655.2	1.424	9.475	592.9	654.3	1.404
100	13.893	602.4	666.7	1.465	11.541	601.8	665.9	1.443	9.861	601.2	665.1	1.424
120	14.418	610.6	677.3	1.484	11.982	610.0	676.6	1.462	10.242	609.5	675.9	1.443
140	14.940	618.7	687.9	1.502	12.420	618.3	687.3	1.480	10.620	617.9	686.7	1.461
160	15.459	626.9	698.5	1.519	12.855	626.6	698.0	1.497	10.996	626.1	697.4	1.479
180	15.976	635.2	709.2	1.536	13.289	634.9	708.7	1.514	11.369	634.5	708.2	1.496
200	16.492	643.6	719.9	1.553	13.721	643.3	719.5	1.531	11.741	642.9	719.0	1.513
220	17.006	652.0	730.7	1.569	14.151	651.7	730.3	1.547	12.111	651.4	729.9	1.529

Tabla A.2.2 I Amoniaco sobrecalentado.

Temp.ºF T	P = 40 lb$_f$/pulg^2 (11.69ºF)				P = 45 lb$_f$/pulg^2 (16.91ºF)				P = 50 lb$_f$/pulg^2 (21.69ºF)			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
0	-	-	-	-	-	-	-	-	-	-	-	-
20	7.196	566.1	619.4	1.321	6.354	564.9	617.8	1.304	-	-	-	-
40	7.560	575.0	631.0	1.344	6.683	574.0	629.7	1.329	5.981	573.0	628.4	1.314
60	7.913	583.7	642.3	1.366	7.002	582.9	641.2	1.351	6.273	582.0	640.1	1.337
80	8.260	592.2	653.4	1.387	7.314	591.5	652.4	1.372	6.557	590.8	651.5	1.359
100	8.600	600.6	664.3	1.407	7.620	600.0	663.5	1.393	6.836	599.4	662.7	1.379
120	8.937	609.0	675.2	1.426	7.922	608.5	674.5	1.412	7.110	608.0	673.8	1.399
140	9.270	617.3	686.0	1.445	8.220	616.9	685.4	1.430	7.380	616.5	684.8	1.417
160	9.601	625.8	696.9	1.463	8.516	625.3	696.3	1.448	7.648	624.9	695.7	1.435
180	9.929	634.2	707.7	1.480	8.809	633.8	707.2	1.465	7.914	633.4	706.7	1.453
200	10.256	642.5	718.5	1.497	9.101	642.3	718.1	1.482	8.177	641.9	717.6	1.469
220	10.582	651.0	729.4	1.513	9.392	650.7	729.0	1.499	8.440	650.5	728.6	1.486

Temp.ºF T	P = 60 lb$_f$/pulg^2 (30.23ºF)				P = 70 lb$_f$/pulg^2 (37.71ºF)				P = 80 lb$_f$/pulg^2 (44.40ºF)			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
40	4.928	570.9	625.7	1.829	-	-	-	-	-	-	-	-
60	5.179	580.3	637.8	1.313	4.396	578.5	635.5	1.291	3.808	576.8	633.2	1.272
80	5.422	589.4	649.6	1.335	4.610	587.8	647.6	1.314	4.001	586.3	645.6	1.296
100	5.659	598.2	661.1	1.356	4.817	597.0	659.4	1.335	4.186	595.7	657.7	1.318
120	5.891	606.8	672.3	1.375	5.020	605.8	670.9	1.356	4.367	604.7	669.4	1.338
140	6.120	615.5	683.5	1.394	5.219	614.6	682.2	1.375	4.544	613.6	680.9	1.358
160	6.346	624.1	694.6	1.413	5.415	623.2	693.4	1.393	4.717	622.4	692.3	1.376
180	6.569	632.6	705.6	1.430	5.609	631.9	704.6	1.411	4.889	631.2	703.6	1.394
200	6.791	641.2	716.7	1.447	5.801	640.5	715.7	1.428	5.059	639.9	714.8	1.412
220	7.012	649.8	727.7	1.464	-	-	-	-	-	-	-	-
240	-	-	-	-	6.182	657.9	738.0	1.461	5.394	657.3	737.2	1.445
280	-	-	-	-	6.558	675.5	760.5	1.492	5.725	675.0	759.8	1.476

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 836 – 837, tabla A.2.2I.

Tabla A.2.2 I Amoniaco sobrecalentado.

Temp.ºF T	P = 90 lb$_f$/pulg^2 (50.48ºF)				P = 100 lb$_f$/pulg^2 (56.05ºF)				P = 140 lb$_f$/pulg^2 (74.77ºF)			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
60	3.350	574.9	630.7	1.255	2.983	573.1	628.3	1.239	-	-	-	-
80	3.526	584.8	643.6	1.279	3.146	583.2	641.5	1.264	2.164	576.6	632.7	1.212
100	3.695	594.3	655.9	1.301	3.301	593.1	654.2	1.287	2.287	587.5	646.8	1.237
120	3.858	603.6	667.9	1.322	3.451	602.5	666.4	1.308	2.403	597.7	660.0	1.261
140	4.018	612.6	679.6	1.342	3.597	611.6	678.2	1.328	2.514	607.5	672.7	1.282
160	4.174	621.5	691.1	1.361	3.740	620.6	689.9	1.347	2.622	617.0	685.0	1.302
180	4.329	630.4	702.5	1.379	3.880	629.6	701.4	1.366	2.727	626.4	697.1	1.321
200	4.481	639.1	713.8	1.397	4.019	638.5	712.9	1.383	2.830	635.6	709.0	1.340
240	4.782	656.7	736.4	1.430	4.291	656.1	735.6	1.417	3.031	653.8	732.4	1.374
280	5.078	674.5	759.1	1.462	4.560	674.0	758.4	1.449	3.228	671.9	755.6	1.407
320	-	-	-	-	-	-	-	-	3.421	690.3	779.0	1.437

Temp.ºF T	P = 180 lb$_f$/pulg^2 (89.76ºF)				P = 220 lb$_f$/pulg^2 (102.40ºF)				P = 240 lb$_f$/pulg^2 (108.07ºF)			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
100	1.719	581.4	638.7	1.197	-	-	-	-	-	-	-	-
120	1.818	592.7	653.3	1.222	1.443	587.2	646.0	1.189	1.301	584.4	642.2	1.174
140	1.910	603.2	666.9	1.245	1.524	598.7	660.8	1.214	1.379	596.3	657.6	1.200
160	1.999	613.4	680.0	1.267	1.602	609.4	674.7	1.237	1.452	607.4	671.9	1.223
180	2.085	623.1	692.6	1.287	1.676	619.6	687.9	1.258	1.522	618.0	685.6	1.245
200	2.168	632.6	704.9	1.306	1.747	629.6	700.8	1.278	1.588	628.1	698.7	1.265
240	2.330	651.3	729.0	1.341	1.884	648.8	725.6	1.314	1.716	647.6	723.9	1.302
280	2.487	669.9	752.8	1.374	2.016	667.8	749.9	1.348	1.839	666.8	748.5	1.337
320	2.641	688.5	776.5	1.406	2.145	686.7	774.1	1.380	1.958	685.8	772.8	1.369
360	-	-	-	-	2.208	696.1	786.1	1.395	2.017	695.4	785.0	1.384

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 837, tabla A.2.2I.

Tabla A.2.2 I Amoniaco sobrecalentado.

Temp.ºF T	P = 260 lb$_f$/pulg^2 (113.40ºF)				P = 280 lb$_f$/pulg^2 (118.43ºF)			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
120	1.180	581.4	638.2	1.159	1.076	578.2	634.0	1.145
140	1.256	593.8	654.3	1.186	1.149	591.3	650.9	1.173
160	1.325	605.3	669.1	1.211	1.216	603.2	666.2	1.198
180	1.391	616.1	683.1	1.233	1.279	614.3	680.6	1.221
200	1.454	626.5	696.5	1.253	1.339	624.9	694.3	1.242
240	1.575	646.4	722.2	1.291	1.453	645.1	720.4	1.281
280	1.689	665.7	747.0	1.326	1.561	664.7	745.6	1.316
320	1.801	684.9	771.6	1.358	1.665	684.0	770.3	1.348
360	1.855	694.5	783.8	1.374	1.717	693.6	782.6	1.364

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 837, tabla A.2.2I.

Tabla A.3 I Propiedades termodinámicas del Refrigerante – 12.
Tabla A.3.1 I Refrigerante - 12 saturado: Tabla de Temperaturas.

Temp.ºF T	Presión lb$_f$/pulg^2, P	Volumen específico, ft^3/lb$_m$			Energía interna, Btu/lb$_m$			Entalpía, Btu/lb$_m$			Entropía, Btu/lb$_m$.ºR		
		Líquido saturado v$_f$	Evap v$_{fg}$	Vapor saturado v$_g$	Líquido saturado u$_f$	Evap u$_{fg}$	Vapor saturado u$_g$	Líquido saturado h$_f$	Evap h$_{fg}$	Vapor saturado h$_g$	Líquido saturado s$_f$	Evap s$_{fg}$	Vapor saturado s$_g$
-130	0.41224	0.009736	70.7203	70.73	-18.61	76.18	57.57	-18.609	81.577	62.968	-0.04983	0.24743	0.19760
-120	0.64190	0.009816	46.7312	46.741	-16.57	75.06	58.50	-16.565	80.617	64.052	-0.04372	0.23731	0.19359
-110	0.97134	0.009899	31.7671	31.777	-14.52	73.95	59.43	-14.518	79.664	65.146	-0.03779	0.22781	0.19002
-100	1.4280	0.009985	22.1540	22.164	-12.47	72.86	60.39	-12.466	78.714	66.248	-0.03200	0.21883	0.18683
-90	2.0509	0.010073	15.8109	15.821	-10.41	71.76	61.35	-10.409	77.764	67.355	-0.02637	0.21035	0.18398
-80	2.8807	0.010164	11.5228	11.533	-8.35	70.67	62.31	-8.345	76.812	68.467	-0.02086	0.20229	0.18143
-70	3.9651	0.010259	8.5584	8.5687	-6.28	69.57	63.29	-6.273	75.853	69.580	-0.01548	0.19464	0.17916
-60	5.3575	0.010357	6.4670	6.4774	-4.20	68.47	64.27	-4.192	74.886	70.694	-0.01021	0.18735	0.17714
-50	7.1168	0.010459	4.9637	4.9742	-2.11	67.36	65.25	-2.101	73.906	71.805	-0.00506	0.18039	0.17533
-40	**9.3076**	**0.010564**	**3.8644**	**3.875**	**-0.02**	**66.25**	**66.23**	**0**	**72.913**	**72.913**	**0**	**0.17373**	**0.17373**
-30	11.999	0.010674	3.0478	3.0585	2.09	65.13	67.22	2.112	71.903	74.015	0.00496	0.16733	0.17229
-20	15.267	0.010788	2.4321	2.4429	4.21	64.00	68.20	4.236	70.874	75.110	0.00983	0.16119	0.17102
-10	19.189	0.010906	1.9618	1.9727	6.33	62.85	69.19	6.372	69.824	76.196	0.01462	0.15527	0.16989
0	23.849	0.011030	1.5979	1.6089	8.47	61.69	70.17	8.521	68.750	77.271	0.01932	0.14956	0.16888
10	29.335	0.011160	1.3129	1.3241	10.62	60.52	71.14	10.684	67.651	78.335	0.02395	0.14403	0.16798
20	35.736	0.011296	1.0875	1.0988	12.79	59.33	72.11	12.863	66.522	79.385	0.02852	0.13867	0.16719
30	43.148	0.011438	0.90736	0.91880	14.97	58.11	73.08	15.058	65.361	80.419	0.03301	0.13347	0.16648
40	51.667	0.011588	0.76198	0.77357	17.16	56.87	74.03	17.273	64.163	81.436	0.03745	0.12841	0.16586
50	61.394	0.011746	0.64363	0.65538	19.37	55.61	74.98	19.508	62.925	82.433	0.04184	0.12346	0.16530
60	72.433	0.011913	0.54648	0.55839	21.61	54.31	75.92	21.766	61.643	83.409	0.04618	0.11861	0.16479
70	84.888	0.012089	0.46609	0.47818	23.86	52.98	76.84	24.051	60.308	84.359	0.05048	0.11386	0.16434
80	98.870	0.012277	0.39907	0.41135	26.14	51.61	77.75	26.365	58.917	85.282	0.05475	0.10917	0.16392
90	114.49	0.012478	0.34281	0.35529	28.45	50.19	78.64	28.713	57.461	86.174	0.05900	0.10453	0.16353
100	131.86	0.012693	0.29525	0.30794	30.79	48.72	79.51	31.100	55.929	87.029	0.06323	0.09992	0.16315
110	151.11	0.012924	0.25477	0.26769	33.17	47.18	80.35	33.531	54.313	87.844	0.06745	0.09534	0.16279
120	172.35	0.013174	0.22009	0.23326	35.59	45.57	81.17	36.013	52.597	88.610	0.07168	0.09073	0.16241
130	195.71	0.013447	0.19019	0.20364	38.07	43.88	81.94	38.553	50.769	89.322	0.07593	0.08609	0.16202
140	221.32	0.013746	0.16424	0.17799	40.60	42.07	82.67	41.162	48.805	89.967	0.08020	0.08139	0.16159
150	249.31	0.014078	0.14156	0.15564	43.20	40.15	83.35	43.850	46.684	90.534	0.08453	0.07657	0.16110

Tabla A.3.2 I Refrigerante - 12 saturado: Tabla de Temperaturas.

Temp.ºF T	Presión lb$_f$/pulg^2, P	Volumen específico, ft^3/lb$_m$			Energía interna, Btu/lb$_m$			Entalpía, Btu/lb$_m$			Entropía, Btu/lb$_m$.ºR		
		Líquido saturado v_f	Evap v_{fg}	Vapor saturado v_g	Líquido saturado u_f	Evap u_{fg}	Vapor saturado u_g	Líquido saturado h_f	Evap h_{fg}	Vapor saturado h_g	Líquido saturado s_f	Evap s_{fg}	Vapor saturado s_g
160	279.82	0.014449	0.12159	0.13604	45.88	38.07	83.96	46.633	44.373	91.006	0.08893	0.07160	0.16053
170	313.00	0.014871	0.10386	0.11873	48.67	35.81	84.48	49.529	41.830	91.359	0.09342	0.06643	0.15985
180	349.00	0.015360	0.087940	0.10330	51.57	33.32	84.89	52.562	38.999	91.561	0.09804	0.06096	0.15900
190	387.98	0.015942	0.073476	0.089418	54.62	30.51	85.14	55.769	35.792	91.561	0.10284	0.05509	0.15793
200	430.09	0.016659	0.060069	0.076728	57.88	27.29	85.17	59.203	32.075	91.278	0.10789	0.04862	0.15651
210	475.52	0.017601	0.047242	0.064843	61.41	23.44	84.85	62.959	27.599	90.558	0.11332	0.04121	0.15453
220	524.43	0.018986	0.034154	0.053140	65.40	18.47	83.88	67.246	21.791	89.037	0.11943	0.03206	0.15149
230	577.03	0.021854	0.017581	0.039435	70.56	10.35	80.91	72.894	12.228	85.122	0.12739	0.01773	0.14512
233.6	596.90	0.028700	0	0.028700	75.68	0	75.68	78.855	0	78.855	0.13587	0	0.13587

La línea en negritas corresponde al estado de referencia para la entalpía y la entropía del líquido saturado.

Tabla A.3.1 I Refrigerante - 12 saturado: Tabla de Presiones.

Presión lbf/pulg^2, P	Temp.ºF T	Volumen específico, ft^3/lb$_m$			Energía interna, Btu/lb$_m$			Entalpía, Btu/lb$_m$			Entropía, Btu/lb$_m$.ºR		
		Líquido saturado v_f	Evap v_{fg}	Vapor saturado v_g	Líquido saturado u_f	Evap u_{fg}	Vapor saturado u_g	Líquido saturado h_f	Evap h_{fg}	Vapor saturado h_g	Líquido saturado s_f	Evap s_{fg}	Vapor saturado s_g
5	-62.35	0.0103	6.8966	6.9069	-4.69	68.72	64.04	-4.68	75.11	70.43	-0.0114	0.1890	0.1776
10	-37.23	0.0106	3.6140	3.6246	0.56	65.95	66.51	0.58	72.64	73.22	0.0014	0.1719	0.1733
15	-20.75	0.0108	2.4727	2.4835	4.05	64.08	68.13	4.08	70.95	75.03	0.0095	0.1616	0.1711
20	-8.13	0.0109	1.8868	1.8977	6.73	62.64	69.37	6.77	69.63	76.40	0.0155	0.1542	0.1697
30	11.11	0.0112	1.2852	1.2964	10.87	60.38	71.25	10.93	67.52	78.45	0.0245	0.1434	0.1679
40	25.93	0.0114	0.9760	0.9874	14.08	58.61	72.69	14.16	65.84	80.00	0.0312	0.1356	0.1668
50	38.15	0.0116	0.7866	0.7982	16.75	57.11	73.86	16.86	64.39	81.25	0.0366	0.1294	0.1660
60	48.64	0.0117	0.6584	0.6701	19.07	55.78	74.85	19.20	63.10	82.30	0.0413	0.1241	0.1654
70	57.90	0.0119	0.5653	0.5772	21.14	54.59	75.73	21.29	61.92	83.21	0.0453	0.1196	0.1649
80	66.21	0.0120	0.4948	0.5068	23.00	53.49	76.49	23.18	60.82	84.00	0.0489	0.1156	0.1645
90	73.79	0.0122	0.4392	0.4514	24.72	52.47	77.19	24.92	59.79	84.71	0.0521	0.1121	0.1642
100	80.76	0.0123	0.3944	0.4067	26.31	51.51	77.82	26.54	58.81	85.35	0.0551	0.1088	0.1639
120	93.29	0.0126	0.3263	0.3389	29.21	49.72	78.93	29.49	56.97	86.46	0.0604	0.1030	0.1634
140	104.35	0.0128	0.2768	0.2896	31.82	48.06	79.88	32.15	55.24	87.39	0.0651	0.0979	0.1630
160	114.30	0.0130	0.2392	0.2522	34.20	46.50	80.71	34.59	53.59	88.18	0.0693	0.0933	0.1626
180	123.38	0.0133	0.2095	0.2228	36.42	45.02	81.43	36.86	52.00	88.86	0.0731	0.0892	0.1623
200	131.74	0.0135	0.1854	0.1989	38.50	43.57	82.07	39.00	50.44	89.44	0.0767	0.0853	0.1620
220	139.51	0.0137	0.1655	0.1792	40.47	42.17	82.64	41.03	48.91	89.94	0.0816	0.0800	0.1616
240	146.77	0.0140	0.1485	0.1625	42.35	40.79	83.14	42.97	47.39	90.36	0.0831	0.0782	0.1613
260	153.60	0.0142	0.1341	0.1483	44.16	39.42	83.58	44.84	45.88	90.72	0.0861	0.0748	0.1609
280	160.06	0.0145	0.1214	0.1359	45.90	38.07	83.96	46.65	44.36	91.01	0.0890	0.0715	0.1605
300	166.18	0.0147	0.1104	0.1251	47.59	36.70	84.29	48.41	42.83	91.24	0.0917	0.0684	0.1601

Fuente: Yunus Çengel y Michael Boles. *Termodinámica*, 2a. ed. (Mc Graw Hill, México, 1996), p. A-23, tabla A.12E.

Tabla A.3.2 I Refrigerante - 12 sobrecalentado.

Temp.ºF T	P = 5.00 lb$_f$/pulg^2				P = 10.00 lb$_f$/pulg^2				P = 15.00 lb$_f$/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
0	8.0612	71.118	78.582	0.19663	3.9810	70.874	78.246	0.18471	2.6201	70.624	77.902	0.17751
20	8.4265	73.507	81.309	0.20244	4.1691	73.294	81.014	0.19061	2.7494	73.075	80.712	0.18349
40	8.7903	75.959	84.098	0.20812	4.3556	75.763	83.828	0.19635	2.8770	75.570	83.561	0.18931
60	9.1528	78.448	86.922	0.21367	4.5408	78.281	86.689	0.20197	3.0031	78.110	86.451	0.19498
80	9.5142	80.997	89.806	0.21912	4.7248	80.847	89.596	0.20746	3.1281	80.694	89.383	0.20051
100	9.8747	83.595	92.738	0.22445	4.9079	83.460	92.548	0.21283	3.2521	83.324	92.357	0.20593
120	10.2344	86.241	95.717	0.22968	5.0903	86.120	95.546	0.21809	3.3754	85.997	95.373	0.21122
140	10.5936	88.935	98.743	0.23481	5.2721	88.823	98.586	0.22325	3.4981	88.713	98.429	0.21640
160	10.9523	91.672	101.812	0.23985	5.4533	91.571	101.669	0.22830	3.6202	91.470	101.525	0.22148
180	11.3105	94.453	104.925	0.24479	5.6341	94.360	104.793	0.23326	3.7419	94.267	104.661	0.22646
200	11.6684	97.276	108.079	0.24964	5.8145	97.190	107.957	0.23813	3.8632	97.105	107.835	0.23135
220	12.0260	100.137	111.272	0.25441	5.9946	100.059	111.159	0.24291	3.9841	99.980	111.046	0.23614

Temp.ºF T	P = 20.00 lb$_f$/pulg^2				P = 25.00 lb$_f$/pulg^2				P = 30.00 lb$_f$/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
20	2.0391	72.851	80.403	0.17829	1.6125	72.623	80.088	0.17414	1.3278	72.389	79.765	0.17065
40	2.1373	75.374	83.289	0.18419	1.6932	75.174	83.012	0.18012	1.3969	74.970	82.730	0.17671
60	2.2340	77.936	86.210	0.18992	1.7723	77.760	85.965	0.18591	1.4644	77.581	85.716	0.18257
80	2.3295	80.541	89.168	0.19550	1.8502	80.385	88.950	0.19155	1.5306	80.226	88.729	0.18826
100	2.4241	83.186	92.164	0.20095	1.9271	83.047	91.968	0.19704	1.5957	82.906	91.770	0.19379
120	2.5179	85.873	95.198	0.20628	2.0032	85.747	95.021	0.20240	1.6600	85.621	94.843	0.19918
140	2.6110	88.600	98.270	0.21149	2.0786	88.487	98.110	0.20763	1.7237	88.372	97.948	0.20445
160	2.7036	91.367	101.380	0.21659	0.1535	100.523	101.234	0.21276	1.7867	91.160	101.086	0.20960
180	2.7957	94.174	104.528	0.22159	2.2279	94.079	104.393	0.21778	1.8494	93.984	104.258	0.21463
200	2.8874	97.019	107.712	0.22649	2.3019	96.932	107.588	0.22269	1.9116	96.845	107.464	0.21957
220	2.9789	99.900	110.932	0.23130	2.3757	99.819	110.817	0.22752	1.9735	99.739	110.702	0.22440
240	3.0700	102.816	114.186	0.23602	2.4491	102.742	114.080	0.23225	2.0351	102.668	113.973	0.22915

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 839 – 840, tabla A.3.2I.

Tabla A.3.2 I Refrigerante - 12 sobrecalentado.

Temp.ºF T	P = 35.00 lb$_f$/pulg^2				P = 40.00 lb$_f$/pulg^2				P = 50 lb$_f$/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
40	1.1850	74.762	82.442	0.17375	1.0258	74.550	82.148	0.17112	0.80248	74.110	81.540	0.16655
60	1.2442	77.399	85.463	0.17968	1.0789	77.215	85.206	0.17712	0.84713	76.833	84.676	0.17271
80	1.3021	80.065	88.504	0.18542	1.1306	79.903	88.277	0.18292	0.89025	79.569	87.811	0.17862
100	1.3589	82.763	91.570	0.19100	1.1812	82.618	91.367	0.18854	0.93216	82.322	90.953	0.18434
120	1.4148	85.494	94.663	0.19643	1.2309	85.363	94.480	0.19401	0.97313	85.100	94.110	0.18988
140	1.4701	88.257	97.785	0.20172	1.2798	88.141	97.620	0.19933	1.0133	87.904	97.286	0.19527
160	1.5248	91.056	100.938	0.20689	1.3282	90.950	100.788	0.20453	1.0529	90.737	100.485	0.20051
180	1.5789	93.889	104.122	0.21195	1.3761	93.792	103.985	0.20961	1.0920	93.598	103.708	0.20563
200	1.6327	96.756	107.338	0.21690	1.4236	96.667	107.212	0.21457	1.1307	96.489	106.958	0.21064
220	1.6862	99.658	110.586	0.22175	1.4707	99.576	110.469	0.21944	1.1690	99.412	110.235	0.21553
240	1.7394	102.592	113.865	0.22651	1.5176	102.516	113.757	0.22420	1.2070	102.364	113.539	0.22032
260	1.7923	105.559	117.175	0.23117	1.5642	105.488	117.074	0.22888	1.2448	105.346	116.871	0.22502

Temp.ºF T	P = 60.00 lb$_f$/pulg^2				P = 70.00 lb$_f$/pulg^2				P = 80.00 lb$_f$/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
60	0.69210	76.436	84.126	0.16892	0.58088	76.023	83.552	0.16556	-	-	-	-
100	0.76588	82.019	90.528	0.18079	0.64685	81.706	90.091	0.17768	0.55734	81.384	89.640	0.17489
120	0.80110	84.830	93.731	0.18641	0.67803	84.554	93.343	0.18339	0.58556	84.271	92.945	0.18070
140	0.83551	87.662	96.945	0.19186	0.70836	87.415	96.597	0.18891	0.61286	87.163	96.242	0.18629
160	0.86928	90.518	100.176	0.19716	0.73800	90.296	99.862	0.19427	0.63943	90.070	99.542	0.19170
180	0.90252	93.400	103.427	0.20233	0.76708	93.198	103.141	0.19948	0.66543	92.993	102.851	0.19696
200	0.93531	96.308	106.700	0.20736	0.79571	96.125	106.439	0.20455	0.69095	95.938	106.174	0.20207
220	0.96775	99.245	109.997	0.21229	0.82397	99.076	109.756	0.20951	0.71609	98.905	109.513	0.20706
240	0.99989	102.210	113.319	0.21710	0.85191	102.053	113.096	0.21435	0.74090	101.896	112.872	0.21193
260	1.03176	105.203	116.666	0.22182	0.87959	105.058	116.459	0.21909	0.76544	104.912	116.251	0.21669
280	1.06342	108.224	120.039	0.22644	0.90705	108.089	119.846	0.22373	0.78975	107.953	119.652	0.22135

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 840 – 841, tabla A.3.2I.

Tabla A.3.2 I Refrigerante - 12 sobrecalentado.

Temp.ºF T	P = 90.00 lb_f/pulg²				P = 100.00 lb_f/pulg²				P = 125.00 lb_f/pulg²			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)
100	0.48749	81.051	89.175	0.17234	0.43138	80.706	88.694	0.16996	0.32943	79.782	87.407	0.16455
120	0.51436	83.964	92.536	0.17824	0.45562	83.679	92.116	0.17597	0.35086	82.887	91.008	0.17087
140	0.53845	86.905	95.879	0.18391	0.47881	86.641	95.507	0.18172	0.37098	85.950	94.537	0.17686
160	0.56268	89.839	99.216	0.18938	0.50118	89.603	98.884	0.18726	0.36902	89.482	98.023	0.18258
180	0.58629	92.786	102.557	0.19469	0.52291	92.574	102.257	0.19262	0.40857	92.027	101.484	0.18807
200	0.60941	95.749	105.905	0.19984	0.54413	95.557	105.633	0.19782	0.42642	95.064	104.934	0.19338
220	0.63213	98.732	109.267	0.20486	0.56492	98.557	109.018	0.20287	0.44380	98.107	108.380	0.19853
240	0.65451	101.736	112.644	0.20976	0.58538	101.575	112.415	0.20780	0.46081	101.163	111.829	0.20353
260	0.67662	104.764	116.040	0.21455	0.60554	104.615	115.828	0.21261	0.47750	104.234	115.287	0.20840
280	0.69849	107.815	119.456	0.21923	0.62546	107.676	119.258	0.21731	0.49394	107.323	118.756	0.21316
300	0.72016	110.890	122.892	0.22381	0.64518	110.760	122.707	0.22191	0.51016	110.429	122.238	0.21780
320	0.74166	113.989	126.349	0.22830	0.66472	113.867	126.176	0.22641	0.52619	113.557	125.737	0.22235

Temp.ºF T	P = 150.00 lb_f/pulg²				P = 175.00 lb_f/pulg²				P = 200.00 lb_f/pulg²			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)
120	0.28007	82.021	89.800	0.16629	-	-	-	-	-	-	-	-
140	0.29845	85.208	93.498	0.17256	0.24595	84.403	92.373	0.16859	0.20579	83.516	91.137	0.16480
160	0.31566	88.344	97.112	0.17849	0.26198	87.652	96.142	0.17478	0.22121	86.908	95.100	0.17130
180	0.33200	91.453	100.675	0.18415	0.27697	90.848	99.823	0.18062	0.23535	90.205	98.921	0.17737
200	0.34769	94.549	104.206	0.18958	0.29120	94.011	103.447	0.18620	0.24860	93.445	102.652	0.18311
220	0.36285	97.641	107.720	0.19483	0.30485	97.157	107.036	0.19156	0.26117	96.653	106.325	0.18860
240	0.37761	100.737	111.226	0.19992	0.31804	100.299	110.605	0.19674	0.27353	99.832	109.962	0.19387
260	0.39203	103.843	114.732	0.20485	0.33087	103.440	114.162	0.20175	0.28489	103.025	113.576	0.19896
280	0.40617	106.960	118.242	0.20967	0.34339	106.589	117.717	0.20662	0.29623	106.207	117.178	0.20390
300	0.42008	110.093	121.761	0.21436	0.35567	109.747	121.273	0.21137	0.30730	109.394	120.775	0.20870
320	0.43379	113.241	125.290	0.21894	0.36773	112.919	124.835	0.21599	0.31815	112.590	124.373	0.21337
340	0.44733	116.408	128.833	0.22343	0.37963	116.105	128.407	0.22052	0.32881	115.797	127.974	0.21793

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 841, tabla A.3.2I.

Tabla A.3.2 I Refrigerante - 12 sobrecalentado.

Temp.ºF T	P = 250.00 lb_f/pulg²				P = 300.00 lb_f/pulg²				P = 400.00 lb_f/pulg²			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)
160	0.16249	85.195	92.717	0.16462	-	-	-	-	-	-	-	-
180	0.17605	88.775	96.925	0.17130	0.13482	87.066	94.556	0.16537	-	-	-	-
200	0.18824	92.216	100.930	0.17747	0.14697	90.810	98.975	0.17217	0.09101	86.977	93.718	0.16092
220	0.19952	95.573	104.809	0.18326	0.15774	94.373	103.136	0.17838	0.10316	91.405	99.046	0.16888
240	0.21014	98.879	108.607	0.18877	0.16761	97.829	107.140	0.18419	0.11300	95.365	103.735	0.17568
260	0.22027	102.154	112.351	0.19404	0.17685	101.219	111.043	0.18969	0.12163	99.096	108.105	0.18183
280	0.23001	105.412	116.060	0.19913	0.18562	104.567	114.879	0.19495	0.12949	102.695	112.286	0.18756
300	0.23944	108.662	119.747	0.20405	0.19402	107.892	118.670	0.20000	0.13680	106.210	116.343	0.19298
320	0.24862	111.911	123.420	0.20882	0.20214	111.201	122.430	0.20489	0.14382	109.665	120.318	0.19814
340	0.25759	115.164	127.089	0.21346	0.21002	114.504	126.171	0.20963	0.15032	113.101	124.235	0.20310
360	0.26639	118.422	130.754	0.21799	0.21770	117.806	129.900	0.21423	0.15668	116.507	128.112	0.20789
380	0.27504	121.690	134.423	0.22241	0.22522	121.113	133.624	0.21872	0.16285	119.899	131.961	0.21253

Temp.ºF T	P = 500.00 lb_f/pulg²				P = 600.00 lb_f/pulg²				P = 700.00 lb_f/pulg²			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)
220	0.06421	86.452	92.397	0.15683	-	-	-	-	-	-	-	-
240	0.07762	92.031	99.218	0.16672	0.04790	85.702	91.024	0.15335	0.01997	69.313	71.902	0.12528
260	0.08705	96.466	104.526	0.17421	0.06192	92.861	99.741	0.16656	0.04022	86.676	91.889	0.15344
280	0.09492	100.489	109.277	0.18072	0.07086	97.764	105.637	0.17374	0.05245	94.164	100.963	0.16589
300	0.10190	104.294	113.729	0.18666	0.07806	102.056	110.729	0.18053	0.06047	99.364	107.202	0.17421
320	0.10829	107.971	117.997	0.19221	0.08433	106.051	115.420	0.18663	0.06693	103.850	112.526	0.18113
340	0.11426	111.564	122.143	0.19746	0.09002	109.869	119.871	0.19227	0.07255	107.989	117.393	0.18730
360	0.11992	115.102	126.205	0.20247	0.09529	113.580	124.167	0.19757	0.07763	111.923	121.986	0.19297
380	0.12533	118.603	130.207	0.20730	0.10025	117.217	128.355	0.20262	0.08232	115.731	126.401	0.19829
400	0.13054	122.080	134.166	0.21196	0.10498	120.802	132.466	0.20746	0.08674	119.449	130.692	0.20334
420	0.13559	125.542	138.096	0.21648	0.10952	124.355	136.523	0.21213	0.09093	123.108	134.895	0.20818
440	0.14051	128.995	142.004	0.22087	0.11391	127.883	140.539	0.21664	0.09495	126.725	139.033	0.21283

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 842, tabla A.3.2I.

Tabla A.4 I Propiedades termodinámicas del Refrigerante – 22.
Tabla A.4.1 I Refrigerante - 22 saturado: Tabla de Temperaturas.

Temp.ºF T	Presión $lb_f/pulg^2$, P	Volumen específico, ft^3/lb_m			Energía interna, Btu/lb_m			Entalpía, Btu/lb_m			Entropía, $Btu/lb_m \cdot ºR$		
		Líquido saturado v_f	Evap v_{fg}	Vapor saturado v_g	Líquido saturado u_f	Evap u_{fg}	Vapor saturado u_g	Líquido saturado h_f	Evap h_{fg}	Vapor saturado h_g	Líquido saturado s_f	Evap s_{fg}	Vapor saturado s_g
-100	2.3980	0.010664	18.4219	18.4326	-14.57	99.75	85.19	-14.564	107.94	93.371	-0.03734	0.30008	0.26274
-90	3.4230	0.010771	13.2243	13.2351	-12.22	98.38	86.15	-12.216	106.76	94.544	-0.03091	0.28878	0.25787
-80	4.7820	0.010881	9.6840	9.69487	-9.85	96.97	87.13	-9.838	105.55	95.710	-0.02457	0.27799	0.25342
-70	6.5520	0.010995	7.2208	7.23180	-7.44	95.54	88.09	-7.429	104.30	96.868	-0.01832	0.26764	0.24932
-60	8.818	0.011113	5.4733	5.48442	-5.01	94.06	89.06	-4.988	103.00	98.014	-0.01214	0.25770	0.24556
-50	11.674	0.011235	4.2111	4.22238	-2.54	92.55	90.02	-2.512	101.66	99.144	-0.00604	0.24813	0.24209
-40	**15.222**	**0.011363**	**3.2844**	**3.29572**	**-0.03**	**91.00**	**90.97**	**0**	**100.26**	**100.257**	**0**	**0.23888**	**0.23888**
-30	19.573	0.011495	2.5934	2.60489	2.51	89.40	91.91	2.547	98.80	101.348	0.05980	0.17611	0.23591
-20	24.845	0.011634	2.0709	2.08257	5.08	87.76	92.83	5.131	97.28	102.415	0.01189	0.22126	0.23315
-10	31.162	0.011778	1.6707	1.68248	7.68	86.06	93.75	7.751	95.70	103.455	0.01776	0.21282	0.23058
0	38.657	0.011930	1.3603	1.37227	10.32	84.32	94.64	10.409	94.06	104.465	0.02356	0.20461	0.22817
10	47.464	0.012088	1.1170	1.12904	13.00	82.52	95.52	13.104	92.34	105.442	0.02932	0.19660	0.22592
20	57.727	0.012255	0.92405	0.936309	15.71	80.67	96.37	15.837	90.55	106.383	0.03503	0.18876	0.22379
30	69.591	0.012431	0.76965	0.782082	18.45	78.76	97.21	18.609	88.68	107.284	0.04070	0.18108	0.22178
40	83.206	0.012618	0.64491	0.657527	21.23	76.78	98.01	21.421	86.72	108.142	0.04632	0.17354	0.21986
50	98.727	0.012815	0.54324	0.556059	24.04	74.75	98.79	24.275	84.68	108.953	0.05190	0.16613	0.21803
60	116.312	0.013025	0.45969	0.472719	26.89	72.64	99.53	27.172	82.54	109.712	0.05745	0.15882	0.21627
70	136.123	0.013251	0.39048	0.403734	29.78	70.46	100.24	30.116	80.30	110.414	0.06296	0.15160	0.21456
80	158.326	0.013492	0.33271	0.346206	32.71	68.19	100.90	33.109	77.94	111.052	0.06846	0.14442	0.21288
90	183.094	0.013754	0.28413	0.297887	35.69	65.83	101.52	36.158	75.46	111.619	0.07394	0.13728	0.21122
100	210.604	0.014038	0.24298	0.257021	38.72	63.36	102.08	39.267	72.84	112.105	0.07942	0.13014	0.20956
110	241.042	0.014350	0.20787	0.222220	41.81	60.77	102.58	42.446	70.05	112.498	0.08491	0.12296	0.20787
120	274.604	0.014694	0.17769	0.192379	44.96	58.04	103.00	45.705	67.08	112.782	0.09042	0.11571	0.20613
130	311.496	0.015080	0.15153	0.166606	48.19	55.14	103.33	49.059	63.88	112.936	0.09598	0.10833	0.20431
140	351.944	0.015518	0.12866	0.144176	41.52	62.02	103.53	42.528	70.40	112.931	0.10163	0.10072	0.20235
150	396.194	0.016025	0.10846	0.124484	44.98	58.62	103.60	46.153	66.58	112.728	0.10739	0.09281	0.20020
160	444.525	0.016627	0.090384	0.107011	58.58	44.88	103.45	59.948	52.32	112.263	0.11334	0.08442	0.19776
170	497.259	0.017367	0.073912	0.091279	62.42	40.61	103.03	64.019	47.42	111.438	0.11959	0.07531	0.19490
180	554.783	0.018332	0.058458	0.076790	66.61	35.56	102.18	68.498	41.57	110.068	0.12635	0.06498	0.19133
190	617.590	0.019733	0.043104	0.062837	71.45	29.09	100.55	73.711	34.02	107.734	0.13409	0.05237	0.18646
200	686.356	0.022436	0.025002	0.047438	78.01	18.81	96.82	80.862	21.99	102.853	0.14460	0.03334	0.17794
204.81	721.906	0.030525	0	0.030525	87.30	0	87.30	91.378	0	91.378	0.16022	0	0.16022

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 843, tabla A.4.1I.

La línea en negritas corresponde al estado de referencia para la entalpía y la entropía del líquido saturado.

Tabla A.4.2 I Refrigerante - 22 sobrecalentado.

Temp.ºF T	P = 5.00 lb_f/pulg²				P = 10.00 lb_f/pulg²				P = 15.00 lb_f/pulg²			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)
-20	10.8034	93.882	103.885	0.27238	5.3460	93.627	103.526	0.25588	3.5261	93.365	103.159	0.24596
0	11.3114	96.262	106.735	0.27872	5.6060	96.033	106.414	0.26230	3.7037	95.801	106.088	0.25248
20	11.8177	98.701	109.643	0.28491	5.8643	98.506	109.365	0.26856	3.8794	98.290	109.065	0.25882
40	12.3227	101.202	112.611	0.29097	6.1212	101.018	112.353	0.27468	4.0537	100.831	112.091	0.26450
60	12.8265	103.762	115.638	0.29691	6.3769	103.596	115.404	0.28067	4.2268	103.428	115.168	0.27103
80	13.3293	106.383	118.724	0.30274	6.6316	106.232	118.512	0.28654	4.3989	106.080	118.298	0.27694
100	13.8313	109.061	121.867	0.30845	6.8855	108.924	121.674	0.29229	4.5701	108.786	121.480	0.28273
120	14.3327	111.799	125.069	0.31407	7.1387	111.673	124.892	0.29794	4.7406	111.547	124.715	0.28841
140	14.8335	114.593	128.327	0.31960	7.3913	114.478	128.165	0.30349	4.9105	114.364	128.003	0.29399
160	15.3337	117.445	131.642	0.32504	7.6434	117.339	131.493	0.30895	5.0799	117.234	131.344	0.29947
180	15.8336	120.352	135.012	0.33039	7.8951	120.255	134.875	0.31432	5.2489	120.158	134.737	0.30486
200	16.3331	123.315	138.437	0.33566	8.1464	123.225	138.310	0.31961	5.4174	123.136	138.183	0.31016
220	16.8322	126.332	141.916	0.34086	8.3974	126.249	141.799	0.32482	5.5857	126.165	141.680	0.31538
240	17.3312	129.403	145.449	0.34598	8.6481	129.385	145.399	0.32995	5.7537	129.247	145.229	0.32053

Temp.ºF T	P = 20.00 lb_f/pulg²				P = 25.00 lb_f/pulg²				P = 30.00 lb_f/pulg²			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)
0	2.7521	95.564	105.756	0.24535	2.1808	95.323	105.419	0.23970	1.7997	95.078	105.076	0.23497
20	2.8867	98.078	108.769	0.25177	2.2908	97.864	108.469	0.24619	1.8933	97.647	108.165	0.24154
40	3.0198	100.642	111.826	0.25801	2.3992	100.451	111.558	0.25250	1.9853	100.257	111.286	0.24792
60	3.1516	103.258	114.930	0.26410	2.5063	103.086	114.689	0.25864	2.0760	102.912	114.445	0.25412
80	3.2823	105.926	118.082	0.27005	2.6123	105.772	117.865	0.26464	2.1655	105.615	117.645	0.26016
100	3.4122	108.647	121.284	0.27588	2.7175	108.507	121.087	0.27050	2.2542	108.365	120.888	0.26606
120	3.5414	111.421	124.536	0.28159	2.8219	111.293	124.357	0.27624	2.3421	111.165	124.176	0.27183
140	3.6700	114.248	127.840	0.28719	2.9257	114.131	127.675	0.28187	2.4294	114.014	127.510	0.27748
160	3.7981	117.128	131.194	0.29269	3.0289	107.021	121.043	0.28739	2.5162	116.913	130.891	0.28303
180	3.9257	120.060	134.599	0.29810	3.1318	119.962	134.460	0.29282	2.6025	119.863	134.320	0.28848
200	4.0529	123.045	138.055	0.30342	3.2342	122.954	137.926	0.29815	2.6884	122.862	137.797	0.29383
220	4.1799	126.082	141.562	0.30865	3.3363	125.998	141.443	0.30340	2.7739	125.913	141.323	0.29909
240	4.3065	129.170	145.119	0.31381	3.4382	129.091	145.008	0.30857	2.8592	129.014	144.897	0.30427
260	4.4329	132.308	148.725	0.31889	3.5397	132.235	148.622	0.31367	2.9443	132.162	148.518	0.30938

Tabla A.4.2 I Refrigerante - 22 sobrecalentado.

Temp.ºF T	P = 40.00 lb$_f$/pulg^2				P = 50.00 lb$_f$/pulg^2				P = 60.00 lb$_f$/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
20	1.3959	97.202	107.541	0.23399	1.0968	96.742	106.897	0.22788	-	-	-	-
40	1.4676	99.862	110.732	0.24051	1.1564	99.456	110.163	0.23455	0.94863	108.505	109.557	0.22950
60	1.5378	102.560	113.950	0.24682	1.2145	102.198	113.443	0.24099	0.99871	101.834	112.923	0.23607
80	1.6068	105.298	117.199	0.25296	1.2714	104.973	116.745	0.24722	1.0475	104.643	116.281	0.24241
100	1.6749	108.079	120.485	0.25893	1.3272	107.787	120.075	0.25328	1.0952	107.490	119.658	0.24855
120	1.7423	110.905	123.810	0.26477	1.3822	110.641	123.438	0.25918	1.1421	110.372	123.061	0.25453
140	1.8090	113.777	127.176	0.27048	1.4366	113.537	126.838	0.26495	1.1882	113.294	126.495	0.26035
160	1.8751	116.696	130.585	0.27607	1.4903	116.478	130.276	0.27059	1.2338	116.255	129.963	0.26604
180	1.9407	119.664	134.039	0.28156	1.5436	119.463	133.755	0.27611	1.2788	119.260	133.468	0.27161
200	2.0060	122.680	137.538	0.28694	1.5965	122.494	137.276	0.28153	1.3235	122.307	137.012	0.27706
220	2.0709	125.743	141.082	0.29223	1.6491	125.571	140.840	0.28686	1.3678	125.399	140.596	0.28241
240	2.1356	128.855	144.673	0.29744	1.7013	128.696	144.448	0.29209	1.4118	128.535	144.221	0.28767
260	2.2000	132.015	148.310	0.30257	1.7533	131.867	148.100	0.29723	1.4556	131.717	147.889	0.29284
280	2.2641	135.222	151.992	0.30761	1.8051	135.084	151.797	0.30230	1.4991	134.944	151.600	0.29792

Temp.ºF T	P = 70.00 lb$_f$/pulg^2				P = 80.00 lb$_f$/pulg^2				P = 100.00 lb$_f$/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
40	0.79981	98.605	108.972	0.22507	0.68782	98.158	108.347	0.22107	-	-	-	-
60	0.84429	101.447	112.391	0.23178	0.72820	101.056	111.843	0.22793	0.56498	100.238	110.700	0.22117
80	0.88736	104.305	115.807	0.23823	0.76708	103.960	115.323	0.23450	0.59818	103.242	114.319	0.22801
100	0.92932	107.188	119.234	0.24446	0.80477	106.879	118.801	0.24083	0.63003	106.244	117.911	0.23454
120	0.97038	110.101	122.679	0.25051	0.84152	109.824	122.290	0.24696	0.66084	109.255	121.492	0.24083
140	1.0107	113.047	126.148	0.25639	0.87751	112.797	125.796	0.25290	0.69081	112.285	125.077	0.24691
160	1.0504	116.032	129.647	0.26213	0.91286	115.803	129.326	0.25869	0.72011	115.339	128.674	0.25281
180	1.0896	119.054	133.178	0.26774	0.94770	118.846	132.885	0.26435	0.74885	118.423	132.290	0.25855
200	1.1284	122.118	136.745	0.27323	0.98209	121.926	136.475	0.26987	0.77712	121.541	135.931	0.26418
220	1.1669	125.224	140.350	0.27862	1.0161	125.049	140.101	0.27529	0.80501	124.692	139.599	0.26963
240	1.2050	128.374	143.993	0.28390	1.0498	128.211	143.763	0.28060	0.83257	127.882	143.299	0.27500
260	1.2428	131.568	147.677	0.28909	1.0833	131.415	147.463	0.28581	0.85985	131.110	147.032	0.28026
280	1.2805	134.803	151.401	0.29419	1.1165	134.662	151.202	0.29094	0.88689	134.377	150.800	0.28542
300	1.3179	138.084	155.167	0.29922	1.1495	137.952	154.981	0.29598	0.91373	137.685	154.605	0.29050

Tabla A.4.2 I Refrigerante - 22 sobrecalentado.

Temp.ºF T	P = 125.00 lb$_f$/pulg^2				P = 150.00 lb$_f$/pulg^2				P = 175.00 lb$_f$/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
80	0.46219	102.291	112.989	0.22104	0.37055	101.264	111.556	0.21484	-	-	-	-
100	0.48962	105.410	116.743	0.22787	0.39534	104.523	115.504	0.22202	0.32731	103.573	114.180	0.21668
120	0.51584	108.516	120.456	0.23439	0.41870	107.738	119.368	0.22880	0.34884	106.917	118.221	0.22378
140	0.54112	111.623	124.148	0.24065	0.44098	110.932	123.181	0.23527	0.36910	110.211	122.172	0.23048
160	0.56565	114.742	127.835	0.24670	0.46241	114.124	126.968	0.24148	0.38843	113.482	126.069	0.23687
180	0.58957	117.881	131.528	0.25256	0.48319	117.323	130.744	0.24748	0.40702	116.745	129.935	0.24301
200	0.61299	121.045	135.234	0.25827	0.50342	120.537	134.520	0.25329	0.42502	120.014	133.787	0.24894
220	0.63600	124.238	138.959	0.26383	0.52322	123.772	138.305	0.25895	0.44256	123.296	137.637	0.25469
240	0.65867	127.462	142.708	0.26927	0.54265	127.034	142.107	0.26446	0.45970	126.596	141.493	0.26028
260	0.68104	130.721	146.485	0.27459	0.56177	130.325	145.929	0.26984	0.47651	129.911	145.353	0.26573
280	0.70316	134.016	150.292	0.27980	0.58062	133.648	149.775	0.27512	0.49305	133.274	149.251	0.27106
300	0.72507	137.347	154.130	0.28493	0.59925	137.004	153.649	0.28028	0.50936	136.656	153.162	0.27628
320	0.74679	140.717	158.003	0.28996	0.61770	140.396	157.553	0.28536	0.52546	140.070	157.098	0.28139
340	0.76835	144.126	161.911	0.29491	0.63597	143.824	161.489	0.29034	0.54140	143.518	161.062	0.28641

Temp.ºF T	P = 200.00 lb$_f$/pulg^2				P = 250.00 lb$_f$/pulg^2				P = 300.00 lb$_f$/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
100	0.27553	102.546	112.750	0.21165	-	-	-	-	-	-	-	-
120	0.29595	106.044	117.004	0.21911	0.22038	104.095	114.297	0.21036	-	-	-	-
140	0.31487	109.453	121.114	0.22608	0.23795	107.802	118.818	0.21803	0.18520	105.911	116.199	0.21042
160	0.33270	112.813	125.134	0.23268	0.25401	111.382	123.141	0.22512	0.20062	109.793	120.938	0.21820
180	0.34972	116.148	129.100	0.23898	0.26902	114.886	127.340	0.23179	0.21460	113.515	125.436	0.22534
200	0.36609	119.476	133.034	0.24503	0.28325	118.348	131.461	0.23814	0.22759	117.141	129.784	0.23204
220	0.38196	122.807	136.953	0.25089	0.29688	121.789	135.533	0.24422	0.23984	120.711	134.035	0.23839
240	0.39741	126.149	140.867	0.25656	0.31002	125.224	139.576	0.25008	0.25154	124.251	138.225	0.24445
260	0.41251	129.510	144.787	0.26209	0.32278	128.661	143.604	0.25576	0.26280	127.776	142.375	0.25031
280	0.42733	132.893	148.719	0.26747	0.33522	132.111	147.629	0.26127	0.27370	131.298	146.503	0.25597
300	0.44190	136.302	152.668	0.27274	0.34740	135.577	151.659	0.26665	0.28431	134.827	150.621	0.26146
320	0.45627	139.739	156.637	0.27790	0.35935	139.063	155.699	0.27190	0.29467	138.368	154.738	0.26681
340	0.47046	143.208	160.631	0.28296	0.37111	142.566	159.746	0.27704	0.30483	141.927	158.861	0.27203
360	0.48449	146.709	164.652	0.28792	0.38270	146.114	163.831	0.28207	0.31482	145.506	162.995	0.27714
380	0.49839	150.242	168.700	0.29280	0.39416	149.682	167.929	0.28701	0.32465	149.110	167.145	0.28214
400	0.51218	153.811	172.779	0.29760	0.40549	153.280	172.052	0.29186	0.33436	152.740	171.314	0.28705

Tabla A.4.2 I Refrigerante - 22 sobrecalentado.

Temp.ºF T	P = 400.00 lb$_f$/pulg^2				P = 500.00 lb$_f$/pulg^2				P = 600.00 lb$_f$/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
160	0.13053	105.848	115.516	0.20459	-	-	-	-	-	-	-	-
180	0.14460	110.304	121.014	0.21332	0.098744	105.922	115.064	0.20054	-	-	-	-
200	0.15674	114.413	126.023	0.22104	0.11220	111.044	121.432	0.21034	0.079113	106.349	115.116	0.19810
220	0.16770	118.334	130.755	0.22810	0.12319	115.548	126.954	0.21859	0.091943	112.105	122.320	0.20887
240	0.17785	122.142	135.315	0.23471	0.13285	119.751	132.051	0.22598	0.10197	116.966	128.295	0.21753
260	0.18740	125.880	139.761	0.24098	0.14164	123.780	136.894	0.23281	0.11061	121.416	133.705	0.22516
280	0.19650	129.576	144.131	0.24697	0.14984	127.699	141.572	0.23922	0.11839	125.636	138.790	0.23213
300	0.20524	133.249	148.451	0.25273	0.15757	131.552	146.141	0.24532	0.12558	129.716	143.668	0.23863
320	0.21369	136.913	152.741	0.25831	0.16495	135.362	150.634	0.25115	0.13233	133.705	148.407	0.24479
340	0.22191	140.575	157.012	0.26372	0.17206	139.146	155.077	0.25678	0.13875	137.634	153.050	0.25067
360	0.22992	144.245	161.275	0.26898	0.17893	142.920	159.487	0.26223	0.14490	141.529	157.628	0.25633
380	0.23776	147.927	165.538	0.27412	0.18561	146.692	163.877	0.26752	0.15083	145.402	162.160	0.26179
400	0.24546	151.626	169.807	0.27914	0.19212	150.469	168.257	0.27267	0.15658	149.265	166.662	0.26709
420	0.25303	155.345	174.087	0.28407	0.19851	154.255	172.634	0.27771	0.16219	153.126	171.146	0.27225
440	0.26049	159.087	178.381	0.28889	0.20477	158.055	177.014	0.28263	0.16766	156.993	175.621	0.27727

Temp.ºF T	P = 700.00 lb$_f$/pulg^2				P = 800.00 lb$_f$/pulg^2				P = 900.00 lb$_f$/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
220	0.067104	107.350	116.048	0.19748	0.042152	98.147	104.391	0.17883	-	-	-	-
240	0.078820	113.575	123.792	0.20872	0.059974	109.140	118.024	0.19865	0.043352	102.683	109.908	0.18568
260	0.087856	118.700	130.088	0.21759	0.070151	115.490	125.882	0.20973	0.055694	111.570	120.852	0.20113
280	0.095590	123.342	135.733	0.22533	0.078163	120.760	132.339	0.21858	0.064298	117.814	128.530	0.21165
300	0.10253	127.717	141.007	0.23237	0.085058	125.531	138.131	0.22631	0.071320	123.124	135.010	0.22030
320	0.10891	131.929	146.046	0.23892	0.091252	130.020	143.538	0.23333	0.077446	127.965	140.872	0.22792
340	0.11489	136.033	150.925	0.24510	0.096959	134.333	148.696	0.23987	0.082984	132.529	146.359	0.23487
360	0.12057	140.067	155.695	0.25099	0.10231	138.530	153.686	0.24603	0.088104	136.917	151.600	0.24134
380	0.12599	144.056	160.387	0.25664	0.10737	142.651	158.557	0.25190	0.092910	141.188	156.672	0.24745
400	0.13122	148.016	165.025	0.26210	0.11222	146.720	163.344	0.25753	0.097471	145.379	161.623	0.25328
420	0.13628	151.960	169.625	0.26739	0.11688	150.757	168.071	0.26297	0.10184	149.515	166.487	0.25888
440	0.14120	155.898	174.201	0.27253	0.12140	154.772	172.756	0.26824	0.10604	153.617	171.289	0.26427
460	0.14601	159.835	178.761	0.27755	0.12579	158.778	177.412	0.27335	0.11011	157.695	176.046	0.26950
480	0.15071	163.780	183.315	0.28245	0.13007	162.781	182.049	0.27834	0.11406	161.762	180.771	0.27458
500	0.15532	167.734	187.867	0.28724	0.13425	166.787	186.675	0.28321	0.11792	165.823	185.475	0.27954

Tabla A.5 I Propiedades termodinámicas del Refrigerante - 134a (Van Wylen).
Tabla A.5.1 I Refrigerante - 134a saturado: Tabla de Temperaturas.

Temp.ºF T	Presión lb$_f$/pulg^2, P	Volumen específico, ft^3/lb$_m$			Energía interna, Btu/lb$_m$			Entalpía, Btu/lb$_m$			Entropía, Btu/lb$_m$.ºR		
		Líquido saturado v$_f$	Evap v$_{fg}$	Vapor saturado v$_g$	Líquido saturado u$_f$	Evap u$_{fg}$	Vapor saturado u$_g$	Líquido saturado h$_f$	Evap h$_{fg}$	Vapor saturado h$_g$	Líquido saturado s$_f$	Evap s$_{fg}$	Vapor saturado s$_g$
-25	11.4028	0.011526	3.8551	3.8666	68.358	86.311	154.669	68.382	94.451	162.833	0.2010	0.2173	0.4183
-20	13.0097	0.011592	3.4049	3.4164	69.835	85.522	155.357	69.863	93.724	163.587	0.2044	0.2131	0.4175
-10	16.7602	0.011173	2.6804	2.6921	72.833	83.901	156.734	72.868	92.220	165.089	0.2111	0.2051	0.4162
0	21.3150	0.011873	2.1339	2.1458	75.877	82.235	158.113	75.924	90.658	166.582	0.2178	0.1972	0.4150
10	26.7864	0.012024	1.7162	1.7282	78.964	80.528	159.492	79.024	89.039	168.064	0.2244	0.1896	0.4140
30	40.9608	0.012350	1.1398	1.1522	85.250	76.986	162.237	85.344	85.632	170.976	0.2375	0.1749	0.4124
35	45.2708	0.012437	1.0339	1.0464	86.844	76.074	162.918	86.948	84.742	171.690	0.2408	0.1713	0.4121
40	49.9206	0.012526	0.93952	0.9520	88.447	75.150	163.597	88.563	83.834	172.397	0.2440	0.1678	0.4118
45	54.9278	0.012619	0.85509	0.8677	90.060	74.212	164.271	90.188	82.910	173.097	0.2472	0.1643	0.4115
50	60.3101	0.012714	0.77942	0.7921	91.681	73.262	164.943	91.823	81.966	173.789	0.2504	0.1608	0.4112
55	66.0855	0.012812	0.71145	0.72426	93.312	72.296	165.608	93.469	81.002	174.471	0.2536	0.1574	0.4110
60	72.2724	0.012913	0.65024	0.66316	94.954	71.315	166.269	95.127	80.017	175.144	0.2568	0.1540	0.4108
65	78.8898	0.013017	0.59502	0.60803	96.607	70.318	166.925	96.797	79.010	175.807	0.2600	0.1505	0.4105
70	85.9569	0.013125	0.54508	0.55820	98.270	69.302	167.572	98.479	77.979	176.457	0.2631	0.1472	0.4103
75	93.4933	0.013237	0.49983	0.51307	99.945	68.269	168.213	100.174	76.922	177.096	0.2663	0.1438	0.4101
80	101.5189	0.013353	0.45875	0.47210	101.631	67.214	168.845	101.882	75.838	177.720	0.2694	0.1405	0.4099
85	110.0543	0.013474	0.42138	0.43485	103.330	66.138	169.468	103.605	74.725	178.330	0.2725	0.1372	0.4097
90	119.1203	0.013599	0.38731	0.40091	105.042	65.039	170.081	105.342	73.582	178.924	0.2757	0.1338	0.4095
95	128.7381	0.013730	0.35621	0.36994	106.768	63.914	170.682	107.095	72.406	179.501	0.2788	0.1305	0.4093
100	138.9297	0.013866	0.32775	0.34162	108.507	62.763	171.270	108.864	71.194	180.059	0.2819	0.1272	0.4091
110	161.1238	0.014156	0.27772	0.29188	112.033	60.372	172.404	112.455	68.657	181.113	0.2882	0.1205	0.4087
120	185.8877	0.014475	0.23540	0.24988	115.625	57.846	173.471	116.123	65.949	182.072	0.2945	0.1137	0.4082
130	213.4166	0.014830	0.19933	0.21416	119.290	55.166	174.456	119.876	63.043	182.919	0.3008	0.1069	0.4077
140	243.9180	0.015227	0.16837	0.18360	123.041	52.299	175.340	123.729	59.904	183.633	0.3071	0.0999	0.4070
150	277.6140	0.015679	0.14156	0.15724	126.892	49.210	176.102	127.698	56.487	184.185	0.3135	0.0927	0.4062
160	314.7458	0.016203	0.11813	0.13434	130.863	45.843	176.705	131.807	52.728	184.535	0.3200	0.0851	0.4051
170	355.5800	0.016827	0.097399	0.11423	134.986	42.119	177.105	136.094	48.532	184.626	0.3267	0.0770	0.4037
180	400.4193	0.017599	0.078726	0.096325	139.318	37.900	177.218	140.623	43.737	184.360	0.3336	0.0684	0.4020
190	449.6228	0.018615	0.061411	0.080026	143.964	32.930	176.894	145.514	38.043	183.557	0.3409	0.0586	0.3995
200	503.6514	0.020125	0.044361	0.064487	149.192	26.586	175.778	151.069	30.724	181.792	0.3491	0.0466	0.3957
210	563.2197	0.023379	0.023989	0.047368	156.216	16.233	172.449	158.654	18.735	177.389	0.3601	0.0280	0.3881
214.07	589.4334	0.031532	0	0.031532	164.648	0	164.648	168.090	0	168.090	0.3740	0	0.3740

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 848 - 849, tabla A.5.1I.

Tabla A.5.2 I Refrigerante - 134a sobrecalentado.

Temp.ºF T	P = 10.00 lb_f/pulg²				P = 15.00 lb_f/pulg²				P = 20.00 lb_f/pulg²			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)
-20	4.4879	155.614	163.924	0.42323	-	-	-	-	-	-	-	-
0	4.7168	158.923	167.657	0.43154	3.1033	158.573	167.193	0.42288	2.2955	158.21	166.712	0.41647
20	4.9417	162.297	171.448	0.43961	3.2586	162.008	171.059	0.43111	2.4164	161.71	170.658	0.42488
40	5.1637	165.744	175.306	0.44749	3.4109	165.500	174.974	0.43911	2.5340	165.25	174.634	0.43300
60	5.3836	169.269	179.238	0.45521	3.5610	169.060	178.951	0.44691	2.6492	168.85	178.658	0.44089
80	5.6019	172.876	183.249	0.46278	3.7093	172.694	182.997	0.45455	2.7627	172.51	182.741	0.44860
100	5.8189	176.565	187.340	0.47022	3.8563	176.406	187.117	0.46204	2.8748	176.24	186.890	0.45615
120	6.0350	180.340	191.515	0.47755	4.0024	180.197	191.314	0.46941	2.9859	180.05	191.111	0.46356
140	6.2503	184.198	195.772	0.48477	4.1476	184.071	195.591	0.47666	3.0962	183.94	195.407	0.47085
160	6.4650	188.143	200.114	0.49189	4.2922	188.026	199.948	0.48381	3.2058	187.91	199.780	0.47802
180	6.6791	192.172	204.540	0.49892	4.4364	192.064	204.387	0.49086	3.3149	191.96	204.233	0.58509
200	6.8929	196.285	209.049	0.50586	4.5801	196.185	208.907	0.49782	3.4236	196.09	208.765	0.49207
220	7.1064	200.482	213.641	0.51272	4.7234	200.389	213.509	0.50469	3.5319	200.30	213.376	0.49895
240	7.3195	204.761	218.315	0.51950	4.8665	204.675	218.192	0.51148	3.6399	204.59	218.068	0.50576

Temp.ºF T	P = 30.00 lb_f/pulg²				P = 40.00 lb_f/pulg²				P = 50.00 lb_f/pulg²			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)
20	1.5725	161.082	169.818	0.41565	-	-	-	-	-	-	-	-
40	1.6559	164.729	173.928	0.42404	1.2157	164.177	173.182	0.41731	-	-	-	-
60	1.7367	168.405	178.053	0.43214	1.2796	167.942	177.420	0.42563	1.0045	167.46	176.756	0.42032
80	1.8155	172.129	182.214	0.44000	1.3413	171.733	181.668	0.43365	1.0563	171.32	181.099	0.42852
100	1.8929	175.911	186.426	0.44766	1.4015	175.566	185.947	0.44143	1.1062	175.21	185.451	0.43644
120	1.9691	179.758	190.697	0.45516	1.4604	179.454	190.271	0.44902	1.1549	179.14	189.834	0.44413
140	2.0445	183.676	195.034	0.46251	1.5184	183.404	194.651	0.45645	1.2026	183.13	194.260	0.45164
160	2.1192	187.668	199.441	0.46974	1.5757	187.423	199.094	0.46374	1.2495	187.17	198.741	0.45899
180	2.1933	191.737	203.921	0.47686	1.6324	191.513	203.604	0.47090	1.2957	191.29	203.282	0.46620
200	2.2670	195.883	208.477	0.48387	1.6886	195.678	208.185	0.47798	1.3415	195.47	207.889	0.47329
220	2.3403	200.108	213.109	0.49079	1.7444	199.917	212.838	0.48490	1.3869	199.72	212.565	0.48027
240	2.4133	204.412	217.818	0.49761	1.7999	204.234	217.566	0.49176	1.4319	204.05	217.311	0.48716
260	2.4860	208.795	222.605	0.50436	1.8552	208.628	222.369	0.49853	1.4766	208.46	222.131	0.49395

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 849 - 850, tabla A.5.2I.

Temp.°F T	P = 60.00 lb$_f$/pulg^2				P = 70.00 lb$_f$/pulg^2				P = 80.00 lb$_f$/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.°R)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.°R)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.°R)
60	0.82042	166.942	176.057	0.41574	0.68820	166.397	175.318	0.41165	-	-	-	-
80	0.86571	170.888	180.506	0.42514	0.72913	170.435	179.886	0.42027	0.62624	169.960	179.237	0.41675
100	0.90906	174.839	184.939	0.43221	0.79789	174.066	184.408	0.42850	0.66170	174.053	183.855	0.42516
120	0.95098	178.818	189.384	0.44001	0.80509	178.484	188.920	0.43642	0.69545	178.139	188.441	0.43321
140	0.99182	182.840	193.860	0.44760	0.84112	182.546	193.449	0.44410	0.72793	182.245	193.028	0.44099
160	1.0318	186.916	198.380	0.45502	0.87626	186.654	198.012	0.45159	0.75947	186.385	197.636	0.44855
180	1.0712	191.053	202.954	0.46229	0.91071	190.816	202.621	0.45891	0.79027	190.575	202.282	0.45593
200	1.1100	195.256	207.589	0.46942	0.94461	195.040	207.284	0.46609	0.82050	194.820	206.975	0.46315
220	1.1484	199.529	212.288	0.47644	0.97807	199.329	212.007	0.47314	0.85026	199.128	211.724	0.47024
240	1.1865	203.871	217.054	0.48335	1.0112	203.688	216.795	0.48008	0.87964	203.501	216.532	0.47721
260	1.0000	210.781	221.891	0.49016	1.0440	208.116	221.649	0.48692	0.90871	207.943	221.405	0.48408
280	1.2243	213.196	226.799	0.49689	1.0765	212.619	226.573	0.49367	0.93752	212.457	226.345	0.49085
300	1.2618	217.761	231.780	0.50353	1.1088	217.195	231.567	0.50033	0.96611	217.041	231.353	0.49753

Temp.°F T	P = 90.00 lb$_f$/pulg^2				P = 100.00 lb$_f$/pulg^2				P = 125.00 lb$_f$/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.°R)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.°R)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.°R)
80	0.54574	169.459	178.554	0.41349	0.44088	169.669	177.833	0.41039	-	-	-	-
100	0.57881	173.635	183.281	0.42209	0.51219	173.198	182.682	0.41922	0.39104	172.008	181.059	0.41262
120	0.60997	187.781	197.947	0.43028	0.54138	177.412	187.437	0.42756	0.41714	176.422	186.077	0.42143
140	0.63976	181.933	192.595	0.43816	0.56909	181.613	192.151	0.43556	0.44133	180.767	190.982	0.42975
160	0.66854	186.110	197.252	0.44580	0.59569	185.828	196.859	0.44328	0.46421	185.091	195.836	0.43771
180	0.69653	190.329	201.937	0.45324	0.62147	190.077	201.585	0.45079	0.48610	189.423	200.675	0.44540
200	0.72392	194.597	206.662	0.46051	0.64661	194.369	206.343	0.45811	0.50726	193.784	205.525	0.45286
220	0.75082	198.923	211.436	0.46764	0.67123	198.716	211.145	0.46528	0.52785	198.184	210.402	0.46015
240	0.77732	203.312	216.267	0.47465	0.69545	203.122	216.000	0.47232	0.54798	202.634	215.318	0.46727
260	0.80351	207.768	221.159	0.48154	0.71933	207.591	220.911	0.47924	0.56774	207.141	220.282	0.47427
280	0.82942	212.292	226.115	0.48834	0.74293	212.127	225.884	0.48606	0.58720	211.707	225.299	0.48115
300	0.85510	216.887	231.138	0.49504	0.76629	216.731	230.921	0.49278	0.60641	216.339	230.375	0.48792
320	0.88059	221.553	236.229	0.50165	0.78946	221.406	236.025	0.49941	0.62540	221.037	235.513	0.49459

Tabla A.5.2 I Refrigerante - 134a sobrecalentado.

Temp.ºF T	P = 150.00 lb_f/pulg²				P = 175.00 lb_f/pulg²				P = 200.00 lb_f/pulg²			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)
120	0.33316	175.319	184.573	0.41586	0.27189	174.072	182.883	0.41054	-	-	-	-
140	0.35543	179.847	189.719	0.42459	0.29330	178.836	188.341	0.41980	0.24585	177.713	186.818	0.41519
160	0.37606	184.303	194.748	0.43284	0.31260	183.453	193.583	0.42840	0.26449	182.533	192.328	0.42423
180	0.39552	188.733	199.719	0.44073	0.33049	188.001	198.711	0.43654	0.28139	187.221	197.642	0.43267
200	0.41413	193.170	204.673	0.44836	0.34739	191.526	202.783	0.44435	0.29712	191.848	202.852	0.44069
220	0.43210	197.631	209.633	0.45577	0.36355	197.056	208.837	0.45190	0.31200	196.456	208.011	0.44839
240	0.44955	202.130	214.617	0.46299	0.37915	201.609	213.896	0.45924	0.32624	201.072	213.154	0.45585
260	0.46661	206.677	219.638	0.47007	0.39430	206.202	218.979	0.46640	0.34000	205.713	218.305	0.46311
280	0.48333	211.279	224.704	0.47701	0.40909	210.840	224.097	0.47341	0.35337	210.392	223.479	0.47020
300	0.49978	215.939	229.821	0.48384	0.42359	215.532	229.259	0.48030	0.36643	215.117	228.688	0.47715
320	0.51601	220.662	234.995	0.49056	0.43786	220.282	234.471	0.48707	0.37923	219.896	233.941	0.48397
340	0.53204	225.450	240.228	0.49719	0.45192	225.093	239.738	0.49374	0.39181	224.731	239.242	0.49069
360	0.54791	230.305	245.524	0.50373	0.46580	229.968	245.062	0.50032	0.40421	229.628	244.598	0.49730

Temp.ºF T	P = 250.00 lb_f/pulg²				P = 300.00 lb_f/pulg²				P = 350.00 lb_f/pulg²			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)
160	0.19551	180.411	189.462	0.41620	0.14666	177.698	185.845	0.40783	-	-	-	-
180	0.21168	185.485	195.284	0.42545	0.16374	183.432	192.528	0.41845	0.12745	180.871	189.131	0.41104
200	0.22612	190.375	200.843	0.43401	0.17793	188.708	198.592	0.42778	0.14249	186.772	196.007	0.42163
220	0.23942	195.175	206.259	0.44210	0.19050	193.764	204.347	0.43638	0.15497	192.192	202.236	0.43093
240	0.25191	199.936	211.598	0.44984	0.20202	198.711	209.934	0.44448	0.16602	197.379	208.139	0.43949
260	0.26381	204.692	216.905	0.45732	0.21279	203.607	215.428	0.45222	0.17613	202.448	213.863	0.44756
280	0.27524	209.464	222.206	0.46458	0.22302	208.488	220.877	0.45696	0.18557	207.460	219.487	0.45527
300	0.28632	214.264	227.519	0.47167	0.23282	213.377	226.311	0.46694	0.19452	212.452	225.059	0.46270
320	0.29710	219.106	232.860	0.47861	0.24230	218.291	231.751	0.47401	0.20310	217.448	230.611	0.46992
340	0.30764	223.995	238.237	0.48542	0.25150	223.241	237.212	0.48092	0.21138	222.465	236.165	0.47695
360	0.31710	228.978	243.658	0.49212	0.26049	228.234	242.705	0.48771	0.21941	227.516	241.736	0.48383
380	0.32816	233.936	249.128	0.49871	0.26930	233.277	248.237	0.49438	0.22725	232.607	247.335	0.49058
400	0.33819	238.995	254.651	0.50521	0.27794	238.374	253.814	0.50094	0.23492	237.745	252.970	0.49721

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 851 - 852, tabla A.5.2I.

Tabla A.5.2 I Refrigerante - 134a sobrecalentado.

Temp.ºF T	P = 400.00 lb$_f$/pulg^2				P = 500.00 lb$_f$/pulg^2				P = 600.00 lb$_f$/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
180	0.096581	177.257	184.411	0.40204	-	-	-	-	-	-	-	-
200	0.11456	184.435	192.920	0.41515	0.066633	176.375	182.544	0.39688	-	-	-	-
220	0.12766	190.405	199.861	0.42552	0.086749	185.772	193.804	0.41372	0.050668	176.597	182.226	0.39480
240	0.13864	195.918	206.187	0.43470	0.099037	192.452	201.622	0.42506	0.070300	187.749	195.560	0.41418
260	0.14840	201.204	212.196	0.44317	0.10888	198.392	208.473	0.43472	0.081478	194.969	204.022	0.42611
280	0.15735	206.373	218.028	0.45116	0.11743	203.989	214.861	0.44348	0.090262	201.246	211.274	0.43605
300	0.16572	211.484	223.759	0.45880	0.12515	209.407	220.994	0.45166	0.097804	207.098	217.964	0.44497
320	0.17366	216.575	229.438	0.46618	0.13230	214.728	226.977	0.45943	0.10457	212.724	224.342	0.45326
340	0.18126	221.668	235.094	0.47335	0.13903	220.002	232.874	0.46690	0.11080	218.227	230.537	0.46111
360	0.18860	226.780	240.750	0.48033	0.14543	225.260	238.725	0.47413	0.11664	223.662	236.621	0.46862
380	0.19572	231.925	246.422	0.48717	0.15158	230.525	244.559	0.48116	0.12218	229.068	242.643	0.47588
400	0.20266	237.108	252.119	0.49387	0.15753	235.808	250.393	0.48803	0.12748	234.469	248.633	0.48293

Tabla A.5 l Propiedades termodinámicas del Refrigerante – 134a (Çengel).
Tabla A.5.1 l Refrigerante - 134a saturado: Tabla de Temperaturas.

Temp.ºF T	Presión lb$_f$/pulg^2, P	Volumen específico, ft^3/lb$_m$			Energía interna, Btu/lb$_m$			Entalpía, Btu/lb$_m$			Entropía, Btu/lb$_m$.ºR		
		Líquido saturado v_f	Evap v_{fg}	Vapor saturado v_g	Líquido saturado u_f	Evap u_{fg}	Vapor saturado u_g	Líquido saturado h_f	Evap h_{fg}	Vapor saturado h_g	Líquido saturado s_f	Evap s_{fg}	Vapor saturado s_g
-40	**7.490**	**0.01130**	**5.70600**	**5.7173**	**-0.02**	**87.91**	**87.89**	**0.00**	**95.82**	**95.82**	**0.0000**	**0.2283**	**0.2283**
-30	9.920	0.01143	4.37967	4.3911	2.81	86.44	89.25	2.83	94.49	97.32	0.0067	0.2199	0.2266
-20	12.949	0.01156	3.40574	3.4173	5.68	84.93	90.62	5.71	93.10	98.81	0.0133	0.2117	0.2250
-15	14.718	0.01163	3.01697	3.0286	7.14	84.16	91.30	7.17	92.38	99.55	0.0166	0.2077	0.2243
-10	16.674	0.01170	2.68010	2.6918	8.61	83.36	91.98	8.65	91.64	100.29	0.0199	0.2037	0.2236
-5	18.831	0.01178	2.38742	2.3992	10.09	82.57	92.65	10.13	90.89	101.02	0.0231	0.1999	0.2230
0	21.203	0.01185	2.13215	2.1440	11.58	81.75	93.33	11.63	90.12	101.75	0.0264	0.1960	0.2224
5	23.805	0.01193	1.90887	1.9208	13.09	80.92	94.00	13.14	89.33	102.47	0.0296	0.1923	0.2219
10	26.651	0.01200	1.71310	1.7251	14.60	80.08	94.68	14.66	88.53	103.19	0.0329	0.1885	0.2214
15	29.756	0.01208	1.54082	1.5529	16.13	79.21	95.34	16.20	87.70	103.90	0.0361	0.1848	0.2209
20	33.137	0.01216	1.38874	1.4009	17.67	78.35	96.01	17.74	86.87	104.61	0.0393	0.1812	0.2205
25	36.809	0.01225	1.25435	1.2666	19.22	77.47	96.69	19.30	86.02	105.32	0.0426	0.1774	0.2200
30	40.788	0.01233	1.13507	1.1474	20.78	76.57	97.34	20.87	85.14	106.01	0.0458	0.1738	0.2196
40	49.738	0.01251	0.93449	0.9470	23.93	74.73	98.67	24.05	83.34	107.39	0.0522	0.1667	0.2189
50	60.125	0.01270	0.77440	0.7871	27.14	72.84	99.98	27.28	81.46	108.74	0.0585	0.1598	0.2183
60	72.092	0.01290	0.64550	0.6584	30.39	70.87	101.26	30.56	79.49	110.05	0.0648	0.1530	0.2178
70	85.788	0.01311	0.54069	0.5538	33.68	68.85	102.53	33.89	77.44	111.33	0.0711	0.1462	0.2173
80	101.37	0.01334	0.45486	0.4682	37.02	66.75	103.77	37.27	75.29	112.56	0.0774	0.1395	0.2169
85	109.92	0.01346	0.41774	0.4312	38.72	65.67	104.38	38.99	74.17	113.16	0.0805	0.1362	0.2167
90	118.99	0.01358	0.38392	0.3975	40.42	64.57	104.99	40.72	73.03	113.75	0.0836	0.1329	0.2165
95	128.62	0.01371	0.35309	0.3668	42.14	63.45	105.59	42.47	71.86	114.33	0.0867	0.1296	0.2163
100	138.83	0.01385	0.32495	0.3388	43.87	62.31	106.18	44.23	70.66	114.89	0.0898	0.1263	0.2161
105	149.63	0.01399	0.29911	0.3131	45.62	61.13	106.75	46.01	69.42	115.43	0.0930	0.1229	0.2159
110	161.04	0.01414	0.27546	0.2896	47.39	59.94	107.32	47.81	68.15	115.96	0.0961	0.1196	0.2157
115	173.10	0.01429	0.25371	0.2680	49.17	58.71	107.88	49.63	66.84	116.47	0.0992	0.1163	0.2155
120	185.82	0.01445	0.23365	0.2481	50.97	57.44	108.41	51.47	65.48	116.95	0.1023	0.1130	0.2153
140	243.86	0.01520	0.16750	0.1827	58.39	52.01	110.40	59.08	59.57	118.65	0.1150	0.0993	0.2143
160	314.63	0.01617	0.11793	0.1341	66.26	45.71	111.97	67.20	52.58	119.78	0.1280	0.0848	0.2128
180	400.22	0.01758	0.07882	0.0964	74.83	37.94	112.77	76.13	43.78	119.91	0.1417	0.0684	0.2101
200	503.52	0.02014	0.04456	0.0647	84.89	26.77	111.66	86.77	30.92	117.69	0.1575	0.0469	0.2044
210	563.51	0.02329	0.02431	0.0476	91.84	16.64	108.48	94.27	19.18	113.45	0.1684	0.0287	0.1971

Fuente: Yunus Çengel y Michael Boles. *Termodinámica*, 4a. ed. (Mc Graw Hill, México, 2004), p. 789, tabla A.11E.

La línea en negritas corresponde al estado de referencia para la entalpía y la entropía del líquido saturado.

Tabla A.5.2 I Refrigerante - 134a saturado: Tabla de Presiones.

Presión lb_f/pulg², P	Temp.ºF T	Volumen específico, ft³/lb_m			Energía interna, Btu/lb_m			Entalpía, Btu/lb_m			Entropía, Btu/lb_m·ºR		
		Líquido saturado v_f	Evap v_{fg}	Vapor saturado v_g	Líquido saturado u_f	Evap u_{fg}	Vapor saturado u_g	Líquido saturado h_f	Evap h_{fg}	Vapor saturado h_g	Líquido saturado s_f	Evap s_{fg}	Vapor saturado s_g
5	-53.48	0.01113	8.3397	8.3508	-3.74	89.80	86.06	-3.73	97.52	93.79	-0.0090	0.2401	0.2311
10	-29.71	0.01143	4.3467	4.3581	2.89	86.41	89.30	2.91	94.46	97.37	0.0068	0.2197	0.2265
15	-14.25	0.01164	2.9631	2.9747	7.37	84.03	91.40	7.40	92.26	99.66	0.0171	0.2071	0.2242
20	-2.48	0.01181	2.2543	2.2661	10.85	82.15	93.00	10.89	90.50	101.39	0.0248	0.1979	0.2227
30	15.38	0.01209	1.5287	1.5408	16.24	79.16	95.40	16.31	87.65	103.96	0.0364	0.1845	0.2209
40	29.04	0.01232	1.1569	1.1692	20.48	76.74	97.22	20.57	85.31	105.88	0.0452	0.1745	0.2197
50	40.27	0.01252	0.9297	0.9422	24.02	74.68	98.71	24.14	83.29	107.43	0.0523	0.1666	0.2189
60	49.89	0.01270	0.7760	0.7887	27.10	72.86	99.96	27.24	81.48	108.72	0.0584	0.1599	0.2183
70	58.35	0.01286	0.6649	0.6778	29.84	71.20	101.04	30.01	79.82	109.83	0.0638	0.1541	0.2179
80	65.93	0.01302	0.5808	0.5938	32.34	69.68	102.01	32.53	78.28	110.81	0.0686	0.1489	0.2175
90	72.83	0.01317	0.5146	0.5278	34.62	68.26	102.88	34.84	76.84	111.68	0.0729	0.1443	0.2172
100	79.17	0.01332	0.4614	0.4747	36.74	66.93	103.67	36.99	75.47	112.46	0.0768	0.1401	0.2169
120	90.54	0.01360	0.3805	0.3941	40.61	64.45	105.06	40.91	72.91	113.82	0.0839	0.1326	0.2165
140	100.56	0.01386	0.3219	0.3358	44.07	62.17	106.24	44.43	70.52	114.95	0.0902	0.1259	0.2161
160	109.56	0.01412	0.2775	0.2916	47.23	60.04	107.27	47.65	68.26	115.91	0.0958	0.1199	0.2157
180	117.74	0.01438	0.2425	0.2569	50.16	58.02	108.18	50.64	66.10	116.74	0.1009	0.1145	0.2154
200	125.28	0.01463	0.2142	0.2288	52.90	56.07	108.97	53.44	64.00	117.44	0.1057	0.1094	0.2151
220	132.27	0.01489	0.1907	0.2056	55.48	54.19	109.67	56.09	61.96	118.05	0.1101	0.1046	0.2147
240	138.79	0.01515	0.1710	0.1861	57.94	52.35	110.29	58.61	59.95	118.56	0.1142	0.1002	0.2144
260	144.92	0.01541	0.1541	0.1695	60.28	50.55	110.83	61.02	57.97	118.99	0.1181	0.0959	0.2140
280	150.70	0.01568	0.1393	0.1550	62.53	48.79	111.31	63.34	56.01	119.35	0.1219	0.0917	0.2136
300	156.17	0.01596	0.1264	0.1424	64.70	47.01	111.71	65.59	54.03	119.62	0.1254	0.0878	0.2132
350	168.72	0.01671	0.0999	0.1166	69.89	42.56	112.44	70.97	49.03	120.00	0.1338	0.0780	0.2118
400	179.95	0.01758	0.0789	0.0965	74.81	37.95	112.76	76.11	43.80	119.91	0.1417	0.0685	0.2102
450	190.12	0.01863	0.0614	0.0800	79.63	32.97	112.59	81.18	38.08	119.26	0.1493	0.0586	0.2079
500	199.38	0.02002	0.0457	0.0657	84.54	27.21	111.75	86.39	31.44	117.83	0.1570	0.0477	0.2047

Fuente: Yunus Çengel y Michael Boles. *Termodinámica*, 4a. ed. (Mc Graw Hill, México, 2004), p. 790, tabla A.12E.

Tabla A.5.3 I Refrigerante - 134a sobrecalentado.

Temp.ºF T	P = 10.00 lb$_f$/pulg^2 (-29.71ºF)				P = 15.00 lb$_f$/pulg^2 (-14.25ºF)				P = 20.00 lb$_f$/pulg^2 (-2.48ºF)			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
Sat	4.3581	89.30	97.37	0.2265	2.9747	91.40	99.66	0.2242	2.2661	93.00	101.39	0.2227
-20	4.4718	90.89	99.17	0.2307	-	-	-	-	-	-	-	-
0	4.7026	94.23	102.94	0.2391	3.0893	93.84	102.42	0.2303	2.2816	93.43	101.88	0.2238
20	4.9297	97.66	106.79	0.2472	3.2468	97.32	106.34	0.2386	2.4046	96.97	105.88	0.2323
40	5.1539	101.18	110.72	0.2553	3.4012	100.88	110.33	0.2468	2.5244	100.59	109.94	0.2406
60	5.3758	104.79	114.74	0.2632	3.5533	104.53	114.40	0.2548	2.6416	104.28	114.06	0.2487
80	5.5959	108.49	118.85	0.2709	3.7034	108.27	118.56	0.2626	2.7569	108.04	118.25	0.2566
100	5.8145	112.28	123.05	0.2786	3.8520	112.09	122.79	0.2703	2.8705	111.89	122.52	0.2644
120	6.0318	116.17	127.34	0.2861	3.9993	116.00	127.11	0.2779	2.9829	115.82	126.87	0.2720
140	6.2482	120.15	131.72	0.2935	4.1456	120.00	131.51	0.2854	3.0942	119.84	131.30	0.2795
160	6.4638	124.22	136.19	0.3009	4.2911	124.08	136.00	0.2927	3.2047	123.94	135.81	0.2869
180	6.6786	128.37	140.74	0.3081	4.4359	128.25	140.57	0.3000	3.3144	128.13	140.40	0.2922
200	6.8929	132.63	145.39	0.3152	4.5801	132.51	145.23	0.3072	3.4236	132.39	145.07	0.3014
220	-	-	-	-	-	-	-	-	3.5323	136.75	149.83	0.3085

Temp.ºF T	P = 30.00 lb$_f$/pulg^2 (15.38ºF)				P = 40.00 lb$_f$/pulg^2 (29.04ºF)				P = 50.00 lb$_f$/pulg^2 (40.27ºF)			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
Sat	1.5408	95.40	103.96	0.2209	1.1692	97.220	105.880	0.2197	0.9422	98.71	107.43	0.2189
20	1.5611	96.25	104.92	0.2229	-	-	-	-	-	-	-	-
40	1.6465	99.97	109.12	0.2314	1.2065	99.324	108.260	0.2245	-	-	-	-
60	1.7293	103.74	113.35	0.2398	1.2723	103.196	112.620	0.2331	0.9974	102.62	111.85	0.2276
80	1.8098	107.58	117.63	0.2478	1.3357	107.107	117.000	0.2414	1.0508	106.61	116.34	0.2361
100	1.8887	111.49	121.98	0.2558	1.3973	111.070	121.420	0.2494	1.1022	110.65	120.85	0.2443
120	1.9662	115.47	126.39	0.2635	1.4575	115.104	125.900	0.2573	1.1520	114.72	125.39	0.2523
140	2.0426	119.52	130.87	0.2711	1.5165	119.197	130.430	0.2650	1.2007	118.87	129.99	0.2601
160	2.1181	123.65	135.42	0.2786	1.5746	123.367	135.030	0.2725	1.2484	123.08	134.64	0.2677
180	2.1929	127.87	140.05	0.2859	1.6319	127.613	139.700	0.2799	1.2953	127.35	139.34	0.2752
200	2.2671	132.17	144.76	0.2932	1.6887	131.932	144.440	0.2872	1.3415	131.70	144.12	0.2825
220	2.3407	136.54	149.54	0.3003	1.7449	136.326	149.250	0.2944	1.3873	136.12	148.96	0.2897
240	-	-	-	-	1.8006	140.803	154.140	0.3015	1.4326	140.61	153.87	0.2969
260	-	-	-	-	1.8561	145.352	159.100	0.3085	1.4775	145.17	158.85	0.3039
280	-	-	-	-	1.9112	149.974	164.130	0.3154	1.5221	149.81	163.90	0.3108

Fuente: Yunus Çengel y Michael Boles. *Termodinámica*, 4a. ed. (Mc Graw Hill, México, 2004), p. 791, tabla A.13E.

Tabla A.5.3 I Refrigerante - 134a sobrecalentado.

Temp.ºF T	P = 60.00 lb_f/pulg² (49.89ºF)				P = 70.00 lb_f/pulg² (58.35ºF)				P = 80.00 lb_f/pulg² (65.93ºF)			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)
Sat	0.7887	99.96	108.72	0.2183	0.6778	101.04	109.83	0.2179	0.5938	102.01	110.81	0.2175
60	0.8135	102.02	111.06	0.2229	0.6814	101.40	110.23	0.2186	-	-	-	-
80	0.8604	106.10	115.66	0.2316	0.7239	105.58	114.96	0.2276	0.2186	110.99	114.23	0.2239
100	0.9051	110.20	120.26	0.2399	0.7640	109.76	119.66	0.2361	0.2276	115.67	119.04	0.2327
120	0.9482	114.35	124.88	0.2480	0.8023	113.96	124.36	0.2444	0.2361	120.32	123.82	0.2411
140	0.9900	118.53	129.53	0.2559	0.8393	118.20	129.08	0.2524	0.2444	124.98	128.60	0.2492
160	1.0308	122.78	134.23	0.2636	0.8752	122.48	133.82	0.2601	0.2524	129.67	133.41	0.2570
180	1.0707	127.08	138.98	0.2712	0.9103	126.82	138.62	0.2678	0.2601	134.40	138.25	0.2647
200	1.1100	131.46	143.79	0.2786	0.9446	131.22	143.46	0.2752	0.2678	139.16	143.13	0.2722
220	1.1488	135.90	148.66	0.2859	0.9784	135.68	148.36	0.2825	0.2752	143.98	148.06	0.2796
240	1.1871	140.41	153.60	0.2930	1.0118	140.21	153.33	0.2897	0.2825	148.87	153.05	0.2868
260	1.2251	144.99	158.60	0.3001	1.0448	144.81	158.35	0.2968	0.2897	153.81	158.10	0.2940
280	1.2627	149.64	163.67	0.3070	1.0774	149.47	163.44	0.3038	0.2968	158.81	163.21	0.3010
300	1.3001	154.37	168.81	0.3139	1.1098	154.21	168.60	0.3107	0.3038	163.88	168.38	0.3079
320	-	-	-	-	-	-	-	-	0.3107	169.02	173.62	0.3147

Temp.ºF T	P = 90.00 lb_f/pulg² (72.83ºF)				P = 100.00 lb_f/pulg² (79.17ºF)				P = 120.00 lb_f/pulg² (90.54ºF)			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m·ºR)
Sat	0.5278	102.88	111.68	0.2172	0.4747	103.67	112.46	0.2169	0.3941	105.06	113.82	0.2165
80	0.5408	104.46	113.47	0.2205	0.4761	103.86	112.68	0.2173	-	-	-	-
100	0.5751	108.81	118.39	0.2295	0.5086	108.31	117.73	0.2265	0.4080	107.25	116.32	0.2210
120	0.6073	113.15	123.27	0.2380	0.5388	112.72	122.70	0.2352	0.4355	111.84	121.52	0.2301
140	0.6380	117.49	128.12	0.2463	0.5674	117.12	127.63	0.2436	0.4610	116.37	126.61	0.2387
160	0.6675	121.86	132.98	0.2542	0.5947	121.54	132.55	0.2517	0.4852	120.88	131.66	0.2470
180	0.6961	126.27	137.87	0.2620	0.6210	125.99	137.49	0.2595	0.5082	125.41	136.70	0.2550
200	0.7239	130.73	142.79	0.2696	0.6466	130.48	142.45	0.2671	0.5305	129.96	141.75	0.2628
220	0.7512	135.24	147.76	0.2770	0.6717	135.01	147.45	0.2746	0.5520	134.55	146.82	0.2704
240	0.7779	139.81	152.77	0.2843	0.6960	139.60	152.49	0.2819	0.5731	139.19	151.92	0.2778
260	0.8043	144.44	157.84	0.2914	0.7201	144.26	157.59	0.2891	0.5937	143.88	157.07	0.2850
280	0.8303	149.13	162.97	0.2984	0.7438	148.97	162.74	0.2962	0.6140	148.62	162.26	0.2921
300	0.8561	153.89	168.16	0.3054	0.7672	153.74	167.95	0.3031	0.6339	153.42	167.51	0.2991
320	0.8816	158.73	173.42	0.3122	0.7904	158.57	173.21	0.3099	0.6537	158.28	172.81	0.3060

Fuente: Yunus Çengel y Michael Boles. *Termodinámica*, 4a. ed. (Mc Graw Hill, México, 2004), p. 791 - 792, tabla A.13E.

Tabla A.5.3 I Refrigerante - 134a sobrecalentado.

Temp.ºF T	P = 140.00 lb_f/pulg² (100.56ºF)				P = 160.00 lb_f/pulg² (109.55ºF)				P = 180.00 lb_f/pulg² (117.74ºF)			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)
Sat	0.3358	106.24	114.95	0.2161	0.2916	107.271	115.91	0.2157	0.2569	108.18	116.74	0.2154
120	0.3610	110.89	120.25	0.2254	0.3044	109.871	118.89	0.2209	0.2595	108.76	117.41	0.2166
140	0.3846	115.27	125.24	0.2344	0.3269	114.725	124.41	0.2303	0.2814	113.83	123.21	0.2264
160	0.4066	120.20	130.74	0.2429	0.3474	119.487	129.78	0.2391	0.3011	118.73	128.77	0.2355
180	0.4274	124.81	135.89	0.2511	0.3666	124.198	135.06	0.2475	0.3191	123.55	134.19	0.2441
200	0.4474	129.43	141.03	0.2590	0.3849	128.886	140.29	0.2555	0.3361	128.33	139.53	0.2524
220	0.4666	134.08	146.18	0.2667	0.4023	133.601	145.52	0.2633	0.3523	133.10	144.84	0.2603
240	0.4852	138.76	151.34	0.2742	0.4192	138.330	150.75	0.2709	0.3678	137.89	150.15	0.2680
260	0.5034	143.49	156.54	0.2815	0.4356	143.094	156.00	0.2783	0.3828	142.70	155.46	0.2755
280	0.5212	148.27	161.78	0.2887	0.4516	147.910	161.29	0.2856	0.3974	147.54	160.79	0.2828
300	0.5387	153.09	167.06	0.2957	0.4672	152.768	166.61	0.2927	0.4116	152.43	166.15	0.2899
320	0.5559	157.98	172.39	0.3026	0.4826	157.682	171.98	0.2996	0.4256	157.36	171.55	0.2969
340	0.5730	162.93	177.78	0.3094	0.4978	162.641	177.39	0.3065	0.4393	162.36	177.00	0.3038
360	0.5898	167.92	183.21	0.6162	0.5128	167.657	182.85	0.3132	0.4529	167.39	182.49	0.3106

Temp.ºF T	P = 200.00 lb_f/pulg² (125.28ºF)				P = 300.00 lb_f/pulg² (156.17ºF)				P = 400.00 lb_f/pulg² (179.95ºF)			
	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)	v (ft³/lb_m)	u (Btu/lb_m)	h (Btu/lb_m)	s (Btu/lb_m.ºR)
Sat	0.2288	108.97	117.44	0.2151	0.1424	111.71	119.62	0.2132	0.0965	112.76	119.91	0.2102
140	0.2446	112.86	121.92	0.2226	-	-	-	-	-	-	-	-
160	0.2636	117.94	127.70	0.2321	0.1462	112.95	121.07	0.2155	-	-	-	-
180	0.2809	122.88	133.28	0.2410	0.1633	118.93	128.00	0.2265	0.0965	112.78	119.93	0.2102
200	0.2970	127.75	138.75	0.2494	0.1777	124.47	134.34	0.2363	0.1143	120.13	128.60	0.2235
220	0.3121	132.59	144.15	0.2575	0.1905	129.78	140.36	0.2453	0.1275	126.35	135.79	0.2343
240	0.3266	137.43	149.53	0.2653	0.2021	134.98	146.21	0.2537	0.1386	132.11	142.38	0.2438
260	0.3405	142.29	154.90	0.2728	0.2130	140.12	151.95	0.2618	0.1484	137.65	148.64	0.2527
280	0.3540	147.17	160.28	0.2802	0.2234	145.22	157.63	0.2696	0.1575	143.05	154.72	0.2610
300	0.3671	152.09	165.69	0.2874	0.2333	150.32	163.28	0.2772	0.1660	148.37	160.67	0.2689
320	0.3799	157.06	171.13	0.2945	0.2428	155.43	168.92	0.2845	0.1740	153.68	166.57	0.2766
340	0.3926	162.06	176.60	0.3014	0.2521	160.56	174.56	0.2916	0.1816	158.97	172.42	0.2840
360	0.4050	167.12	182.12	0.3082	0.2611	165.73	180.23	0.2986	0.1890	164.26	178.26	0.2912
380	-	-	-	-	0.2699	170.93	185.92	0.3055	0.1962	169.56	184.09	0.2983
400	-	-	-	-	0.2786	176.16	191.64	0.3122	0.2032	178.65	189.94	0.3051

Tabla A.6 I Propiedades termodinámicas del Nitrógeno.
Tabla A.6.1 I Nitrógeno saturado: Tabla de Temperaturas.

Temp.ºR T	Presión lbf/pulg², P	Volumen específico, ft³/lb_m			Energía interna, Btu/lb_m			Entalpía, Btu/lb_m			Entropía, Btu/lb_m.ºR		
		Líquido saturado v_f	Evap v_{fg}	Vapor saturado v_g	Líquido saturado u_f	Evap u_{fg}	Vapor saturado u_g	Líquido saturado h_f	Evap h_{fg}	Vapor saturado h_g	Líquido saturado s_f	Evap s_{fg}	Vapor saturado s_g
113.670	1.813	0.01845	23.793	23.8120	-0.006	84.993	84.987	0.000	92.981	92.981	0.00000	0.81720	0.81720
120.000	3.337	0.01875	13.570	13.5890	3.101	82.839	85.940	3.113	91.224	94.337	0.02661	0.76020	0.78681
130.000	7.654	0.01929	6.3208	6.3401	8.035	79.473	87.508	8.062	88.432	96.494	0.06610	0.68025	0.74634
139.255	14.696	0.01984	3.4592	3.4791	12.585	76.253	88.838	12.639	85.668	98.306	0.09992	0.61518	0.71510
140.000	15.425	0.01989	3.3072	3.3271	12.949	75.991	88.940	13.006	85.436	98.443	0.10253	0.61026	0.71279
150.000	28.120	0.02056	1.8865	1.9071	17.838	72.356	90.194	17.945	82.179	100.124	0.13628	0.54786	0.68414
160.000	47.383	0.02132	1.1469	1.1682	22.741	68.485	91.226	22.928	78.548	101.476	0.16795	0.49093	0.65888
170.000	74.991	0.02219	0.7299	0.7521	27.737	64.246	91.983	28.045	74.383	102.427	0.19829	0.43754	0.63584
180.000	112.808	0.02323	0.4789	0.5021	32.926	59.475	92.401	33.411	69.478	102.889	0.22805	0.38599	0.61404
190.000	162.761	0.02449	0.3190	0.3435	38.415	53.967	92.382	39.153	63.582	102.735	0.25789	0.33464	0.59254
200.000	226.853	0.02613	0.2119	0.2380	44.185	47.574	91.759	45.283	56.474	101.757	0.28780	0.28237	0.57017
210.000	307.276	0.02845	0.1354	0.1639	50.442	39.768	90.210	52.061	47.474	99.536	0.31894	0.22607	0.54501
220.000	406.739	0.03249	0.0750	0.1075	57.889	28.886	86.775	60.336	34.536	94.872	0.35494	0.15698	0.51192
226.000	477.10	0.03806	0.0374	0.0755	64.761	17.115	81.876	68.123	20.423	88.546	0.38789	0.09037	0.47826

Tabla A.6.2 I Nitrógeno sobrecalentado.

Temp.ºR T	P = 14.7 lbf/pulg^2				P = 20 lbf/pulg^2				P = 50 lbf/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
150	3.7702	90.823	101.086	0.7343	2.7395	90.569	100.715	0.7109	-	-	-	-
200	5.1366	99.867	113.849	0.8078	3.7538	99.723	113.625	0.7852	1.4534	98.858	112.315	0.7159
250	6.4680	108.837	126.443	0.8640	4.7397	108.740	126.293	0.8418	1.8663	108.152	125.432	0.7744
300	7.7876	117.760	138.958	0.9096	5.7138	117.689	138.850	0.8875	2.2662	117.257	138.239	0.8212
350	9.1015	126.657	151.432	0.9481	6.6820	126.604	151.351	0.9261	2.6599	126.269	150.896	0.8602
400	10.412	135.540	163.882	0.9814	7.6469	135.501	163.821	0.9564	3.0502	135.230	163.471	0.8938
450	11.721	144.414	176.319	1.0107	8.6098	144.385	176.271	0.9887	3.4385	144.161	175.997	0.9233
500	13.028	153.285	188.748	1.0368	9.5714	153.263	188.710	1.0149	3.8255	153.073	188.492	0.9496
540	14.073	160.383	198.690	1.0560	10.340	160.363	198.657	1.0341	4.1344	160.195	198.474	0.9688

Temp.ºR T	P = 100 lbf/pulg^2				P = 200 lbf/pulg^2				P = 500 lbf/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
200	0.6834	97.276	109.931	0.6585	0.2884	93.230	103.911	0.5875	-	-	-	-
250	0.9078	107.138	123.948	0.7212	0.4272	104.942	120.763	0.6631	0.1321	96.147	108.378	0.5608
300	1.1169	116.523	137.205	0.7696	0.5420	115.003	135.076	0.7153	0.1966	109.965	128.168	0.6335
350	1.3192	125.705	150.133	0.8094	0.6490	124.553	148.589	0.7570	0.2473	120.941	143.838	0.6819
400	1.5181	134.777	162.888	0.8435	0.7522	133.860	161.718	0.7921	0.2932	131.059	158.205	0.7202
450	1.7149	143.785	175.540	0.8733	0.8532	143.032	174.630	0.8225	0.3368	140.750	171.933	0.7526
500	1.9103	152.755	188.129	0.8998	0.9529	152.118	187.408	0.8494	0.3790	150.202	185.292	0.7807
540	2.0660	159.913	198.170	0.9192	1.0319	159.351	197.567	0.8690	0.4120	157.661	195.807	0.8010

Temp.ºR T	P = 1000 lbf/pulg^2				P = 2000 lbf/pulg^2				P = 3000 lbf/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
250	0.0384	71.015	78.1260	0.4145	0.0286	59.698	70.2898	0.3596	0.0261	55.219	69.7185	0.3371
300	0.0828	99.892	115.224	0.5514	0.0398	83.080	97.8200	0.4599	0.0321	75.383	93.2156	0.4228
350	0.1150	114.494	135.789	0.6150	0.0552	102.171	122.614	0.5366	0.0403	93.678	116.066	0.4933
400	0.1417	126.248	152.487	0.6597	0.0699	116.981	142.868	0.5908	0.0493	109.496	136.883	0.5490
450	0.1659	136.917	167.637	0.6954	0.0833	129.556	160.406	0.6321	0.0582	123.191	155.522	0.5930
500	0.1887	147.027	181.969	0.7256	0.0958	140.932	176.411	0.6659	0.0667	135.498	172.551	0.6289
540	0.2063	154.868	193.069	0.7470	0.1053	149.528	188.526	0.6892	0.0732	144.697	185.361	0.6535

Tabla A.7 I Propiedades termodinámicas del Oxígeno.
Tabla A.7.1 I Oxígeno saturado: Tabla de Presiones.

Presión lbf/pulg^2, P	Temp.ºR T	Volumen específico, ft^3/lb$_m$			Energía interna, Btu/lb$_m$			Entalpía, Btu/lb$_m$			Entropía, Btu/lb$_m$.ºR		
		Líquido saturado v_f	Evap v_{fg}	Vapor saturado v_g	Líquido saturado u_f	Evap u_{fg}	Vapor saturado u_g	Líquido saturado h_f	Evap h_{fg}	Vapor saturado h_g	Líquido saturado s_f	Evap s_{fg}	Vapor saturado s_g
2.00	134.454	0.01323	22.3837	22.397	49.183	-459.696	-410.513	49.512	97.601	147.113	0.62913	0.72590	1.35503
5.00	145.875	0.01353	9.63547	9.6490	53.526	-164.762	-111.236	53.891	95.514	149.405	0.66032	0.65476	1.31508
10.00	156.026	0.01384	5.09496	5.1088	57.539	-53.818	3.721	57.939	93.385	151.324	0.68705	0.59853	1.28558
14.70	162.362	0.01406	3.57294	3.5870	60.112	-15.506	44.606	60.535	91.915	152.450	0.70329	0.56611	1.26940
20.00	167.840	0.01425	2.68835	2.7026	62.376	6.999	69.375	62.819	90.552	153.371	0.71704	0.53952	1.25656
50.00	186.783	0.01501	1.14139	1.1564	70.427	45.687	116.114	70.946	85.165	156.111	0.76244	0.45596	1.21840
80.00	198.375	0.01556	0.72694	0.7425	75.478	54.625	130.103	76.050	81.328	157.378	0.78851	0.40998	1.19849
100.00	204.415	0.01587	0.58383	0.5997	78.141	57.051	135.192	78.742	79.150	157.892	0.80159	0.38720	1.18879
200.00	225.751	0.01721	0.28459	0.3018	87.773	58.324	146.097	88.492	70.221	158.713	0.84552	0.31106	1.15658
300.00	240.287	0.01845	0.17755	0.1960	94.763	54.605	149.368	95.584	62.505	158.089	0.87454	0.26013	1.13467
400.00	251.622	0.01978	0.12052	0.1403	100.794	49.244	150.038	101.716	54.859	156.575	0.89803	0.21802	1.11605
500.00	261.019	0.02133	0.08357	0.1049	106.418	42.722	149.140	107.449	46.761	154.210	0.91891	0.17915	1.09806
600.00	269.092	0.02340	0.05584	0.0792	112.354	34.415	146.769	113.520	37.197	150.717	0.94028	0.13823	1.07851

Tabla A.7.2 I Oxígeno sobrecalentado.

Temp.ºR T	P = 14.7 lbf/pulg^2				P = 20 lbf/pulg^2				P = 50 lbf/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
200	4.4835	148.663	160.867	1.31604	3.2735	148.515	160.638	1.29618	1.2577	147.636	159.281	1.23480
250	5.6526	156.539	171.926	1.36540	4.1406	156.437	171.772	1.34588	1.6238	155.851	170.885	1.28663
300	6.8099	164.372	182.909	1.40545	4.9956	164.298	182.799	1.38609	1.9762	163.868	182.165	1.32777
350	7.9613	172.184	193.855	1.43920	5.8447	172.125	193.771	1.41992	2.3222	171.793	193.294	1.36208
400	9.1095	179.985	204.782	1.46838	6.6905	179.938	204.716	1.44915	2.6650	179.668	204.342	1.39159
450	10.256	187.786	215.703	1.49411	7.5344	187.747	215.650	1.47490	3.0057	187.520	215.349	1.41752
500	11.401	195.602	226.636	1.51715	8.3770	195.569	226.593	1.49796	3.3451	195.376	226.347	1.44070
540	12.316	201.887	235.412	1.53403	9.0505	201.857	235.375	1.51486	3.6160	201.684	235.163	1.45766

Temp.ºR T	P = 100 lbf/pulg^2				P = 200 lbf/pulg^2				P = 500 lbf/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
250	0.78360	154.819	169.329	1.23938	0.36060	152.494	165.849	1.18664	-	-	-	-
300	0.96931	163.134	181.083	1.28227	0.46515	161.585	178.812	1.23399	0.15593	156.362	170.799	1.15776
350	1.1480	171.229	192.487	1.31744	0.56068	170.070	190.835	1.27108	0.20768	166.300	185.528	1.20328
400	1.3231	179.215	203.715	1.34743	0.65215	178.293	202.445	1.30209	0.24960	175.407	198.517	1.23800
450	1.4961	187.143	214.847	1.37365	0.74139	186.381	213.838	1.32893	0.28876	184.039	210.774	1.26688
500	1.6678	195.054	225.937	1.39702	0.82926	194.405	225.116	1.35270	0.32638	192.433	222.652	1.29192
540	1.8046	201.395	234.811	1.41410	0.89890	200.816	234.107	1.37000	0.35577	199.067	232.007	1.30992

Temp.ºR T	P = 1000 lbf/pulg^2				P = 2000 lbf/pulg^2				P = 3000 lbf/pulg^2			
	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)	v (ft^3/lb$_m$)	u (Btu/lb$_m$)	h (Btu/lb$_m$)	s (Btu/lb$_m$.ºR)
300	0.04695	138.037	146.731	1.04897	0.02227	115.046	123.294	0.95394	0.01998	109.942	121.041	0.93350
350	0.08936	158.755	175.302	1.13834	0.03543	140.930	154.051	1.04870	0.02571	130.611	144.893	1.00697
400	0.11579	170.181	191.622	1.18204	0.05156	158.847	177.942	1.11278	0.03424	149.175	168.196	1.06929
450	0.13844	179.971	205.606	1.21502	0.06521	171.578	195.728	1.15476	0.04320	163.862	187.861	1.11570
500	0.15931	189.083	218.583	1.24237	0.07729	182.345	210.969	1.18691	0.05160	176.038	204.703	1.15123
540	0.17525	196.123	228.575	1.26160	0.08626	190.279	222.225	1.20857	0.05791	184.776	216.946	1.17497

Tabla A.8 I Constantes Críticas.

Sustancia	Fórmula	Masa molar	Temperatura R	Presión, lb_f/in²	Volumen, ft³/lb_mol	Factor acéntrico	Sustancia	Fórmula	Masa molar	Temperatura R	Presión, lb_f/in²	Volumen, ft³/lb_mol	Factor acéntrico
Acetileno	C_2H_6	26.038	554.9	891	1.8053	0.190	Etileno	C_2H_4	28.054	508.3	731	2.0888	0.089
Agua	H_2O	18.015	1165.1	3208	0.9147	0.344	Flúor	F_2	37.997	259.7	757	1.0620	0.054
Alcohol metílico	CH_3OH	32.042	922.7	1173	1.8902	0.556	Helio	He	4.003	9.34	32.9	0.9195	-0.365
Alcohol etílico	C_2H_5OH	46.069	925.0	891	2.6767	0.644	Helio3	He	3.017	6.0	17	1.1677	-0.473
Amoniaco	NH_3	17.031	729.9	1646	1.1613	0.250	n-Heptano	C_7H_{16}	100.205	972.5	397	6.9200	0.349
Argón	Ar	39.948	271.4	706	1.1998	0.001	n-Hexano	C_6H_{14}	86.178	913.5	437	5.9268	0.299
Benceno	C_6H_6	78.114	1012.0	709	4.1488	0.212	Hidrógeno (normal)	H_2	2.016	59.76	188.6	1.0428	-0.218
Bromo	Br_2	159.808	1058.4	1494	2.0375	0.108	Kriptón	Kr	83.800	376.9	798	1.4609	0.005
n-Butano	C_4H_{10}	58.124	765.4	551	4.0847	0.199	Metano	CH_4	16.043	342.7	667	1.5890	0.011
Cloro	Cl_2	70.906	750.4	1157	1.9831	0.090	Monóxido de carbono	CO	28.010	239.2	508	1.4929	0.066
Clorodifluoroetano	CH_3CClF_2	100.495	738.5	616	3.7003	0.250	Neón	Ne	20.183	79.92	400	0.6664	-0.029
Clorodifluorometano	$CHClF_2$	86.469	664.7	721	2.6527	0.221	Nitrógeno	N_2	28.013	227.2	492	1.4385	0.039
Cloroformo	$CHCl_3$	119.378	965.5	779	3.8268	0.218	n-Octano	C_8H_{18}	114.232	1023.8	361	7.8811	0.398
Cloruro de metilo	CH_3Cl	50.488	749.3	972	2.2250	0.153	Óxido nítrico	NO	30.006	324.0	940	0.9243	0.588
Deuterio (normal)	D_2	4.032	69.1	241	0.0000	-0.160	Oxido nitroso	N_2O	44.013	557.3	1050	1.5602	0.165
Diclorodifluorometano (12)	CCl_2F_2	120.914	693.0	600	3.4712	0.204	Oxígeno	O_2	31.999	278.3	731	1.1758	0.025
Diclorofluoroetano (141)	CH_3CCl_2F	116.95	866.7	658	4.0367	0.215	n-Pentano	C_5H_{16}	72.151	845.5	489	4.8696	0.251
Diclorofluorometano (21)	$CHCl_2F$	102.923	812.9	751	3.1460	0.210	Propano	C_3H_8	44.094	665.6	616	3.2517	0.153
Difluoroetano (152a)	CHF_2CH_3	66.050	695.5	656	2.8753	0.275	Propeno	C_3H_6	42.081	656.8	667	2.8993	0.144
Diclorotrifluorometano (123)	$CHCl_2F$	152.93	822.4	532	4.4547	0.282	Propino	C_3H_4	40.065	724.3	817	2.6270	0.215
Dióxido de azufre	SO_2	64.063	775.4	1143	1.9575	0.256	Tetracloruro de carbono	CCl_4	153.823	1001.5	661	4.4195	0.193
Dióxido de carbono	CO_2	44.010	547.4	1070	1.5041	0.239	Tetrafluoroetano (134a)	CF_3CH_2F	102.030	673.6	589	3.1717	0.327
Dióxido de nitrógeno	NO_2	46.006	775.8	1465	2.6879	0.834	Xenón	Xe	131.300	521.5	847	1.8966	0.008
Etano	C_2H_6	30.070	549.7	708	2.3755	0.099							

Tabla A.9 l Propiedades de líquidos y sólidos comunes.
Tabla A.9.1 l Propiedades de diversos sólidos y líquidos a 80ºF.

Sólido	C_p, Btu/lb$_m$.ºR	ρ, lb$_m$/ft^3	Líquido	C_p, Btu/lb$_m$.ºR	ρ, lb$_m$/ft^3
Aluminio	0.215	170	Amoniaco	1.146	38
Concreto	0.155	144	Benceno	0.41	55
Cobre	0.092	555	Butano	0.590	35
Vidrio	0.191	144	Etanol	0.587	49
Granito	0.243	170	Glicerina	0.573	75
Grafito	0.170	155	Iso-octano	0.50	43
Hierro	0.107	490	Mercurio	0.033	847
Plomo	0.030	705	Metanol	0.609	49
Hule (blando)	0.439	70	Petróleo (ligero)	0.430	57
Arena (seca)	0.190	90-110	Propano	0.61	32
Plata	0.056	655	R-12	0.232	82
Acero (AISI302)	0.115	503	R-134a	0.342	75
Estaño	0.052	360	Agua	1.000	62
Madera (la mayoría)	0.420	22-45			

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 854, tabla A.9I.

Tabla A.9.2 | Propiedades de diversos líquidos.

Sustancia	Datos de ebullición		Datos de congelación		Propiedades de líquido		
	Punto normal de ebullición, ºF	Calor latente de vaporización, h_{fg}, Btu/lb$_m$	Punto de congelación, ºF	Calor latente de fusión, h_{lf}, Btu/lb$_m$	Temp., ºF	Densidad lb$_m$/ft^3	Calor específico, Cp Btu/lb$_m$.ºF
Aceite (ligero)	-	-			77	56.8	0.430
Agua	212	970.5	32.0	143.5	32	62.4	1.01
					90	62.1	1.00
					150	61.2	1.00
					212	59.8	1.01
Alcohol etílico	173.5	368	-248.8	46.4	68	49.3	0.678
Amoniaco	-27.9	24.54	-107.9	138.6	-27.9	42.6	1.06
					0	41.3	1.08
					40	39.5	1.103
					80	37.5	1.135
Argón	-302.6	69.5	-308.7	12.0	-302.6	87.0	0.272
Benceno	176.4	169.4	41.9	54.2	68	54.9	0.411
Dióxido de carbono	-109.2	99,6 (a 32ºF)	-69.8	-	32	57.8	0.583
Etanol	172.8	360.5	-173.6	46.9	77	48.9	0.588
Etilén glicol	388.6	344.0	12.6	77.9	68	69.2	0.678
Glicerina	355.8	419	66.0	86.3	68	78.7	0.554
Helio	-452.1	9.80	-	-	-452.1	9.13	5.45
Hidrógeno	-423.0	191.7	-434.5	25.6	-423.0	4.41	2.39
Isobutano	10.9	157.8	-255.5	45.5	10.9	37.1	0.545
Mercurio	674.1	126.7	-38.0	4.90	77	847	0.033
Metano	-258.7	219.6	296.0	25.1	-258.7	26.4	0.834
					-160	20.0	1.074
Metanol	148.1	473	-143.9	42.7	77	49.1	0.609
n-Butano	31.1	165.6	-217.3	34.5	31.1	37.5	0.552
Nitrógeno	-320.4	85.4	-346.0	10.9	-320.4	50.5	0.492
					-260	38.2	0.643
Octano	256.6	131.7	-71.5	77.9	68	43.9	0.502
Oxígeno	-297.3	91.5	-361.8	5.9	-297.3	71.2	0.408
Petróleo	-	99 - 165			68	40.0	0.478
Propano	-43.7	184.0	-305.8	34.4	-43.7	36.3	0.538
					32	33.0	0.604
					100	29.4	0.673
Queroseno	399 - 559	108	-12.8	-	68	51.2	0.478
Refrigerante 134a.	-15.0	93.2	-141.9	-	-40	88.5	0.293
					-15.0	86.0	0.294
					32	80.9	0.318
					90	73.6	0.348
Salmuera (20% cloruro de sodio por masa)	219.0	-	0.7	-	68	71.8	0.743

Fuente: Yunus Çengel y Michael Boles. *Termodinámica*, 4a. ed. (Mc Graw Hill, México, 2004), p. 776, tabla A.3E.

Tabla A.9.3 l Propiedades de diversos sólidos.

Metales			No metales		
Sustancia	ρ, lb_m/ft^3	C_p, $Btu/lb_m.°F$	Sustancia	ρ, lb_m/ft^3	C_p, $Btu/lb_m.°F$
Acero dulce	489	0.119	Arena	62.4	0.800
Aluminio			Arcilla	94.9	0.920
-100ºF		0.192	Asfalto	132	0.920
32ºF		0.212	Caucho (blando)	68.7	1.840
100ºF		0.218	Caucho (Duro)	71.8	2.009
200ºF	170	0.224	Concreto	144	0.653
300ºF		0.229	Diamante	151	0.616
400ºF		0.235	Grafito	156	0.711
500ºF		0.240	Granito	169	1.017
Bronce (76% Cu, 2% Zn, 2% Al)	517	0.0955	Hielo		5.000
Cobre			-100ºF		1.56
-240ºF		0.0674	-50ºF		1.71
-150ºF		0.0784	0ºF	57.5	1.86
-60ºF		0.0862	20ºF		2.01
0ºF	556	0.0893	32ºF		2.11
100ºF		0.0925	Ladrillo común	120	0.79
200ºF		0.0938	Ladrillo refractario (500ºC)	144	0.960
390ºF		0.0963	Madera contrachapada (Abeto Douglas)	34.0	1.21
Hierro	490	0.107	Maderas duras (maple, encino, etc)	45.0	1.26
Latón amarillo (65% Cu, 35% Sn)	519	0.096	Maderas suaves (abeto, pino, etc)	32.0	1.38
Magnesio	108	0.239	Mármol	162	1.880
Níquel	555	0.105	Piedra	103	0.800
Plomo	655	0.056	Piedra caliza	93.6	0.909
Plata	705	0.030	Vidrio para ventanas	169	0.800
Tunsgteno	1211	0.031	Vidrio Pyrex	139	0.840
			Yeso o tabla de yeso.	50	1.09

Tabla A.9.4 I Calores específicos de sólidos y líquidos comunes a diversas temperaturas

Sólidos					
Sustancia	Temp, ºF	Cp Btu/lb$_m$.R)	Sustancia	Temp, ºF	Cp Btu/lb$_m$.R)
Hielo	-100	0.375	Plomo	-455	0.0008
	-50	0.424		-435	0.0073
	0	0.471		-150	0.0283
	20	0.491		32	0.0297
	32	0.502		210	0.0320
Aluminio	-150	0.167		570	0.0356
	-100	0.192	Cobre	-240	0.0674
	32	0.212		-150	0.0784
	100	0.218		-60	0.0862
	200	0.224		0	0.0893
	300	0.229		100	0.0925
	400	0.235		200	0.0938
	500	0.240		390	0.0963
Hierro	68	0.107	Plata	68	0.0558

Líquidos					
Sustancia	Estado	Cp Btu/lb$_m$.R)	Sustancia	Estado	Cp Btu/lb$_m$.R)
Agua	1 atm, 32 ºF	1.007	Glicerina	1 atm, 50 ºF	0.554
	1 atm, 77 ºF	0.998		1 atm,120 ºF	0.617
	1 atm, 212 ºF	1.007	Bismuto	1 atm, 800 ºF	0.0345
Amoniaco	Sat, 0ºF	1.08		1 atm, 1400 ºF	0.0393
	Sat, 120ºF	1.22	Mercurio	1 atm, 50 ºF	0.033
Refrigerante 12	Sat, -40ºF	0.211		1 atm, 600 ºF	0.032
	Sat, 0ºF	0.217	Sodio	1 atm, 200 ºF	0.33
	Sat, 120ºF	0.24		1 atm, 1000 ºF	0.30
Benceno	1 atm, 60ºF	0.43	Propano	1 atm, 32 ºF	0.576
	1 atm, 150ºF	0.46			

Tabla A.10 I Propiedades de combustibles, hidrocarburos y alimentos comunes.
Tabla A.10.1 I Propiedades de algunos combustibles e hidrocarburos comunes.

Combustible (Fase)	Fórmula	Masa molar, lb_m/lb_{mol}	Densidad (lb_m/ft^3)	Entalpía de vaporización (Btu/lb_m)	Calor específico ($Btu/lb_m \cdot ^oF$)	Valor calorifico superior (Btu/lb_m)	Valor calorifico inferior (Btu/lb_m)
1 - Penteno (l)	C_5H_{10}	70.134	40	156	0.525	20540	19190
Acetileno (g)	C_2H_2	26.038	-	-	0.404	21490	20760
Benceno (l)	C_6H_6	78.114	54.7	186	0.411	17970	17240
Butano (l)	C_4H_{10}	58.123	36.1	156	0.578	21130	19510
Carbono (s)	C	12.011	125	-	0.169	14100	14100
Decano (l)	$C_{10}H_{22}$	142.285	45.6	361	2.21	20490	19020
Diesel ligero (l)	$C_nH_{1.8n}$	170	49 - 52	116	0.53	19600	18400
Diesel pesado (l)	$C_nH_{1.7n}$	200	51 - 55	99	0.45	19600	18400
Etano (g)	C_2H_6	30.07	-	74	0.418	22320	20430
Etanol (l)	C_2H_6O	46.069	49.3	395	0.583	12760	11530
Gas natural (g)	$C_nH_{3.8n}N_{0.1n}$	18	-	-	0.48	21500	19400
Gasolina (l)	$C_nH_{1.87n}$	100 - 110	45 - 49	151	0.57	20300	18900
Heptano (l)	C_7H_{16}	100.204	42.7	157	0.535	20680	19180
Hexano (l)	C_6H_{14}	86.177	41.200	157	0.542	20770	19240
Hexeno (l)	C_6H_{12}	84.161	42.0	169	0.439	20430	19090
Hidrógeno (g)	H_2	2.016	-	-	3.44	60970	51600
Isopentano (l)	C_5H_{12}	72.150	39.1	-	0.554	20890	19310
Metano (g)	CH_4	16.043	-	219	0.525	23880	21520
Metanol (l)	CH_4O	32.042	49.3	502	0.604	9740	8570
Monóxido de carbono (g)	CO	28.013	-	-	0.251	4340	4340
Octano (l)	C_8H_{18}	114.231	43.9	156	0.533	20590	19100
Propano (l)	C_3H_8	44.097	31.200	180	0.662	21640	19930
Tolueno (l)	C_7H_8	92.141	40.0	156	0.525	20540	19190

Fuente: Yunus Çengel y Michael Boles. *Termodinámica*, 4a. ed. (Mc Graw Hill, México, 2004), p. 808, tabla A.27E.

Tabla A.10.2 I Propiedades de alimentos comunes.

Alimentos	Contenido de agua, % (masa)	Punto de congelación, ºF	Calor específico, Btu/lb$_m$.ºF		Calor latente de fusión, Btu/lb$_m$
			Por encima del punto de congelación	Por debajo del punto de congelación	
Brócoli	90	31	0.921	0.471	129
Camarón	83	28	0.865	0.450	119
Carne de pollo	74	27	0.793	0.423	106
Carne de res	67	-	0.737	0.402	96
Cerezas	80	29	0.841	0.441	115
Espinaca	93	31	0.945	0.481	134
Fresas	90	31	0.921	0.471	129
Huevo entero	74	31	0.793	0.423	106
Leche entera	88	31	0.905	0.465	126
Lechuga	95	32	0.961	0.487	136
Maíz dulce	74	31	0.793	0.423	106
Mantecado (Helado)	63	22	0.705	0.390	90
Mantequilla	16	-	-	0.249	23
Manzanas	84	30	0.873	0.453	121
Naranjas	87	30	0.873	0.453	121
Papas (Patatas)	78	31	0.825	0.435	112
Pavo	64	-	0.713	0.393	92
Plátanos	75	31	0.801	0.426	108
Queso suizo	39	14	0.513	0.318	56
Salmón	64	28	0.713	0.393	92
Sandía	93	31	0.945	0.481	134
Tomates (jitomates) maduros	94	31	0.953	0.484	135

Fuente: Yunus Çengel y Michael Boles. *Termodinámica*, 4a. ed. (Mc Graw Hill, México, 2004), p. 777, tabla A.3E.

Tabla A.11 I Propiedades de diversos gases ideales.
Tabla A.11.1 I Propiedades de diversos gases ideales a 80 ºF.

Gas	Fórmula química	Masa molar	R, ft.lb$_f$/lb$_m$.ºR	Cpo, Btu/lb$_m$.ºR	Cvo, Btu/lb$_m$.ºR	k
Acetileno	C_2H_2	26.038	59.34	0.406	0.329	1.231
Aire		28.97	53.34	0.240	0.171	1.400
Amoniaco	NH_3	17.031	90.72	0.509	0.392	1.297
Argón	Ar	39.948	38.68	0.1253	0.0756	1.667
Butano	C_4H_{10}	58.124	26.58	0.415	0.381	1.091
Dióxido de carbono	CO_2	44.01	35.10	0.203	0.158	1.289
Monóxido de carbono	CO	28.01	55.16	0.249	0.178	1.400
Etano	C_2H_6	30.07	51.38	0.427	0.361	1.186
Etanol	C_2H_5OH	46.069	33.54	0.341	0.298	1.145
Etileno	C_2H_4	28.054	55.07	0.411	0.340	1.237
Helio	He	4.003	386.0	1.25	0.753	1.667
Hidrógeno	H_2	2.016	766.4	3.43	2.44	1.409
Metano	CH_4	16.04	96.35	0.532	0.403	1.299
Metanol	CH_3OH	32.042	48.22	0.336	0.274	1.227
Neón	Ne	20.183	76.55	0.246	0.1477	1.667
Nitrógeno	N_2	28.013	55.15	0.248	0.177	1.400
Oxido nitroso	N_2O	44.013	35.10	0.210	0.165	1.274
n-Octano	C_8H_{18}	114.23	13.53	0.409	0.392	1.044
Oxígeno	O_2	31.999	48.28	0.219	0.157	1.393
Propano	C_3H_8	44.097	35.04	0.407	0.362	1.126
Vapor de agua	H_2O	18.015	85.76	0.445	0.335	1.327
Dióxido de azufre	SO_2	64.059	24.12	0.149	0.118	1.263
Trióxido de azufre	SO_3	80.058	19.30	0.152	0.127	1.196

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 854 - 855, tabla A.10I.

Tabla A.11.2 I Calores específicos de gas ideal de varios gases comunes a diversas temperaturas.

Temperatura (ºF)	Cpo (Btu/lbm.R)	Cvo (Btu/lbm.R)	k	Cpo (Btu/lbm.R)	Cvo (Btu/lbm.R)	k	Cpo (Btu/lbm.R)	Cvo (Btu/lbm.R)	k
	Aire			**Dióxido de carbono, CO_2**			**Monóxido de carbono, CO**		
40	0.240	0.171	1.401	0.195	0.150	1.300	0.248	0.177	1.400
100	0.240	0.172	1.400	0.205	0.160	1.283	0.249	0.178	1.399
200	0.241	0.173	1.397	0.217	0.172	1.262	0.249	0.179	1.397
300	0.243	0.174	1.394	0.229	0.184	1.246	0.251	0.180	1.394
400	0.245	0.176	1.389	0.239	0.193	1.233	0.253	0.182	1.390
500	0.248	0.179	1.383	0.247	0.202	1.223	0.256	0.185	1.384
600	0.250	0.182	1.377	0.255	0.210	1.215	0.259	0.188	1.377
700	0.254	0.185	1.371	0.262	0.217	1.208	0.262	0.191	1.371
800	0.257	0.188	1.365	0.269	0.224	1.202	0.266	0.195	1.364
900	0.259	0.191	1.358	0.275	0.230	1.197	0.269	0.198	1.357
1000	0.263	0.195	1.353	0.280	0.235	1.192	0.273	0.202	1.351
1500	0.276	0.208	1.330	0.298	0.253	1.178	0.287	0.216	1.328
2000	0.286	0.217	1.312	0.312	0.267	1.169	0.297	0.226	1.314
	Hidrógeno, H_2			**Nitrógeno, N_2**			**Oxígeno, O_2**		
40	3.397	2.412	1.409	0.248	0.177	1,400	0.219	0.156	1.397
100	3.426	2.441	1.404	0.248	0.178	1.399	0.220	0.158	1.394
200	3.451	2.466	1.399	0.249	0.178	1.398	0.223	0.161	1.387
300	3.461	2.476	1.398	0.250	0.179	1.396	0.226	0.164	1.378
400	3.466	2.480	1.397	0.251	0.180	1.393	0.230	0.168	1.368
500	3.469	2.484	1.397	0.254	0.183	1.388	0.235	0.173	1.360
600	3.473	2.488	1.396	0.256	0.185	1.383	0.239	0.177	1.352
700	3.477	2.492	1.395	0.260	0.189	1.377	0.242	0.181	1.344
800	3.494	2.509	1.393	0.262	0.191	1.371	0.246	0.184	1.337
900	3.502	2.519	1.392	0.265	0.194	1.364	0.249	0.187	1.331
1000	3.513	2.528	1.390	0.269	0.198	1.359	0.252	0.190	1.326
1500	3.618	2.633	1.374	0.283	0.212	1.334	0.263	0.201	1.309
2000	3.758	2.773	1.355	0.293	0.222	1.319	0.270	0.208	1.298

Tabla A.12 I Calores específicos a presión constante de diversos gases ideales (Van Wylen).

Gas	Fórmula química	Cp_0, Btu/lb$_{mol}$.°R, $\theta = T\,(°R)/180$	Intervalo de temperaturas	Error máximo, %
Agua	H_2O	$Cp_0 = 34.190 - 43.868\,\theta^{0.25} + 19.778\,\theta^{0.5} - 0.88407\,\theta$	540 – 6300	0.43
n-Butano	C_4H_{10}	$Cp_0 = 0.945 + 8.873\,\theta - 0.438\,\theta^2 + 8.36\times10^{-3}\,\theta^3$	540 – 2700	0.54
Dióxido de Carbono	CO_2	$Cp_0 = -0.89286 + 7.2967\,\theta^{0.5} - 0.98074\,\theta + 5.7835\times10^{-3}\,\theta^2$	540 – 6300	0.19
Dióxido de Nitrógeno	NO_2	$Cp_0 = 11.005 + 51.650\,\theta^{-0.5} - 86.916\,\theta^{-0.75} + 55.580\,\theta^{-2}$	540 – 6300	0.26
Etano	C_2H_6	$Cp_0 = 1.68 + 4.124\,\theta - 0.153\,\theta^2 + 1.74\times10^{-3}\,\theta^3$	540 – 2700	0.83
Etileno	C_2H_4	$Cp_0 = -22.800 + 29.433\,\theta^{0.5} - 8.5185\,\theta^{0.75} + 43.683\,\theta^{-3}$	540 – 3600	0.07
Hidrógeno	H_2	$Cp_0 = 13.505 - 167.96\,\theta^{-0.75} + 278.44\,\theta^{-1} - 134.01\,\theta^{-1.5}$	540 – 6300	0.60
Hidróxilo	OH	$Cp_0 = 19.490 - 14.185\,\theta^{0.25} + 4.1418\,\theta^{-0.75} - 1.0196\,\theta$	540 – 6300	0.43
Metano	CH_4	$Cp_0 = -160.82 + 105.10\,\theta^{0.25} - 5.9452\,\theta^{0.75} + 77.408\,\theta^{-0.5}$	540 – 3600	0.15
Monóxido de carbono	CO	$Cp_0 = 16.256 - 0.16841\,\theta^{0.75} - 47.985\,\theta^{-0.5} + 42.246\,\theta^{-0.75}$	540 – 6300	0.42
Nitrógeno	N_2	$Cp_0 = 9.355 - 122.56\,\theta^{-1.5} + 256.38\,\theta^{-2} - 196.08\,\theta^{-3}$	540 - 6300	0.43
Óxido nítrico	NO	$Cp_0 = 14.169 - 0.40861\,\theta^{0.5} - 16.877\,\theta^{-0.5} + 17.889\,\theta^{-1.5}$	540 – 6300	0.34
Oxígeno	O_2	$Cp_0 = 8.9465 + 4.8044\times10^{-3}\,\theta^{1.5} - 42.679\,\theta^{-1.5} + 56.615\,\theta^{-2}$	540 – 6300	0.30
Propano	C_3H_8	$Cp_0 = -0.966 + 7.2790\,\theta - 0.3755\,\theta^2 + 7.58\times10^{-3}\,\theta^3$	540 – 2700	0.40

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión inglés / SI, 2a ed. (Limusa Wiley, México, 2003), p. 855, tabla A.11I.

Tabla A.13 I Constantes de las ecuaciones de estado.
Tabla A.13.1 I Constantes de la ecuación de estado de Van der Waals.

$$P = \frac{RT}{v-b} - \frac{a}{v^2}; \quad v^3 - \left(b + \frac{RT}{P}\right)v^2 + \frac{a}{P}v - \frac{ab}{P} = 0$$

Sustancia	Fórmula	a (psi.ft^6/lbmol^2)	b (ft^3/lbmol)	Sustancia	Fórmula	a (psi.ft^6/lbmol^2)	b (ft^3/lbmol)
Acetileno	C_2H_6	16796.7165	0.8358	Etileno	C_2H_4	17168.9826	0.9327
Agua	H_2O	20552.8383	0.4871	Flúor	F_2	4328.2055	0.4601
Alcohol metílico	CH_3OH	35241.5008	1.0547	Helio	He	128.7522	0.3806
Alcohol etílico	C_2H_5OH	46669.6536	1.3932	Helio3	He	104.2790	0.4833
Amoniaco	NH_3	15719.2409	0.5947	n-Heptano	C_7H_{16}	115601.9302	3.2823
Argón	Ar	5066.6329	0.5154	n-Hexano	C_6H_{14}	92843.4587	2.8065
Benceno	C_6H_6	70132.3735	1.9137	Hidrógeno (normal)	H_2	919.7350	0.4250
Bromo	Br_2	36421.9456	0.9503	Kriptón	Kr	8650.4038	0.6337
n-Butano	C_4H_{10}	51623.6406	1.8626	Metano	CH_4	8551.0958	0.6890
Cloro	Cl_2	23632.3338	0.8696	Monóxido de carbono	CO	5475.5485	0.6321
Clorodifluoroetano	CH_3CClF_2	42979.3474	1.6070	Neón	Ne	775.0016	0.2678
Clorodifluorometano	$CHClF_2$	29774.7374	1.2369	Nitrógeno	N_2	5097.5879	0.6197
Cloroformo	$CHCl_3$	58136.5112	1.6627	n-Octano	C_8H_{18}	140982.6085	3.8024
Cloruro de metilo	CH_3Cl	28066.2076	1.0343	Óxido nítrico	NO	5425.1996	0.4624
Deuterio (normal)	D_2	963.8292	0.3851	Oxido nitroso	N_2O	14365.1132	0.7118
Diclorodifluorometano (12)	CCl_2F_2	38847.8360	1.5480	Oxígeno	O_2	5145.5779	0.5106
Diclorofluoroetano (141)	CH_3CCl_2F	55409.2719	1.7654	n-Pentano	C_5H_{16}	71032.4727	2.3200
Diclorofluorometano (21)	$CHCl_2F$	42719.2698	1.4512	Propano	C_3H_8	34913.2756	1.4484
Difluoroetano (152a)	CHF_2CH_3	35841.1152	1.4230	Propeno	C_3H_6	31407.6620	1.3204
Diclorotrifluorometano (123)	$CHCl_2F$	61719.4383	2.0723	Propino	C_3H_4	31207.0892	1.1897
Dióxido de azufre	SO_2	25554.7058	0.9100	Tetracloruro de carbono	CCl_4	73663.9688	2.0311
Dióxido de carbono	CO_2	13596.3455	0.6859	Tetrafluoroetano (134a)	CF_3CH_2F	37422.0217	1.5342
Dióxido de nitrógeno	NO_2	19956.2474	0.7103	Xenón	Xe	15593.0064	0.8257
Etano	C_2H_6	20737.8609	1.0417				

Fuente: Calculados a partir de los valores críticos.

Tabla A.13.2 I Constantes de la ecuación de estado de Redlich - Kwong.

$$P = \frac{RT}{v-b} - \frac{a}{v(v+b)T^{\frac{1}{2}}}; \ v^3 - \frac{RT}{P}v^2 + \left(\frac{a}{PT^{\frac{1}{2}}} - \frac{RTb}{P} - b^2\right)v - \frac{ab}{PT^{\frac{1}{2}}} = 0$$

Sustancia	Fórmula	a (psia·ft^6·R$^{0.5}$/lbmol^2)	b (ft^3/lbmol)	Sustancia	Fórmula	a (psia·ft^6·R$^{0.5}$/lbmol^2)	b (ft^3/lbmol)
Acetileno	C_2H_6	400940.0288	0.5793	Etileno	C_2H_4	392233.9405	0.6465
Agua	H_2O	710874.3947	0.3376	Flúor	F_2	70682.0767	0.3189
Alcohol metílico	CH_3OH	1084705.7929	0.7310	Helio	He	398.7553	0.2638
Alcohol etílico	C_2H_5OH	1438275.7218	0.9656	Helio3	He	257.9165	0.3350
Amoniaco	NH_3	430323.6960	0.4122	n-Heptano	C_7H_{16}	3653009.7600	2.2751
Argón	Ar	84584.0292	0.3573	n-Hexano	C_6H_{14}	2843397.6320	1.9453
Benceno	C_6H_6	2260644.2309	1.3264	Hidrógeno (normal)	H_2	7204.4367	0.2946
Bromo	Br_2	1200660.0682	0.6586	Kriptón	Kr	170173.9111	0.4393
n-Butano	C_4H_{10}	1447149.9020	1.2910	Metano	CH_4	160407.0696	0.4775
Cloro	Cl_2	655980.3391	0.6027	Monóxido de carbono	CO	85814.0471	0.4381
Clorodifluoroetano	CH_3CClF_2	1183528.8228	1.1138	Neón	Ne	7020.4075	0.1856
Clorodifluorometano	$CHClF_2$	777867.9124	0.8573	Nitrógeno	N_2	77850.7258	0.4295
Cloroformo	$CHCl_3$	1830465.7778	1.1525	n-Octano	C_8H_{18}	4571025.0229	2.6355
Cloruro de metilo	CH_3Cl	778493.8769	0.7169	Óxido nítrico	NO	98951.0104	0.3205
Deuterio (normal)	D_2	8119.5872	0.2669	Oxido nitroso	N_2O	343619.4911	0.4934
Diclorodifluorometano (12)	CCl_2F_2	1036252.1847	1.0729	Oxígeno	O_2	86977.5488	0.3539
Diclorofluoroetano (141)	CH_3CCl_2F	1652908.6496	1.2236	n-Pentano	C_5H_{16}	2092837.3439	1.6080
Diclorofluorometano (21)	$CHCl_2F$	1234153.1326	1.0058	Propano	C_3H_8	912729.9752	1.0039
Difluoroetano (152a)	CHF_2CH_3	957785.6723	0.9863	Propeno	C_3H_6	815625.5150	0.9152
Diclorotrifluorometano (123)	$CHCl_2F$	1793497.6312	1.4364	Propino	C_3H_4	851041.0559	0.8246
Dióxido de azufre	SO_2	721069.2834	0.6308	Tetracloruro de carbono	CCl_4	2362201.4794	1.4078
Dióxido de carbono	CO_2	322328.4688	0.4754	Tetrafluoroetano (134a)	CF_3CH_2F	984118.5110	1.0634
Dióxido de nitrógeno	NO_2	563229.9988	0.4923	Xenón	Xe	360804.8505	0.5723
Etano	C_2H_6	492682.0460	0.7220				

Fuente: Calculados a partir de los valores críticos.

Tabla A.14 I Propiedades del gas ideal del Aire (Çengel).

T (R)	h (Btu/lb$_m$)	P$_r$	u (Btu/lb$_m$)	v$_r$	s (Btu/lb$_m$.R)	T (R)	h (Btu/lb$_m$)	P$_r$	u (Btu/lb$_m$)	v$_r$	s (Btu/lb$_m$.R)	T (R)	h (Btu/lb$_m$)	P$_r$	u (Btu/lb$_m$)	v$_r$	s (Btu/lb$_m$.R)
360	85.97	0.3363	61.29	396.6	0.50369	1200	291.30	24.01	209.05	18.51	0.79628	3000	790.68	941	858.04	1.180	1.04779
380	90.75	0.4061	64.70	346.6	0.51663	1240	301.52	27.13	216.53	16.93	0.80466	3050	805.34	1011	596.28	1.118	1.05264
400	95.53	0.4868	68.11	305.0	0.52890	1280	311.79	30.55	224.05	15.52	0.81280	3100	820.03	1083	607.53	1.060	1.05741
420	100.32	0.5760	71.52	270.1	0.54058	1320	322.11	34.31	231.63	14.24	0.82075	3150	834.75	1616	618.82	1.006	1.06212
440	105.11	0.6776	74.93	240.6	0.55172	1360	332.48	38.41	239.24	13.12	0.82848	3200	849.48	1242	630.12	0.955	1.06676
460	109.90	0.7913	78.36	215.33	0.56235	1400	342.90	42.88	246.93	12.10	0.83604	3250	864.24	1328	641.46	0.9070	1.07134
480	114.69	0.9182	81.77	193.65	0.27255	1440	353.37	47.75	254.66	11.17	0.84341	3300	879.02	1418	652.81	0.8621	1.07585
500	119.48	1.0590	85.20	174.90	0.28233	1480	363.89	53.04	262.44	10.34	0.85062	3350	893.83	1513	664.20	0.8202	1.08031
520	124.27	1.2147	88.62	158.58	0.59173	1520	374.47	58.78	270.26	9.578	0.85767	3400	908.66	1613	675.60	0.7807	1.08470
537	128.10	1.3593	91.53	146.34	0.59945	1560	385.08	65.00	278.13	8.890	0.86456	3450	923.52	1719	685.40	0.7436	1.08904
540	129.06	1.3860	92.04	144.32	0.60078	1600	395.74	71.13	286.06	8.263	0.87130	3500	938.40	1829	698.48	0.7087	1.09332
560	133.86	1.5742	95.47	131.78	0.60950	1650	409.13	80.89	296.03	7.556	0.87954	3550	953.30	1946	709.95	0.6759	1.09755
580	138.66	1.7800	89.90	120.70	0.61793	1700	422.59	90.95	306.06	6.924	0.88758	3600	968.21	2068	721.44	0.6449	1.10172
600	143.47	2.005	102.34	110.88	0.62607	1750	436.12	101.98	316.16	6.357	0.89542	3650	983.15	2196	732.95	0.6157	1.10584
620	148.28	2.249	105.78	102.12	0.63395	1800	449.71	114.0	326.32	5.847	0.90308	3700	998.11	2330	744.48	0.5882	1.10991
640	153.09	2.514	109.21	94.30	0.64159	1850	463.37	127.2	336.55	5.388	0.91056	3750	1013.1	2471	756.04	0.5621	1.11393
660	157.92	2.801	112.67	87.27	0.64902	1900	477.09	141.5	346.85	4.974	0.91788	3800	1026.1	2618	767.60	0.5376	1.11791
680	162.73	3.111	116.12	80.96	0.65621	1950	490.88	157.1	357.20	4.598	0.92504	3850	1043.1	2773	779.19	0.5143	1.12183
700	167.56	3.446	119.58	75.26	0.66321	2000	504.71	174.0	367.61	4.258	0.93205	3900	1058.1	2934	790.80	0.4923	1.12571
720	172.39	3.806	123.04	70.07	0.67002	2050	518.71	192.3	378.08	3.949	0.93891	3950	1073.2	3103	802.43	0.4715	1.12955
740	177.23	4.193	126.51	65.38	0.67665	2100	532.55	212.1	388.60	3.667	0.94564	4000	1088.3	3280	814.06	0.4518	1.13334
760	182.08	4.607	129.99	61.10	0.68312	2150	546.54	223.5	399.17	3.410	0.95222	4050	1103.4	3464	825.72	0.4331	1.13709
780	186.94	5.051	133.47	57.20	0.68942	2200	560.59	256.6	409.78	3.176	0.95919	4100	1118.5	3656	837.40	0.4154	1.14079
800	191.81	5.526	136.97	53.63	0.69558	2250	574.69	281.4	420.46	2.961	0.96501	4150	1133.6	3858	849.09	0.3985	1.14446
820	196.69	6.033	140.47	50.35	0.70160	2300	588.82	308.1	431.16	2.765	0.97123	4200	1148.7	4067	860.81	0.3826	1.14809
840	201.56	6.573	143.98	47.34	0.70747	2350	603.00	336.8	441.91	2.585	0.97732	4300	1179.0	4513	884.28	0.3529	1.15522
860	206.46	7.149	147.50	44.57	0.71323	2400	617.22	367.6	452.70	2.419	0.98331	4400	1209.4	4997	907.81	0.3262	1.16221
880	211.35	7.761	151.02	42.01	0.71886	2450	631.48	400.5	463.54	2.266	0.98919	4500	1239.9	5521	931.39	0.3019	1.16905
900	216.26	8.411	154.57	39.64	0.72438	2500	645.78	435.7	474.40	2.125	0.99479	4600	1270.4	6089	955.04	0.2799	1.17575
920	221.18	9.102	158.52	37.44	0.72979	2550	660.12	473.3	485.31	1.996	1.00064	4700	1300.9	6701	978.76	0.2598	1.18232
940	226.11	9.834	161.68	35.41	0.73509	2600	674.49	513.5	496.26	1.876	1.00623	4800	1331.5	7362	1002.5	0.2415	1.18876
960	231.06	10.61	165.26	33.52	0.74030	2650	688.90	556.3	507.25	1.765	1.01172	4900	1362.2	8073	1026.3	0.2248	1.19508
980	236.02	11.43	168.83	31.76	0.74540	2700	703.35	601.9	518.26	1.662	1.01712	5000	1392.9	8837	1050.1	0.2096	1.20129
1000	240.98	12.30	172.43	30.12	0.75042	2750	717.83	650.4	529.31	1.566	1.02244	5100	1423.6	9658	1074.0	0.1956	1.20738
1040	250.95	14.18	179.66	27.17	0.76019	2800	732.33	702.2	540.40	1.478	1.02767	5200	1454.4	10539	1098.0	0.1828	1.21336
1080	260.97	16.28	186.93	24.58	0.76964	2850	746.88	814.8	551.52	1.395	1.03282	5300	1485.3	11481	1122.0	0.1710	1.21923
1120	271.03	18.60	194.25	22.30	0.77880	2900	761.45	876.4	562.66	1.318	1.03788						
1160	281.14	21.18	201.63	20.29	0.78767	2950	776.05	941.4	573.84	1.247	1.04288						

Fuente: Kenneth Wark y Donalds Richards. *Termodinámica*, 6a. ed. (Nueva York: Mc Graw Hill, 2001), p. 979 - 980, tabla A.5I.

Tabla A.15 I Propiedades de diversas sustancias como gases ideales.

Tabla A.15.1 I Propiedades del gas ideal del Nitrógeno, N_2.

T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)	T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)	T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)	T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)
300	74.32	53.05	1.48842	1080	269.55	192.99	1.80848	1900	490.56	355.83	1.95966	3500	964.41	716.27	2.13986
320	79.28	56.60	1.50441	1100	274.69	196.71	1.81284	1940	501.84	364.30	1.96555	3540	976.65	725.70	2.14333
340	84.25	60.13	1.51944	1120	279.85	200.45	1.81744	1980	513.15	372.79	1.97133	3580	988.93	735.12	2.14679
360	89.21	63.68	1.53365	1140	285.01	204.19	1.82201	2020	524.54	381.32	1.97705	3620	1001.18	744.58	2.15022
380	94.17	67.23	1.54703	1160	290.19	207.95	1.82654	2060	535.93	389.93	1.98265	3660	1013.49	754.01	2.15357
400	99.13	70.77	1.55978	1180	295.38	211.72	1.83097	2100	547.39	398.53	1.98815	3700	1025.77	763.47	2.15693
420	104.10	74.32	1.57191	1200	300.57	215.51	1.82569	2140	558.88	407.17	1.99357	3740	1038.09	772.96	2.16025
440	109.06	77.87	1.58344	1220	305.79	219.31	1.83965	2180	570.38	415.84	1.99889	3780	1050.41	782.46	2.16353
460	114.02	81.41	1.59444	1240	311.02	223.11	1.84389	2220	581.94	424.55	2.00411	3820	1062.76	791.95	2.16678
480	118.98	84.96	1.60504	1260	316.26	226.94	1.84811	2260	593.51	433.30	2.00928	3860	1075.11	801.45	2.16999
500	123.95	88.51	1.61518	1280	321.51	230.77	1.85225	2300	605.11	442.08	2.01439	3900	1087.46	810.98	2.17317
520	128.92	92.05	1.62492	1300	326.77	234.62	1.82062	2340	616.75	450.86	2.01942	3940	1099.81	820.51	2.17635
537	133.13	95.07	1.63292	1320	332.05	238.47	1.86035	2380	628.42	459.72	2.02435	3980	1112.20	830.04	2.17945
540	133.88	95.60	1.63428	1340	337.34	242.35	1.86431	2420	620.85	468.57	2.02924	4020	1124.59	839.61	2.18252
560	138.85	99.15	1.64331	1360	342.65	246.24	1.86824	2460	651.84	477.46	2.03406	4060	1136.97	849.18	2.18559
580	143.82	102.70	1.65202	1380	347.96	250.13	1.87213	2500	663.62	486.38	2.03877	4100	1149.39	858.74	2.18863
600	148.78	106.25	1.66044	1400	353.30	254.05	1.87595	2540	675.37	495.31	2.04344	4140	1161.82	868.31	2.19166
620	153.75	109.80	1.66858	1420	358.64	257.98	1.87977	2580	687.18	504.30	2.04805	4180	1174.24	877.91	2.19466
640	158.73	113.36	1.67651	1440	364.00	261.91	1.88352	2620	699.03	513.30	2.05258	4220	1186.66	887.52	2.19762
660	163.70	116.92	1.68415	1460	369.36	265.86	1.88723	2660	710.88	522.29	2.05708	4260	1199.12	897.12	2.20055
680	168.68	120.48	1.69157	1480	374.75	269.83	1.89087	2700	722.74	531.36	2.06154	4300	1211.58	906.76	2.20348
700	173.67	124.04	1.69878	1500	380.11	273.81	1.89451	2740	734.66	540.43	2.06590	4340	1224.04	916.36	2.20633
720	178.65	127.61	1.70582	1520	385.55	277.80	1.89808	2780	746.58	549.49	2.07022	4380	1236.50	926.00	2.20922
740	183.64	131.18	1.71267	1540	390.97	281.79	1.90165	2820	758.50	558.60	2.07450	4420	1248.99	935.64	2.21204
760	187.35	134.76	1.71934	1560	396.40	285.81	1.90515	2860	770.50	567.77	2.07871	4460	1261.49	945.31	2.21486
780	193.63	138.34	1.72581	1580	401.85	289.84	1.90858	2900	782.49	576.91	2.08289	4500	1273.98	954.95	2.21765
800	198.64	141.92	1.73212	1600	407.30	293.87	1.91201	2940	794.49	586.05	2.08700	4540	1286.47	964.62	2.22043
820	203.64	145.51	1.73834	1620	412.77	297.92	1.91540	2980	806.52	595.26	2.09103	4580	1299.00	974.30	2.22318
840	208.66	149.11	1.74437	1640	418.25	301.99	1.91879	3020	818.55	604.47	2.09503	4620	1311.50	984.01	2.22590
860	213.68	152.72	1.75029	1660	423.74	306.06	1.92211	3060	830.61	613.72	2.09903	4660	1324.03	993.68	2.22857
880	218.72	156.33	1.75608	1680	429.24	310.15	1.92539	3100	842.72	622.96	2.10295	4700	1336.56	1003.39	2.23125
900	223.76	159.95	1.76175	1700	434.76	314.24	1.92868	3140	854.82	632.21	2.10684	4740	1349.09	1013.07	2.23389
920	228.81	163.59	1.76729	1720	440.28	318.35	1.93189	3180	866.92	641.49	2.11066	4780	1361.65	1022.78	2.23653
940	233.86	167.23	1.77271	1740	445.82	322.47	1.93510	3220	879.06	650.80	2.11445	4820	1374.18	1032.52	2.23914
960	238.93	170.87	1.77803	1760	451.37	326.61	1.93828	3260	891.19	660.09	2.11823	4860	1386.75	1042.23	2.24174
980	244.01	174.54	1.78328	1780	456.94	330.75	1.94142	3300	903.37	669.44	2.12194	4900	1399.31	1051.94	2.24432
1000	249.10	178.20	1.78842	1800	462.51	334.91	1.94453	3340	915.54	678.76	2.12558	5000	1430.76	1076.32	2.25071
1020	254.19	181.88	1.79349	1820	468.09	339.07	1.94763	3380	927.75	688.14	2.12923	5100	1462.25	1100.70	2.25692
1040	259.30	185.57	1.79845	1840	473.69	343.25	1.95070	3420	939.96	697.50	2.13283	5200	1493.74	1125.12	2.26306
1060	264.42	189.28	1.80331	1860	479.30	347.44	1.95370	3460	952.17	706.89	2.13637	5300	1525.29	1149.57	2.26905

Fuente: La tabla A.15.1 I se adaptó de Kenneth Wark y Donalds Richards. *Termodinámica*, 6a. ed. (Nueva York: Mc Graw Hill, 2001), p. 981 - 982, tabla A.6I.

La masa molar del nitrógeno (N_2) es 28.013 lb$_m$/lbmol.

Tabla A.15.2 I Propiedades del gas ideal del Oxígeno, O_2.

T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)	T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)	T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)	T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)
300	64.80	46.18	1.40401	1080	240.53	173.51	1.68955	1900	447.58	329.67	1.83153	3500	883.56	666.36	1.99737
320	69.15	49.29	1.41801	1100	245.33	177.06	1.69393	1940	458.08	327.70	1.83699	3540	894.81	675.11	2.00056
340	73.49	52.39	1.43120	1120	250.15	180.64	1.69827	1980	468.61	345.73	1.84237	3580	906.09	683.90	2.00363
360	77.84	55.50	1.44364	1140	254.98	184.23	1.70255	2020	479.17	353.79	1.84765	3620	917.34	692.68	2.00684
380	82.19	58.60	1.45539	1160	259.83	187.84	1.70674	2060	489.77	361.92	1.85284	3660	928.65	701.49	2.00994
400	86.54	61.71	1.46651	1180	264.69	191.46	1.71093	2100	500.36	370.04	1.85790	3700	939.97	710.33	2.01306
420	90.88	64.82	1.47714	1200	269.56	195.09	1.71502	2140	510.98	378.17	1.86293	3740	951.28	719.18	2.01606
440	95.24	67.93	1.48727	1220	274.46	198.74	1.71905	2180	521.64	386.36	1.86787	3780	962.62	728.02	2.01909
460	99.59	71.05	1.49692	1240	279.36	202.41	1.72305	2220	532.39	394.54	1.87275	3820	973.97	736.90	2.02206
480	103.96	74.17	1.50623	1260	284.28	206.08	1.72699	2260	543.02	402.76	1.87746	3860	985.31	745.77	2.02506
500	108.32	77.29	1.51514	1280	289.22	209.78	1.73087	2300	553.74	410.98	1.88218	3900	996.72	754.68	2.02797
520	112.69	80.42	1.52370	1300	294.16	213.48	1.73468	2340	564.46	419.26	1.88681	3940	1008.09	763.59	2.03088
537	116.41	83.09	1.53074	1320	299.13	217.20	1.73849	2380	575.24	427.51	1.89137	3980	1019.50	772.52	2.03375
540	117.07	83.56	1.53195	1340	304.09	220.93	1.74224	2420	580.39	435.83	1.89587	4020	1030.94	781.46	2.03659
560	121.46	86.71	1.53992	1360	309.08	224.68	1.74590	2460	596.80	444.14	1.90093	4060	1042.38	790.40	2.03944
580	125.86	89.86	1.54761	1380	314.08	228.43	1.74955	2500	607.61	452.39	1.90462	4100	1053.85	799.40	2.04256
600	130.26	93.03	1.55511	1400	319.08	232.20	1.75315	2540	618.46	460.83	1.90893	4140	1065.31	808.37	2.04503
620	134.68	96.20	1.56233	1420	324.10	235.98	1.66296	2580	629.33	469.20	1.91318	4180	1076.78	817.37	2.04778
640	139.11	99.39	1.57874	1440	329.14	239.77	1.76024	2620	640.18	477.58	1.91737	4220	1088.28	817.03	2.05053
660	143.55	102.59	1.57621	1460	334.18	243.57	1.76371	2660	651.08	485.98	1.92150	4260	1099.78	835.43	2.05325
680	148.01	105.81	1.58286	1480	339.23	247.38	1.76715	2700	661.99	494.42	1.92556	4300	1111.32	844.46	2.05594
700	152.48	109.04	1.58936	1500	344.30	251.20	1.77056	2740	672.93	502.86	1.92956	4340	1122.85	853.53	2.05860
720	156.97	112.29	1.59564	1520	349.37	255.04	1.77390	2780	683.87	511.33	1.93353	4380	1134.41	862.59	2.06125
740	161.47	115.55	1.60183	1540	354.46	258.89	1.77721	2820	694.77	519.80	1.93744	4420	1145.97	869.50	2.06388
760	165.99	118.83	1.60786	1560	359.55	262.74	1.78052	2860	705.77	528.30	1.94131	4460	1157.57	880.78	2.06647
780	170.52	122.11	1.61374	1580	364.66	266.61	1.78377	2900	716.77	536.80	1.94512	4500	1169.16	889.87	2.06906
800	175.07	125.42	1.61946	1600	369.78	270.48	1.78699	2940	727.77	545.33	1.94890	4540	1180.76	899.03	2.04038
820	179.63	128.74	1.62511	1620	374.91	274.37	1.79018	2980	738.80	553.86	1.95265	4580	1192.38	908.15	2.07419
840	184.22	132.09	1.63064	1640	380.04	278.26	1.79334	3020	749.84	562.42	1.95628	4620	1204.04	917.31	2.07672
860	188.82	135.44	1.63605	1660	385.18	282.17	1.79643	3060	760.90	570.99	1.95994	4660	1215.66	926.47	2.07922
880	193.43	138.82	1.64136	1680	390.34	286.07	1.79949	3100	771.99	579.58	1.96353	4700	1227.35	935.65	2.08172
900	198.07	142.21	1.64655	1700	395.50	290.00	1.80256	3140	783.06	588.21	1.96709	4740	1239.01	944.84	2.08416
920	202.72	145.62	1.65168	1720	400.67	293.93	1.80559	3180	794.18	596.83	1.97059	4780	1250.70	954.06	2.08663
940	207.38	149.05	1.65668	1740	405.85	297.87	1.80859	3220	805.31	605.46	1.97409	4820	1262.41	963.28	2.08907
960	212.07	152.49	1.66161	1760	411.04	301.82	1.81156	3260	817.99	614.11	1.97753	4860	1274.13	972.53	2.09147
980	216.77	155.95	1.66649	1780	416.24	305.77	1.81449	3300	825.40	622.77	1.98087	4900	1285.85	981.75	2.09391
1000	221.49	159.43	1.67121	1800	421.44	309.73	1.81740	3340	838.74	631.46	1.98425	5000	1315.23	1004.94	2.09985
1020	226.22	162.92	1.67593	1820	426.65	313.70	1.82028	3380	849.93	640.18	1.98759	5100	1344.45	1028.19	2.10569
1040	230.98	166.43	1.68052	1840	431.88	317.68	1.82315	3420	861.12	648.86	1.99087	5200	1374.23	1051.53	2.11138
1060	235.74	169.96	1.68508	1860	437.10	321.67	1.82593	3460	872.34	657.61	1.99416	5300	1403.86	1074.94	2.11703

La masa molar del oxígeno (O_2) es 31.999 lb$_m$/lbmol.

Tabla A.15.3 I Propiedades del gas ideal del Dióxido de carbono, CO_2.

T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)	T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)	T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)	T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)
300	47.90	34.36	1.05324	1080	217.58	168.85	1.31952	1900	447.58	361.85	1.47691	3500	953.53	795.61	1.66921
320	51.27	36.83	1.06412	1100	222.74	173.10	1.32427	1940	459.53	372.01	1.48312	3540	966.67	806.93	1.67296
340	54.70	39.36	1.07451	1120	227.92	41.05	1.32890	1980	471.55	382.21	1.48928	3580	979.80	818.27	1.67664
360	58.18	41.94	1.08448	1140	233.13	181.69	1.33354	2020	483.62	392.48	1.49532	3620	992.98	829.63	1.68032
380	61.72	44.58	1.09402	1160	238.37	186.03	1.33808	2060	495.75	402.79	1.50123	3660	1006.13	840.99	1.68394
400	65.32	47.27	1.10327	1180	243.63	190.39	1.34260	2100	507.91	413.13	1.50709	3700	1019.34	852.37	1.68750
420	68.98	50.03	1.11218	1200	248.93	194.78	1.34703	2140	520.11	423.54	1.51286	3740	1032.54	863.76	1.69105
440	72.70	52.84	1.12086	1220	254.25	199.20	1.35144	2180	532.36	434.01	1.51852	3780	1045.74	875.19	1.69457
460	76.48	55.72	1.12924	1240	259.59	203.64	1.35578	2220	544.65	444.47	1.52411	3820	1058.96	886.59	1.69807
480	80.32	58.66	1.13742	1260	264.96	208.11	1.36010	2260	556.96	454.99	1.52963	3860	1072.21	898.02	1.70152
500	84.21	61.65	1.14538	1280	270.36	212.60	1.36433	2300	569.33	465.55	1.53504	3900	1085.46	909.48	1.70491
520	88.17	64.71	1.15315	1300	275.78	217.12	1.36853	2340	581.73	476.14	1.54038	3940	1098.73	920.95	1.70829
537	91.51	67.34	1.15955	1320	281.22	221.65	1.37269	2380	594.18	486.78	1.54567	3980	1112.00	932.40	1.71166
540	92.18	67.81	1.16069	1340	286.68	226.22	1.37680	2420	606.66	497.46	1.55085	4020	1125.29	943.90	1.71500
560	96.25	70.98	1.16810	1360	292.17	230.80	1.38087	2460	619.15	508.16	1.55599	4060	1138.58	955.40	1.71829
580	100.37	74.20	1.17532	1380	297.68	235.41	1.38489	2500	631.70	518.90	1.56105	4100	1151.90	966.89	1.72154
600	104.54	77.47	1.18241	1400	303.22	240.05	1.38887	2540	644.29	529.65	1.56603	4140	1165.24	978.41	1.72477
620	108.76	80.79	1.18934	1420	308.77	244.70	1.39282	2580	656.90	540.47	1.57096	4180	1178.55	989.96	1.72797
640	113.04	84.16	1.19611	1440	314.35	249.37	1.39671	2620	669.51	551.28	1.57582	4220	1191.91	1001.48	1.73115
660	117.36	87.58	1.20277	1460	319.95	254.06	1.40057	2660	682.19	562.14	1.58062	4260	1205.27	1013.04	1.73431
680	121.74	91.05	1.20938	1480	325.56	258.78	1.40423	2700	694.86	573.05	1.58534	4300	1218.63	1024.61	1.73742
700	126.15	94.57	1.21570	1500	331.20	263.51	1.40818	2740	707.59	583.98	1.59002	4340	1232.02	1036.17	1.74054
720	130.62	98.13	1.22200	1520	336.85	268.27	1.41191	2780	720.34	594.89	1.59466	4380	1245.40	1047.76	1.74360
740	135.12	101.73	1.22815	1540	342.53	273.04	1.41563	2820	733.11	605.86	1.59923	4420	1258.80	1059.35	1.74665
760	139.67	105.38	1.23424	1560	348.22	277.83	1.41931	2860	745.90	616.86	1.60373	4460	1270.17	1070.96	1.74967
780	144.26	109.07	1.24022	1580	353.94	282.41	1.42295	2900	758.74	627.88	1.60818	4500	1285.64	1082.59	1.75267
800	148.90	112.80	1.24606	1600	359.67	287.47	1.42656	2940	771.57	638.90	1.61259	4540	1299.07	1094.21	1.75565
820	153.56	116.56	1.25183	1620	365.41	292.32	1.43011	2980	784.44	649.97	1.61691	4580	1312.52	1105.84	1.75858
840	158.28	120.37	1.25751	1640	371.18	297.18	1.43365	3020	797.32	661.05	1.62122	4620	1325.97	1117.50	1.76280
860	163.02	124.22	1.26310	1660	376.96	302.06	1.43717	3060	810.25	672.17	1.62547	4660	1339.42	1129.15	1.76442
880	167.81	128.10	1.26860	1680	382.77	306.96	1.44065	3100	823.18	683.30	1.62968	4700	1352.90	1140.83	1.76730
900	172.63	132.02	1.27403	1700	388.58	311.87	1.44410	3140	836.13	694.43	1.63381	4740	1366.37	1152.49	1.77017
920	177.49	135.98	1.27937	1720	394.41	316.80	1.44749	3180	849.10	705.61	1.63792	4780	1379.87	1164.19	1.77298
940	182.39	139.97	1.28462	1740	400.26	321.75	1.45087	3220	862.10	716.79	1.64199	4820	1393.37	1175.87	1.77580
960	187.32	144.00	1.28982	1760	406.12	326.71	1.45424	3260	875.10	727.99	1.64601	4860	1406.86	1187.57	1.77860
980	192.28	148.06	1.29493	1780	412.00	331.68	1.45756	3300	888.14	739.22	1.64999	4900	1420.38	1199.30	1.78137
1000	197.28	152.15	1.29998	1800	417.89	336.67	1.46085	3340	901.18	750.47	1.65390	5000	1454.21	1228.61	1.78818
1020	202.30	156.28	1.30498	1820	423.80	341.68	1.46410	3380	914.25	761.74	1.65781	5100	1488.09	1257.96	1.79491
1040	207.37	160.44	1.30986	1840	429.73	346.70	1.46735	3420	927.33	773.01	1.66165	5200	1522.02	1287.39	1.80150
1060	212.46	164.63	1.31472	1860	435.66	351.73	1.47055	3460	940.42	784.30	1.66546	5300	1555.81	1316.84	1.80798

Fuente: La tabla A.15.3 I se adaptó de Kenneth Wark y Donalds Richards. *Termodinámica*, 6a. ed. (Nueva York: Mc Graw Hill, 2001), p. 987 - 988, tabla A.9I.

La masa molar del dióxido de carbono (CO_2) es 44.01 lb$_m$/lbmol.

Tabla A.15.4 I Propiedades del gas ideal del Monóxido de carbono, CO.

T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)	T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)	T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)	T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)
300	74.33	53.06	1.54313	1080	270.30	193.73	1.86373	1900	494.47	359.76	2.01746	3500	973.30	725.13	2.19964
320	79.29	56.60	1.55916	1100	275.50	197.51	1.86851	1940	505.89	368.37	2.02346	3540	985.65	734.59	2.20314
340	84.25	60.15	1.57419	1120	280.72	201.31	1.87319	1980	517.39	377.01	2.02931	3580	998.00	744.16	2.20660
360	89.21	63.69	1.58836	1140	285.94	205.12	1.87783	2020	528.92	385.68	2.03524	3620	1010.35	753.70	2.21003
380	94.18	67.24	1.60179	1160	291.19	208.91	1.88240	2060	540.49	394.43	2.04074	3660	1022.74	763.23	2.21342
400	99.14	70.78	1.61453	1180	296.44	212.78	1.88690	2100	552.05	403.18	2.04630	3700	1035.13	772.80	2.21682
420	104.11	74.33	1.62667	1200	301.71	216.63	1.89132	2140	563.69	411.96	2.05177	3740	1047.52	782.36	2.22014
440	109.07	77.87	1.63820	1220	306.99	220.49	1.89568	2180	575.37	420.81	2.05716	3780	1059.91	791.93	2.22346
460	114.03	81.42	1.64920	1240	312.29	224.37	1.89996	2220	587.04	429.67	2.06248	3820	1072.33	801.50	2.22670
480	118.99	84.96	1.65980	1260	317.60	228.27	1.90421	2260	597.00	438.56	2.06773	3860	1084.76	811.10	2.22995
500	123.96	88.51	1.66994	1280	322.92	232.17	1.90843	2300	610.53	447.48	2.07290	3900	1097.22	820.71	2.23174
520	128.93	92.06	1.67969	1300	328.26	236.09	1.91257	2340	622.31	456.41	2.07797	3940	1109.68	830.31	2.23277
537	132.99	95.08	1.68768	1320	333.62	240.03	1.91664	2380	634.13	465.37	2.08297	3980	1122.13	839.95	2.23949
540	133.89	95.61	1.68904	1340	338.98	243.97	1.92071	2420	645.95	474.37	2.08790	4020	1134.59	849.59	2.24263
560	138.86	99.16	1.69807	1360	344.36	247.94	1.92467	2460	657.84	483.43	2.09279	4060	1147.05	859.23	2.24570
580	143.83	102.71	1.70678	1380	349.75	251.91	1.92863	2500	669.73	492.47	2.09761	4100	1159.55	868.87	2.24877
600	148.80	106.27	1.71524	1400	355.16	255.91	1.93249	2540	681.65	501.54	2.03088	4140	1172.05	878.54	2.25177
620	153.78	109.83	1.72338	1420	360.59	259.91	1.93634	2580	693.57	510.64	2.10696	4180	1184.54	888.18	2.25477
640	158.76	113.38	1.73131	1440	366.02	263.93	1.94016	2620	705.53	519.78	2.11157	4220	1197.07	897.86	2.25777
660	163.75	116.95	1.73899	1460	371.47	267.95	1.94388	2660	717.53	528.92	2.11610	4260	1209.57	907.57	2.26073
680	168.73	120.52	1.74641	1480	376.93	272.00	1.94652	2700	729.53	538.09	2.12060	4300	1222.10	917.24	2.26366
700	174.44	124.09	1.75366	1500	382.40	276.05	1.95162	2740	741.56	547.30	2.12499	4340	1234.63	925.88	2.26655
720	178.73	127.68	1.76069	1520	387.89	280.13	1.95491	2780	753.59	556.52	2.12938	4380	1247.20	936.63	2.26944
740	183.73	131.27	1.76755	1540	357.69	284.21	1.95851	2820	765.66	565.73	2.13370	4420	1259.73	946.38	2.27230
760	188.75	134.86	1.77426	1560	398.91	288.30	1.96208	2860	777.76	574.97	2.13795	4460	1272.30	956.09	2.27512
780	193.77	138.46	1.78079	1580	404.43	292.41	1.96558	2900	789.86	584.26	2.14216	4500	1284.86	965.80	2.27794
800	198.79	142.07	1.78715	1600	409.98	296.54	1.96908	2940	801.96	579.26	2.14630	4540	1297.43	975.54	2.28072
820	203.83	145.70	1.79336	1620	415.53	300.67	1.97255	2980	814.10	602.82	2.15037	4580	1322.60	985.29	2.28347
840	208.88	149.33	1.79943	1640	421.09	304.82	1.97597	3020	826.28	612.14	2.15444	4620	1335.17	995.04	2.28618
860	213.93	152.96	1.80539	1660	426.67	308.98	1.97826	3060	838.45	621.49	2.15844	4660	1347.77	1004.78	2.28893
880	219.00	156.61	1.81121	1680	432.26	313.15	1.98268	3100	850.62	630.85	2.16241	4700	1360.37	1014.53	2.29161
900	224.08	160.27	1.81692	1700	437.85	317.33	1.98600	3140	862.83	640.16	2.16633	4740	1372.97	1024.31	2.29429
920	229.17	163.94	1.82249	1720	443.46	321.52	1.98929	3180	875.04	649.59	2.17019	4780	1385.61	1034.09	2.29693
940	234.26	167.62	1.82799	1740	449.09	325.73	1.99254	3220	887.29	658.98	2.17401	4820	1398.21	1043.88	2.29957
960	239.38	171.31	1.83338	1760	454.72	329.94	1.99572	3260	899.54	668.40	2.17779	4860	1410.85	1053.66	2.30218
980	244.50	175.02	1.83866	1780	460.37	334.17	1.99893	3300	911.78	677.83	2.18154	4900	1410.85	1063.44	2.30475
1000	249.63	178.73	1.84384	1800	466.02	338.40	2.00207	3340	924.06	687.25	2.18526	5000	1442.45	1087.93	2.31114
1020	254.78	182.46	1.84891	1820	471.69	342.65	2.00521	3380	936.34	696.72	2.18890	5100	1474.08	1112.50	2.31739
1040	259.94	186.21	1.85395	1840	477.37	346.91	2.00832	3420	948.66	706.18	2.19250	5200	1505.75	1137.06	2.32353
1060	265.12	189.96	1.85887	1860	483.05	351.18	2.01139	3460	960.98	715.64	2.19611	5300	1537.42	1161.66	2.32960

Fuente: La tabla A.15.4 I se adaptó de Kenneth Wark y Donalds Richards. *Termodinámica*, 6a. ed. (Nueva York: Mc Graw Hill, 2001), p. 985 - 986, tabla A.8I.

La masa molar del monóxido de carbono (CO) es 28.01 lb$_m$/lbmol.

Tabla A.15.5 I Propiedades del gas ideal del vapor de Agua, H_2O.

T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)	T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)	T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)	T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)
300	131.42	98.35	2.24474	1080	486.72	367.67	2.82287	1900	912.46	702.41	3.11391	3500	1905.30	1519.46	3.49020
320	140.26	104.98	2.27322	1100	496.36	375.10	2.83170	1940	934.22	720.34	3.12556	3540	1932.22	1541.99	3.49792
340	149.10	111.62	2.30003	1120	506.21	382.58	2.84047	1980	956.70	738.44	3.13705	3580	1959.26	1564.64	3.50558
360	157.93	118.25	2.32523	1140	515.76	390.09	2.84901	2020	979.35	756.70	3.14843	3620	1986.40	1587.34	3.51307
380	166.77	124.88	2.34915	1160	525.51	397.64	2.85751	2060	1002.16	775.08	3.15959	3660	2013.54	1610.10	3.52057
400	175.62	131.52	2.37180	1180	535.30	405.22	2.85096	2100	1025.09	793.62	3.17064	3700	2040.80	1632.97	3.52800
420	184.47	138.17	2.39339	1200	545.12	412.84	2.87410	2140	1048.18	812.27	3.18152	3740	2068.17	1655.90	3.53539
440	193.32	144.82	2.41393	1220	554.98	420.49	2.88232	2180	1071.38	831.09	3.19228	3780	2095.59	1678.88	3.54266
460	202.18	151.47	2.43358	1240	564.86	428.18	2.89037	2220	1094.75	850.01	3.20294	3820	2123.06	1701.97	3.54993
480	211.05	158.13	2.45251	1260	574.79	435.90	2.89825	2260	1118.23	869.11	3.21338	3860	2150.60	1725.06	3.55715
500	219.93	164.81	2.47061	1280	584.76	443.66	2.90613	2300	1141.88	888.32	3.22381	3900	2178.18	1748.27	3.56425
520	228.81	171.49	2.48798	1300	594.75	451.45	2.91391	2340	1165.64	907.69	3.23403	3940	2205.88	1771.58	3.57136
537	236.36	177.18	2.50230	1320	604.79	459.28	2.92151	2380	1189.51	927.17	3.24424	3980	2233.64	1794.89	3.57841
540	237.71	178.18	2.50480	1340	614.85	467.14	2.92911	2420	1213.54	946.82	3.25423	4020	2261.45	1818.32	3.58540
560	246.62	184.88	2.52095	1360	624.96	475.04	2.93661	2460	1237.75	966.58	3.26411	4060	2289.31	1841.74	3.59228
580	255.55	191.61	2.53655	1380	635.10	482.98	2.94405	2500	1262.00	986.46	3.27394	4100	2317.24	1865.28	3.59917
600	264.49	198.35	2.55176	1400	645.28	490.96	2.95132	2540	1286.43	1006.44	3.28365	4140	2345.27	1888.87	3.60600
620	273.44	205.10	2.56647	1420	655.50	498.97	2.95859	2580	1311.02	1026.59	3.29326	4180	2373.30	1912.52	3.61277
640	282.42	211.87	2.58074	1440	665.75	507.01	2.96575	2620	1335.66	1046.85	3.30280	4220	2401.72	1936.22	3.61943
660	291.42	218.67	2.59456	1460	676.04	515.09	2.97286	2660	1360.42	1067.22	3.31218	4260	2429.59	1960.03	3.62614
680	300.44	225.48	2.60805	1480	686.36	523.21	2.97985	2700	1385.35	1087.70	3.32151	4300	2457.84	1983.85	3.63275
700	309.49	232.32	2.62109	1500	696.72	531.37	2.98684	2740	1410.38	1108.35	3.33072	4340	2486.15	2007.72	3.63936
720	318.56	239.19	2.63392	1520	707.12	539.57	2.99373	2780	1435.53	1129.06	3.33983	4380	2514.46	2031.64	3.64585
740	327.65	246.08	2.64629	1540	717.56	547.80	3.00056	2820	1460.78	1149.88	3.34888	4420	2542.88	2055.62	3.65235
760	336.77	252.99	2.65851	1560	728.04	556.07	3.00400	2860	1486.15	1170.86	3.35776	4460	2571.30	2079.66	3.65878
780	345.92	259.93	2.67033	1580	738.55	564.38	3.01404	2900	1511.57	1191.90	3.36664	4500	2599.83	2103.80	3.66517
800	355.09	266.90	2.68199	1600	749.06	572.72	3.02070	2940	1537.16	1213.04	3.37546	4540	2628.37	2127.89	3.67150
820	364.29	273.89	2.69331	1620	759.68	581.10	3.02720	2980	1562.81	1234.36	3.38412	4580	2657.01	2152.10	3.67777
840	373.52	280.92	2.70447	1640	770.30	589.52	3.03375	3020	1588.62	1255.68	3.39273	4620	2685.65	2176.35	3.67682
860	382.77	287.97	2.71529	1660	780.97	597.99	3.04024	3060	1614.49	1281.43	3.40128	4660	2714.35	2200.67	3.69026
880	392.06	295.05	2.72601	1680	791.67	606.47	3.04668	3100	1640.47	1298.75	3.40971	4700	2743.10	2224.98	3.69642
900	401.38	302.17	2.73650	1700	802.41	615.01	3.05296	3140	1666.56	1320.40	3.41810	4740	2771.91	2249.40	3.70253
920	410.74	309.32	2.74677	1720	813.18	623.58	3.05928	3180	1692.70	1342.16	3.42642	4780	2800.72	2828.92	3.70863
940	420.12	316.50	2.75687	1740	824.00	632.19	3.06556	3220	1718.96	1363.97	3.43458	4820	2829.64	2298.31	3.71468
960	429.53	323.71	2.76675	1760	834.85	640.84	3.07183	3260	1745.32	1385.96	3.44280	4860	2858.56	2323.40	3.72068
980	438.98	330.95	2.77652	1780	845.63	649.53	3.07794	3300	1771.75	1407.99	3.45085	4900	2887.54	2347.38	3.72662
1000	448.42	338.22	2.78607	1800	856.67	658.25	3.08404	3340	1798.28	1430.09	3.45890	5000	2960.14	2408.99	3.74138
1020	457.97	345.53	2.79545	1820	867.64	667.02	3.09009	3380	1824.92	1452.35	3.46678	5100	3033.03	2470.83	3.75587
1040	467.52	352.88	2.80477	1840	878.64	675.81	3.09614	3420	1851.62	1474.60	3.47472	5200	3106.13	2532.94	3.77008
1060	477.10	360.26	2.81393	1860	889.68	684.65	3.10208	3460	1878.38	1496.97	3.48254	5300	3179.52	2595.28	3.78418

Fuente: La tabla A.15.5 I se adaptó de Kenneth Wark y Donalds Richards. *Termodinámica*, 6a. ed. (Nueva York: Mc Graw Hill, 2001), p. 989 - 990, tabla A.10I.

La masa molar del agua (H_2O) es 18.015 lb$_m$/lbmol.

Tabla A.15.6 I Propiedades del gas ideal del Hidrógeno, H₂.

T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)	T (R)	h (Btu/lb$_m$)	u (Btu/lb$_m$)	s (Btu/lb$_m$.R)
300	1023.56	728.03	13.56002	1400	4798.51	3419.44	18.79117
320	1086.01	770.78	13.76091	1500	5149.55	3671.97	19.03373
340	1149.40	814.48	13.95337	1600	5502.23	3926.14	19.26091
360	1213.69	859.08	14.13740	1700	5856.85	4182.24	19.47619
380	1278.67	904.37	14.31349	1800	6213.69	4440.58	19.68006
400	1344.35	950.30	14.48165	1900	6572.87	4701.29	19.87450
420	1410.57	996.83	14.64286	2000	6934.57	4964.48	20.06002
440	1477.23	1043.80	14.79812	2100	7298.86	5230.26	20.23760
460	1544.39	1091.27	14.94692	2200	7665.87	5498.76	20.40823
480	1611.81	1138.99	15.09127	2300	8035.62	5769.99	20.57292
500	1679.61	1187.10	15.22966	2400	8408.04	6043.90	20.73115
520	1747.62	1235.42	15.36310	2500	8783.38	6320.73	20.88492
537	1805.70	1276.74	15.47321	2600	9161.56	6600.40	21.03323
540	1815.92	1283.98	15.49206	2700	9542.56	6882.94	21.17659
560	1884.33	1332.69	15.61607	2800	9926.49	7168.35	21.31597
580	1952.93	1381.60	15.73611	2900	10313.24	7456.60	21.45188
600	2021.63	1430.61	16.34871	3000	10702.83	7747.67	21.58433
620	2090.43	1479.71	15.96577	3100	11095.09	8041.42	21.71280
640	2159.28	1528.82	16.07490	3200	11490.13	8337.95	21.83978
660	2228.22	1578.08	16.18105	3300	11887.65	8636.95	21.96081
680	2297.17	1627.33	16.28423	3400	12287.65	8938.44	22.07986
700	2366.17	1676.64	16.38442	3500	12689.93	9242.26	22.19643
720	2435.27	1725.99	16.48115	3600	13094.49	9548.31	22.31052
740	2504.37	1775.40	16.57589	3700	13501.24	9856.55	22.42212
760	2573.46	1825.30	16.66766	3800	13910.12	10166.91	22.53125
780	2642.66	1874.31	16.75794	3900	14320.98	10479.27	22.63790
800	2711.86	1923.81	16.84573	4000	14733.88	10793.65	22.74256
820	2781.10	1973.36	16.93155	4100	15148.56	11109.97	22.84524
840	2850.35	2022.92	17.01488	4200	15565.38	11428.17	22.94494
860	2919.59	2072.42	17.09623	4300	15983.88	11748.16	23.04365
880	2988.89	2122.02	17.17609	4400	16404.22	12069.99	23.14038
900	3058.18	2171.63	17.25397	4500	16826.19	12393.45	23.23512
920	3127.53	2221.28	17.33036	4600	17249.85	12718.60	23.32837
940	3196.88	2270.88	17.40427	4700	17675.10	13045.34	23.42014
960	3266.22	2320.59	17.47768	4800	18101.88	13373.61	23.50992
980	3335.62	2370.24	17.54911	4900	17538.14	13703.42	23.59821
1000	3405.01	2419.94	17.61905	5000	18959.97	14034.72	23.68502
1100	3752.28	2668.70	18.29365	5100	19391.27	14367.51	23.77034
1200	4100.10	2918.06	18.25298	5200	19823.96	14701.69	23.85417
1300	4448.76	3168.20	18.53175	5300	20258.04	15037.25	23.93700

La masa molar del Hidrógeno (H₂) es 2.016 lb$_m$/lbmol.

Tabla A.16 I Propiedades del aire como gas ideal (Van Wylen), entropía estándar en unidades inglesas a la presión de 14.696 lbf/in².

T, R	u, Btu/lb$_m$	h, Btu/lb$_m$	s°, Btu/lb$_m$·°R	Pr	Vr	T, R	u, Btu/lb$_m$	h, Btu/lb$_m$	s°, Btu/lb$_m$·°R	Pr	Vr
400	68.212	95.634	1.56788	0.39046	379.523	1950	357.243	490.928	1.96404	126.2356	5.72284
440	75.047	105.212	1.59071	0.54470	299.264	2000	367.642	504.755	1.97104	139.8090	5.29973
480	81.887	114.794	1.61155	0.73825	240.877	2050	378.096	518.636	1.97790	154.5119	4.91531
520	88.733	124.383	1.63074	0.97670	197.244	2100	388.602	532.570	1.98461	170.4125	4.56538
536.67	91.589	128.381	1.63831	1.09071	182.288	2150	399.158	546.554	1.99119	187.5812	4.24627
540	92.160	129.180	1.63797	1.11458	179.491	2200	409.764	560.588	1.99765	206.0915	3.95477
560	95.589	133.980	1.64852	1.26592	163.885	2300	431.114	588.793	2.01018	247.4432	3.44359
600	102.457	143.590	1.66510	1.61217	137.880	2400	452.640	617.175	2.02226	295.1096	3.01292
640	109.340	153.216	1.68063	2.02204	87.1367	2500	474.330	645.721	2.03391	349.7802	2.64791
680	116.242	162.860	1.69524	2.50257	75.9775	2600	496.175	674.421	2.04517	412.1964	2.33683
720	123.167	172.528	1.70906	3.06119	66.6778	2700	518.165	703.267	2.05606	483.1554	2.07031
760	130.118	182.221	1.72216	3.70585	58.8555	2800	540.286	732.244	2.06659	563.4304	1.84110
800	137.099	191.944	1.73463	4.44496	52.2211	2900	562.532	761.345	2.07681	653.9284	1.64296
840	144.114	201.701	1.74653	5.28751	46.5519	3000	584.894	790.564	2.08671	755.5802	1.47096
880	151.165	211.494	1.75791	6.24303	41.6744	3100	607.369	819.894	2.09633	869.3694	1.32104
920	158.255	221.327	1.76884	7.32166	37.4523	3200	629.948	849.328	2.10567	996.3336	1.18988
960	165.388	231.202	1.77935	8.53415	33.7768	3300	652.625	878.861	2.11476	1137.566	1.07472
1000	172.564	241.121	1.78947	9.89193	30.5609	3400	675.396	908.488	2.12361	1294.214	0.97327
1040	179.787	251.086	1.79924	11.40706	27.7339	3500	698.257	938.204	2.13222	1467.483	0.88360
1080	187.058	261.099	1.80868	13.09232	25.2381	3600	721.203	968.005	2.14062	1658.635	0.80410
1120	194.378	271.161	1.81783	14.96119	23.0259	3700	744.230	997.888	2.14880	1869.020	0.73341
1160	201.748	281.273	1.82670	17.02788	21.0581	3800	767.334	1027.848	2.15679	2100.030	0.67037
1200	209.168	291.436	1.83532	19.30735	19.3017	3900	790.513	1057.882	2.16459	2353.126	0.61401
1240	216.640	301.650	1.84369	21.81531	17.7290	4000	813.763	1087.988	2.17221	2629.834	0.56350
1280	224.160	311.915	1.85184	24.56826	16.3168	4100	837.081	1118.162	2.17967	2931.747	0.51810
1320	231.737	322.231	1.85977	27.58348	15.0451	4200	860.466	1148.402	2.18695	3260.527	0.47722
1360	239.362	332.598	1.86751	30.87907	13.8972	4300	883.913	1178.705	2.19408	3617.908	0.44032
1400	247.037	343.016	1.87506	34.47392	12.8585	4400	907.422	1209.069	2.20106	4005.693	0.40694
1440	254.762	353.483	1.88243	38.38777	11.9165	4500	930.989	1239.492	2.20790	4425.759	0.37669
1480	262.537	364.000	1.88964	42.64121	11.0603	4600	954.613	1269.972	2.21460	4880.058	0.34921
1520	270.359	374.565	1.89668	47.25567	10.2807	4700	978.292	1300.506	2.22117	5370.617	0.32421
1560	278.230	385.177	1.90357	52.25344	9.40126	4800	1002.023	1331.093	2.22761	5899.541	0.30143
1600	286.146	395.837	1.91032	57.65771	8.61487	4900	1025.806	1361.732	2.23392	6469.012	0.28062
1650	296.106	409.224	1.91856	65.02144	7.90980	5000	1049.638	1392.419	2.24012	7081.293	0.26159
1700	306.136	422.681	1.92659	73.10700	8.61487	5100	1073.518	1423.155	2.24621	7738.728	0.24415
1750	316.232	436.205	1.93444	81.96560	7.90980	5200	1097.444	1453.936	2.25219	8443.744	0.22815
1800	326.393	449.794	1.94209	91.65077	7.27604	5300	1121.424	1484.762	2.25806	9198.851	0.21345
1850	336.616	463.445	1.94957	102.2183	6.70505	5400	1145.428	1515.632	2.26383	10006.645	0.19992
1900	346.901	477.158	1.95689	113.7264	6.18944						

Tabla A.17 I Propiedades de diversas sustancias como gases ideales, entropía a la presión de 1 atm.

T, R	Nitrógeno diatómico (N_2) $h^0_{f,537} = 0$ Btu/lbmol $M = 28.013$ lb$_m$/lbmol		Nitrógeno monoatómico (N) $h^0_{f,537} = 203216$ Btu/lbmol $M = 14.007$ lb$_m$/lbmol		Oxígeno diatómico (O_2) $h^0_{f,537} = 0$ Btu/lbmol $M = 31.999$ lb$_m$/lbmol		Oxígeno monoatómico (O) $h^0_{f,537} = 107124$ Btu/lbmol $M = 16.00$ lb$_m$/lbmol	
	$h-h^0_{537}$, Btu/lb$_m$	s^0, Btu/lb$_m$.°R	$h-h^0_{537}$, Btu/lb$_m$	s^0, Btu/lb$_m$.°R	$h-h^0_{537}$, Btu/lb$_m$	s^0, Btu/lb$_m$.°R	$h-h^0_{537}$, Btu/lb$_m$	s^0, Btu/lb$_m$.°R
0	**-133.045**	**0**	**-190.195**	**0**	**-116.660**	**0**	**-180.693**	**0**
200	-83.568	1.38782	-119.300	2.26242	-73.284	1.31567	-114.316	2.06513
400	-33.913	1.55981	-48.477	2.50809	-29.845	1.46630	-45.251	2.30532
537	**0**	**1.63278**	**0**	**2.61225**	**0**	**1.53045**	**0**	**2.40270**
600	15.743	1.66048	22.418	2.65180	13.938	1.55499	20.626	2.43901
800	65.577	1.73220	93.312	2.75375	58.783	1.61939	84.878	2.53152
1000	116.053	1.78846	164.207	2.83286	105.191	1.67115	148.380	2.60233
1200	167.529	1.83536	235.102	2.89747	153.224	1.71493	211.444	2.65983
1400	220.219	1.87599	305.996	2.95209	202.725	1.75305	274.196	2.70821
1600	274.194	1.91201	376.891	2.99942	253.383	1.78690	336.823	2.75002
1800	329.383	1.94453	447.786	3.04119	305.041	1.81731	399.325	2.78684
2000	385.678	1.97415	518.680	3.07853	357.449	1.84490	461.702	2.81971
2200	442.902	2.00143	589.575	3.11230	410.513	1.87018	524.079	2.84940
2400	500.982	2.02670	660.470	3.14314	464.140	1.89353	586.331	2.87653
2600	559.776	2.05023	731.364	3.17155	518.266	1.91518	648.645	2.90147
2800	619.177	2.07222	802.259	3.19783	572.799	1.93537	710.835	2.92453
3000	679.149	2.09292	873.154	3.22224	627.770	1.95434	773.087	2.94597
3200	739.549	2.11241	944.048	3.24516	683.146	1.97222	835.276	2.96603
3400	800.378	2.13083	1014.943	3.26665	738.898	1.98912	897.466	2.98491
3600	861.564	2.14832	1085.837	3.28686	795.056	2.00513	959.655	3.00266
3800	923.036	2.16496	1156.732	3.30606	851.589	2.02044	1021.844	3.01947
4000	984.793	2.18077	1227.627	3.32427	908.497	2.03503	1084.034	3.03541
4200	1046.800	2.19591	1298.593	3.34154	965.780	2.04900	1146.223	3.05060
4400	1109.057	2.21040	1369.559	3.35804	1023.407	2.06241	1208.413	3.06503
4600	1171.492	2.22429	1440.596	3.37381	1081.440	2.07531	1270.665	3.07891
4800	1234.106	2.23760	1511.705	3.38895	1139.786	2.08772	1957.999	3.09216
5000	1296.898	2.25042	1582.885	3.40351	1198.475	2.09972	1395.356	3.10491
5500	1454.503	2.28044	1761.300	3.43750	1346.636	2.12794	1551.486	3.13466
6000	1612.894	2.30800	1940.928	3.46877	1496.734	2.15407	1708.116	3.16191
6500	1771.963	2.33349	2122.127	3.49775	1648.520	2.17835	1865.496	3.18710
7000	1931.567	2.35712	2305.611	3.52496	1801.838	2.20110	2023.688	3.21054
7500	2091.707	2.37922	2491.879	3.55066	1956.561	2.22244	2182.818	3.23248
8000	2252.276	2.39996	2681.502	3.57515	2112.566	2.24257	2342.886	3.25316
8500	2413.272	2.41948	2875.053	3.59863	2269.852	2.26163	2504.016	3.27273
9000	2574.697	2.43794	3072.815	3.62120	2428.451	2.27976	2666.208	3.29123
9500	2736.515	2.45543	3275.218	3.64311	2588.456	2.29707	2829.463	3.30892
10000	2898.761	2.47207	3482.405	3.66432	2749.992	2.31363	2993.656	3.32573

Los datos en negritas corresponden al estado de referencia para la entalpía y la entropía.

Tabla A.17 I Propiedades de diversas sustancias como gases ideales, entropías a la presión de 1 atm.

T, R	Dióxido de carbono (CO$_2$) $h^0_{f,537}$ = -169184 Btu/lbmol M = 44.01 lb$_m$/lbmol		Monóxido de carbono (CO) $h^0_{f,537}$ = -47518 Btu/lbmol M = 28.01 lb$_m$/lbmol		Agua (H$_2$O) $h^0_{f,537}$ = -103966 Btu/lbmol M = 18.015 lb$_m$/lbmol		Hidroxilo (OH) $h^0_{f,537}$ = 16761 Btu/lbmol M = 17.007 lb$_m$/lbmol	
	$h-h^0_{537}$, Btu/lb$_m$	s^0, Btu/lb$_m$·ºR	$h-h^0_{537}$, Btu/lb$_m$	s^0, Btu/lb$_m$·ºR	$h-h^0_{537}$, Btu/lb$_m$	s^0, Btu/lb$_m$·ºR	$h-h^0_{537}$, Btu/lb$_m$	s^0, Btu/lb$_m$·ºR
0	-91.479	0	-133.095	0	-236.359	0	-231.805	0
200	-59.895	0.98764	-83.649	1.43945	-149.098	2.06545	-146.032	2.13116
400	-26.199	1.10350	-33.952	1.61146	-60.616	2.37180	-57.966	2.45320
537	0	1.15969	0	1.68447	0	2.50214	0	2.57801
600	13.020	1.18262	15.744	1.71221	28.254	2.55193	26.573	2.62487
800	57.373	1.24626	65.762	1.78415	118.901	2.68221	109.935	2.74480
1000	105.771	1.30020	116.601	1.84084	212.268	2.78640	192.828	2.83733
1200	157.396	1.34722	168.618	1.88829	308.965	2.87449	275.838	2.91293
1400	211.656	1.38903	222.064	1.92945	409.159	2.95165	359.318	2.97725
1600	268.075	1.42668	276.830	1.96601	512.961	3.02093	443.680	3.03357
1800	326.244	1.46092	332.845	1.99900	620.483	3.08426	529.159	3.08389
2000	385.867	1.46960	389.968	2.02910	731.779	3.14288	615.932	3.12963
2200	446.694	1.52129	448.019	2.05673	846.739	3.19761	704.174	3.17166
2400	508.521	1.54819	506.855	2.08233	965.196	3.24913	793.886	3.21070
2600	571.188	1.57326	566.369	2.10614	1086.983	3.29786	885.009	3.24721
2800	634.538	1.59675	626.455	2.12838	1211.879	3.34416	977.484	3.28142
3000	698.500	1.61881	687.005	2.14927	1339.550	3.38818	1071.135	3.31376
3200	762.986	1.63963	747.983	2.16894	1469.831	3.43025	1166.020	3.34433
3400	827.925	1.65930	809.318	2.18754	1602.387	3.47044	1261.964	3.37343
3600	893.252	1.67796	870.939	2.20518	1737.052	3.50891	1358.848	3.40112
3800	958.918	1.69573	932.810	2.22192	1873.772	3.54582	1456.614	3.42757
4000	1024.881	1.71263	994.966	2.23788	2012.268	3.58135	1555.262	3.45285
4200	1091.138	1.72879	1057.265	2.25305	2152.318	3.61554	1654.615	3.47707
4400	1157.646	1.74426	1119.814	2.26758	2293.922	3.64846	1754.791	3.50041
4600	1224.381	1.75910	1182.506	2.28151	2436.803	3.68021	1855.556	3.52275
4800	1291.297	1.77335	1245.377	2.29489	2580.960	3.71091	1956.908	3.54433
5000	1358.419	1.78705	1308.461	2.30778	2726.284	3.74055	2058.848	3.56514
5500	1266.508	1.55985	1406.391	2.19482	3094.033	3.81066	2315.873	3.61417
6000	1696.433	1.84867	1626.134	2.36569	3467.277	3.87560	2575.661	3.65938
6500	1866.735	1.87594	1785.898	2.39125	3845.129	3.93605	2837.860	3.70129
7000	2037.764	1.90127	1946.233	2.41503	4226.811	3.99262	3102.116	3.74051
7500	2209.475	1.92497	2107.105	2.43724	4611.768	4.04574	3368.254	3.77719
8000	2381.800	1.94722	2268.440	2.45805	4999.667	4.09581	3636.155	3.81176
8500	2554.738	1.96819	2430.168	2.47765	5390.008	4.14316	3905.585	3.84444
9000	2728.266	1.98803	2592.288	2.49618	5782.737	4.18807	4176.543	3.87543
9500	2902.386	2.00684	2754.766	2.51375	6177.574	4.23075	4448.971	3.90488
10000	3077.164	2.02477	2917.565	2.53045	6574.521	4.27144	4722.810	3.93298

Las líneas en negritas corresponden al estado de referencia para la entalpía y la entropía.

T, K	Hidrógeno (H$_2$) $h^0_{f,537} = 0$ Btu/lbmol $M = 2.016$ lb$_m$/lbmol		Hidrógeno monoatómico (H) $h^0_{f,537} = 93723$ Btu/lbmol $M = 1.008$ lb$_m$/lbmol		Óxido nítrico (NO) $h^0_{f,537} = 38818$ Btu/lbmol $M = 30.006$ lb$_m$/lbmol		Dióxido de nitrógeno (NO$_2$) $h^0_{f,537} = 14230$ Btu/lbmol $M = 46.005$ lb$_m$/lbmol	
	$h-h^0_{537}$, Btu/lb$_m$	s^0, Btu/lb$_m$.ºR	$h-h^0_{537}$, Btu/lb$_m$	s^0, Btu/lb$_m$.ºR	$h-h^0_{537}$, Btu/lb$_m$	s^0, Btu/lb$_m$.ºR	$h-h^0_{537}$, Btu/lb$_m$	s^0, Btu/lb$_m$.ºR
0	-1805.556	0	-2642.857	0	-131.707	0	-95.183	0
200	-1103.175	12.25347	-1658.730	22.29464	-74.119	0.82327	-36.343	0.48848
400	-459.821	14.48065	-673.611	25.70833	-30.894	0.97291	-14.759	0.56327
537	0	15.46925	0	27.15575	0	1.03933	0	0.59499
600	217.262	15.85169	311.508	27.70536	14.597	1.06502	6.825	0.60703
800	908.234	16.84524	1296.627	29.12202	61.021	1.13177	28.409	0.63807
1000	1599.702	17.61855	2281.746	30.22123	107.479	1.18373	49.993	0.66215
1200	2292.659	18.25248	3266.865	31.11905	154.036	1.22632	71.578	0.68182
1400	2990.575	18.79117	4251.984	31.87897	200.926	1.26251	93.162	0.69847
1600	3694.444	19.26141	5237.103	32.53671	248.217	1.29411	114.746	0.71289
1800	4406.746	19.68056	6222.222	33.11607	296.074	1.32227	136.330	0.72558
2000	5127.480	20.06002	7207.341	33.63591	344.498	1.34776	157.914	0.73697
2200	5859.127	20.40823	8192.460	34.10516	393.655	1.37116	179.498	0.74725
2400	6601.687	20.73115	9177.579	34.53373	443.545	1.39285	201.082	0.75664
2600	7355.655	21.03224	10162.698	34.92758	494.201	1.41308	222.667	0.76527
2800	8121.032	21.31597	11147.817	35.29266	545.624	1.43208	244.251	0.77327
3000	8897.817	21.58333	12132.937	35.63194	597.814	1.45011	265.835	0.78070
3200	9685.020	21.83730	13118.056	35.95040	650.703	1.46717	287.419	0.78768
3400	10482.639	22.07937	14102.183	36.24901	704.292	1.48344	308.981	0.79422
3600	11290.179	22.31002	15087.302	36.53075	758.548	1.49893	330.566	0.80040
3800	12106.647	22.53075	16072.421	36.79663	813.404	1.51376	352.150	0.80622
4000	12932.044	22.74256	17057.540	37.04960	868.860	1.52799	373.734	0.81176
4200	13765.873	22.94643	18042.659	37.28968	924.882	1.54169	395.318	0.81702
4400	14607.639	23.14236	19027.778	37.51885	981.437	1.55486	416.902	0.82204
4600	15456.845	23.33085	20012.897	37.73810	1038.492	1.56752	438.486	0.82685
4800	16312.996	23.51339	20998.016	37.94742	1096.014	1.57978	460.070	0.83144
5000	17176.091	23.68948	21983.135	38.14881	1154.003	1.59162	481.655	0.83585
5500	19361.111	24.10615	24445.437	38.61806	1390.589	2.29837	1377.972	1.84737
6000	21583.829	24.49306	26908.730	39.04663	1450.143	1.64560	589.575	0.85552
6500	23840.278	24.85367	29371.032	39.44048	1601.746	1.66983	643.525	0.86415
7000	26129.960	25.19296	31833.333	39.80556	1755.582	1.69263	697.474	0.87215
7500	28450.397	25.51290	34296.627	40.14583	1911.484	1.71412	751.445	0.87960
8000	30800.595	25.81597	36758.929	40.46329	2069.386	1.73449	805.395	0.88656
8500	33179.067	26.10466	39221.230	40.76190	2229.187	1.75388	859.344	0.89310
9000	35584.325	26.37996	41684.524	41.04365	2390.789	1.77238	913.316	0.89927
9500	38014.881	26.64286	44146.825	41.30952	2554.089	1.79004	967.265	0.90510
10000	40466.766	26.89484	46609.127	41.56250	2718.823	1.80697	1021.215	0.91064

Propiedades de la atmósfera a gran altitud.

Altitud, ft	Temperatura, ºF	Presión, psia	Gravedad ft/s^2	Velocidad del sonido, ft/s	Densidad, lb$_m$/ft^3	Viscosidad, lb$_m$/ft.s	Conductividad térmica, Btu/h.ft.ºC
0	59.00	14.7	32.174	1116	0.07647	1.202	0.0146
500	57.22	14.4	32.173	1115	0.07536	1.199	0.0146
1000	55.43	14.2	32.171	1113	0.07426	1.196	0.0146
1500	53.65	13.9	32.169	1111	0.07317	1.193	0.0145
2000	51.87	13.7	32.168	1109	0.07210	1.190	0.0145
2500	50.09	13.4	32.166	1107	0.07104	1.186	0.0144
3000	48.30	13.2	32.165	1105	0.06998	1.183	0.0144
3500	46.52	12.9	32.163	1103	**0.06985**	1.180	0.0143
4000	44.74	12.7	32.162	1101	0.06792	1.177	0.0143
4500	42.96	12.5	32.160	1099	0.06690	1.173	0.0142
5000	41.17	12.2	32.159	1097	0.06590	1.170	0.0142
5500	39.39	12.0	32.157	1095	0.06491	1.167	0.0141
6000	37.61	11.8	32.156	1093	0.06393	1.164	0.0141
6500	35.83	11.6	32.154	1091	0.06296	1.160	0.0141
7000	34.05	11.3	32.152	1089	0.06200	1.157	0.0140
7500	32.26	11.1	32.151	1087	0.06105	1.154	0.0140
8000	30.48	10.9	32.149	1085	0.06012	1.150	0.0139
8500	28.70	10.7	32.148	1083	0.05919	1.147	0.0139
9000	26.92	10.5	32.146	1081	0.05828	1.144	0.0138
9500	25.14	10.3	32.145	1079	0.05738	1.140	0.0138
10000	23.36	10.1	32.145	1077	0.05648	1.137	0.0137
11000	19.79	9.72	32.140	1073	0.05473	1.130	0.0136
12000	16.23	9.34	32.137	1069	0.05302	1.124	0.0136
13000	12.67	8.99	32.134	1065	0.05135	1.117	0.0135
14000	9.12	8.63	32.131	1061	0.04973	1.110	0.0134
15000	5.55	8.29	32.128	1057	0.04814	1.104	0.0133
16000	1.99	7.97	32.125	1053	0.04659	1.097	0.0132
17000	-1.58	7.65	32.122	1049	0.04508	1.090	0.0132
18000	-5.14	7.34	32.119	1045	0.04361	1.083	0.0130
19000	-8.70	7.05	32.115	1041	0.04217	1.076	0.0129
20000	-12.2	6.76	32.112	1037	0.04077	1.070	0.0128
22000	-19.4	6.21	32.106	1029	0.03808	1.056	0.0126
24000	-26.5	5.70	32.100	1020	0.03553	1.042	0.0124
26000	-33.6	5.22	32.094	1012	0.03311	1.028	0.0122
28000	-40.7	4.78	32.088	1003	0.03082	1.014	0.0121
30000	-47.8	4.37	32.082	995	0.02866	1.000	0.0119
32000	-54.9	3.99	32.08	987	0.02661	0.986	0.0117
34000	-62.0	3.63	32.07	969	0.02468	0.971	0.0115
36000	-69.7	3.30	32.06	968	0.02285	0.956	0.0113
38000	-69.7	3.05	32.06	968	0.02079	0.955	0.0113
40000	-69.7	2.73	32.05	968	0.01890	0.955	0.0113
45000	-69.7	2.148	32.04	968	0.01487	0.955	0.0113
50000	-69.7	1.691	32.02	968	0.01171	0.955	0.0113

Fuente: Yunus Çengel y Michael Boles. *Termodinámica*, 4a. ed. (Mc Graw Hill, México, 2004), p. 809, tabla A.29E.

Entalpía de formación, función de formación de Gibbs y entropía absoluta de diversas sustancias a 77ºF, 1 atm de presión.

Sustancia	Fórmula	M (lbm/lbmol)	Estado	h_f (Btu/lbmol)	g_f (Btu/lbmol)	s_f (Btu/lbmol.K)
Agua	H_2O	18.015	Gas	-241826	-228582	188.834
Agua	H_2O	18.015	Líquido	-285830	-237141	69.95
Peróxido de hidrógeno	H_2O_2	34.015	Gas	-136106	-105445	232.991
Ozono	O_3	47.998	Gas	142674	163184	238.932
Cabono (grafito)	C	12.011	Sólido	0	0	5.740
Monóxido de carbono	CO	28.011	Gas	-110527	-137163	197.653
Dióxido de carbono	CO_2	44.01	Gas	-393522	-394389	213.795
Metano	CH_4	16.043	Gas	-74873	-50768	186.251
Acetileno	C_2H_2	26.038	Gas	226731	209200	200.958
Eteno	C_2H_4	28.054	Gas	52467	68421	219.33
Etano	C_2H_6	30.07	Gas	-84740	-32885	229.597
Propeno	C_3H_6	42.081	Gas	20430	62825	267.066
Propano	C_3H_8	44.094	Gas	-103900	-23393	269.917
Butano	C_4H_{10}	58.124	Gas	-126200	-15970	306.647
Pentano	C_5H_{12}	72.151	Gas	-146500	-8208	348.945
Benceno	C_6H_6	78.114	Gas	82980	129765	269.562
Hexano	C_6H_{14}	86.178	Gas	-167300	28	387.979
Heptano	C_7H_{16}	100.205	Gas	-187900	8227	427.805
n-Octano	C_8H_{18}	114.232	Gas	-208600	16600	466.514
n-Octano	C_8H_{18}	114.232	Líquido	-250105	6741	360.575
Metanol	CH_3OH	32.042	Gas	-201300	-162551	239.709
Etanol	C_2H_5OH	46.069	Gas	-235000	-168319	282.444
Amoniaco	NH_3	17.031	Gas	-45720	-16128	192.572
Diesel T-T	$C_{14.4}H_{24.9}$	198.06	Líquido	-174000	178919	525.90
Azufre	S	32.06	Sólido	0	0	32.056
Dióxido de azufre	SO_2	64.059	Gas	-296842	-300125	248.212
Trióxido de azufre	SO_3	80.058	Gas	-395765	-371016	256.769
Óxido de nitrógeno	N_2O	44.013	Gas	82050	104179	219.957
Nitrometano	CH_3NO_2	61.04	Líquido	-113100	-14439	171.80

Fuente: Gordon J. Van Wylen, Richard E. Sontag y Claus Borgnakke. *Fundamentos de Termodinámica*, versión español / SI, 2a ed. (Limusa Wiley, México, 2003), p. 864, tabla A.16I.