

TABLA A.1SI Propiedades termodinámicas del agua (unidades SI)  
 TABLA A.1.SI Agua saturada: tabla de temperatura (unidades SI)

Temp. °C T	Presión kPa, MPa P	Volumen específico, m <sup>3</sup> /kg		Energía interna, kJ/kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado v <sub>f</sub>	Vapor saturado v <sub>g</sub>	Líquido saturado u <sub>f</sub>	Evap. u <sub>fg</sub>	Vapor saturado u <sub>g</sub>	Líquido saturado h <sub>f</sub>	Evap. h <sub>fg</sub>	Vapor saturado h <sub>g</sub>	Líquido saturado s <sub>f</sub>	Evap. s <sub>fg</sub>	Vapor saturado s <sub>g</sub>
0.01	0.6113	0.001000	206.132	0.00	2375.3	2375.3	0.00	2501.3	2501.3	0.0000	9.1562	9.1562
5	0.8721	0.001000	147.118	20.97	2361.3	2382.2	20.98	2489.6	2510.5	0.0761	8.9496	9.0257
10	1.2276	0.001000	106.377	41.99	2347.2	2389.2	41.99	2477.7	2519.7	0.1510	8.7498	8.9007
15	1.7051	0.001001	77.925	62.98	2333.1	2396.0	62.98	2465.9	2528.9	0.2245	8.5569	8.7813
20	2.3385	0.001002	57.790	83.94	2319.0	2402.9	83.94	2454.1	2538.1	0.2966	8.3706	8.6671
25	3.1691	0.001003	43.359	104.86	2304.9	2409.8	104.86	2442.3	2547.2	0.3673	8.1905	8.5579
30	4.2461	0.001004	32.893	125.77	2290.8	2416.6	125.77	2430.5	2556.2	0.4369	8.0164	8.4533
35	5.6280	0.001006	25.216	146.65	2276.7	2423.4	146.66	2418.6	2565.3	0.5052	7.8478	8.3530
40	7.3837	0.001008	19.523	167.53	2262.6	2430.1	167.54	2406.7	2574.3	0.5724	7.6845	8.2569
45	9.5934	0.001010	15.258	188.41	2248.4	2436.8	188.42	2394.8	2583.2	0.6386	7.5261	8.1647
50	12.350	0.001012	12.032	209.30	2234.2	2443.5	209.31	2382.7	2592.1	0.7037	7.3725	8.0762
55	15.758	0.001015	9.568	230.19	2219.9	2450.1	230.20	2370.7	2600.9	0.7679	7.2234	7.9912
60	19.941	0.001017	7.671	251.09	2205.5	2456.6	251.11	2358.5	2609.6	0.8311	7.0784	7.9095
65	25.033	0.001020	6.197	272.00	2191.1	2463.1	272.03	2346.2	2618.2	0.8934	6.9375	7.8309
70	31.188	0.001023	5.042	292.93	2176.6	2469.5	292.96	2333.8	2626.8	0.9548	6.8004	7.7552
75	38.578	0.001026	4.131	313.87	2162.0	2475.9	313.91	2321.4	2635.3	1.0154	6.6670	7.6824
80	47.390	0.001029	3.407	334.84	2147.4	2482.2	334.88	2308.8	2643.7	1.0752	6.5369	7.6121
85	57.834	0.001032	2.828	355.82	2132.6	2488.4	355.88	2296.0	2651.9	1.1342	6.4102	7.5444
90	70.139	0.001036	2.361	376.82	2117.7	2494.5	376.90	2283.2	2660.1	1.1924	6.2866	7.4790
95	84.554	0.001040	1.982	397.86	2102.7	2500.6	397.94	2270.2	2668.1	1.2500	6.1659	7.4158
100	101.325	0.001044	1.6729	418.91	2087.6	2506.5	419.02	2257.0	2676.0	1.3068	6.0480	7.3548

TABLA A.151 (Continuación) *Propiedades termodinámicas del agua (unidades SI)*  
 TABLA A.1.51 *Agua saturada: tabla de temperatura (unidades SI)*

Temp. °C T	Presión Mpa P	Volumen específico, m³/kg			Energía interna, kJ/kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado v <sub>f</sub>	Vapor saturado v <sub>g</sub>	Líquido saturado v <sub>fg</sub>	Líquido saturado u <sub>f</sub>	Evap. u <sub>fg</sub>	Vapor saturado u <sub>g</sub>	Líquido saturado h <sub>f</sub>	Evap. h <sub>fg</sub>	Vapor saturado h <sub>g</sub>	Líquido saturado s <sub>f</sub>	Evap. s <sub>fg</sub>	Vapor saturado s <sub>g</sub>
105	0.12082	0.001047	1.4194	0.001047	440.00	2072.3	2512.3	440.13	2243.7	2683.8	1.3629	5.9328	7.2958
110	0.14328	0.001052	1.2102	0.001052	461.12	2057.0	2518.1	461.27	2230.2	2691.5	1.4184	5.8202	7.2386
115	0.16906	0.001056	1.0366	0.001056	482.28	2041.4	2523.7	482.46	2216.5	2699.0	1.4733	5.7100	7.1832
120	0.19853	0.001060	0.8919	0.001060	503.48	2025.8	2529.2	503.69	2202.6	2706.3	1.5275	5.6020	7.1295
125	0.2321	0.001065	0.77059	0.001065	524.72	2009.9	2534.6	524.96	2188.5	2713.5	1.5812	5.4962	7.0774
130	0.2701	0.001070	0.66850	0.001070	546.00	1993.9	2539.9	546.29	2174.2	2720.5	1.6343	5.3925	7.0269
135	0.3130	0.001075	0.58217	0.001075	567.34	1977.7	2545.0	567.67	2159.6	2727.3	1.6869	5.2907	6.9777
140	0.3613	0.001080	0.50885	0.001080	588.72	1961.3	2550.0	589.11	2144.8	2733.9	1.7390	5.1908	6.9298
145	0.4154	0.001085	0.44632	0.001085	610.16	1944.7	2554.9	610.61	2129.6	2740.3	1.7906	5.0926	6.8832
150	0.4759	0.001090	0.39278	0.001090	631.66	1927.9	2559.5	632.18	2114.3	2746.4	1.8417	4.9960	6.8378
155	0.5431	0.001096	0.34676	0.001096	653.23	1910.8	2564.0	653.82	2098.6	2752.4	1.8924	4.9010	6.7934
160	0.6178	0.001102	0.30706	0.001102	674.85	1893.5	2568.4	675.53	2082.6	2758.1	1.9426	4.8075	6.7501
165	0.7005	0.001108	0.27269	0.001108	696.55	1876.0	2572.5	697.32	2066.2	2763.5	1.9924	4.7153	6.7078
170	0.7917	0.001114	0.24283	0.001114	718.31	1858.1	2576.5	719.20	2049.5	2768.7	2.0418	4.6244	6.6663
175	0.8920	0.001121	0.21680	0.001121	740.16	1840.0	2580.2	741.16	2032.4	2773.6	2.0909	4.5347	6.6256
180	1.0022	0.001127	0.19405	0.001127	762.08	1821.6	2583.7	763.21	2015.0	2778.2	2.1378	4.4461	6.5857
185	1.1227	0.001134	0.17409	0.001134	784.08	1802.9	2587.0	785.36	1997.1	2782.4	2.1878	4.3586	6.5464
190	1.2544	0.001141	0.15654	0.001141	806.17	1783.8	2590.0	807.61	1978.8	2786.4	2.2358	4.2720	6.5078
195	1.3978	0.001149	0.14105	0.001149	828.36	1764.4	2592.8	829.96	1960.0	2790.0	2.2835	4.1863	6.4697
200	1.5538	0.001156	0.12736	0.001156	850.64	1744.7	2595.3	852.43	1940.7	2793.2	2.3308	4.1014	6.4322
205	1.7230	0.001164	0.11521	0.001164	873.02	1724.5	2597.5	875.03	1921.0	2796.0	2.3779	4.0172	6.3951
210	1.9063	0.001173	0.10441	0.001173	895.51	1703.9	2599.4	897.75	1900.7	2798.5	2.4247	3.9337	6.3584
215	2.1042	0.001181	0.09479	0.001181	918.12	1682.9	2601.1	920.61	1879.9	2800.5	2.4713	3.8507	6.3221
220	2.3178	0.001190	0.08619	0.001190	940.85	1661.5	2602.3	943.61	1858.5	2802.1	2.5177	3.7683	6.2860

Temp. °C T	Presión Mpa P	Volumen específico, m³/kg			Energía interna, kJ/kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado v <sub>f</sub>	Vapor saturado v <sub>g</sub>	Líquido saturado v <sub>fg</sub>	Líquido saturado u <sub>f</sub>	Evap. u <sub>fg</sub>	Vapor saturado u <sub>g</sub>	Líquido saturado h <sub>f</sub>	Evap. h <sub>fg</sub>	Vapor saturado h <sub>g</sub>	Líquido saturado s <sub>f</sub>	Evap. s <sub>fg</sub>	Vapor saturado s <sub>g</sub>
225	2.5477	0.001199	0.07849	0.001199	963.72	1639.6	2603.3	966.77	1836.5	2803.3	2.5639	3.6863	6.2502
230	2.7949	0.001209	0.07158	0.001209	986.72	1617.2	2603.9	990.10	1813.8	2803.9	2.6099	3.6047	6.2146
235	3.0601	0.001219	0.06536	0.001219	1009.88	1594.2	2604.1	1013.61	1790.5	2804.1	2.6557	3.5233	6.1791
240	3.3442	0.001229	0.05976	0.001229	1033.19	1570.8	2603.9	1037.31	1766.5	2803.8	2.7015	3.4422	6.1436
245	3.6482	0.001240	0.05470	0.001240	1056.69	1546.7	2603.4	1061.21	1741.7	2802.9	2.7471	3.3612	6.1083
250	3.9730	0.001251	0.05013	0.001251	1080.37	1522.0	2602.4	1085.34	1716.2	2801.5	2.7927	3.2802	6.0729
255	4.3195	0.001263	0.04598	0.001263	1104.26	1496.7	2600.9	1109.72	1689.8	2799.5	2.8382	3.1992	6.0374
260	4.6886	0.001276	0.04220	0.001276	1128.37	1470.6	2599.0	1134.35	1662.5	2796.9	2.8837	3.1181	6.0018
265	5.0813	0.001289	0.03877	0.001289	1152.72	1443.9	2596.6	1159.27	1634.3	2793.6	2.9293	3.0368	5.9661
270	5.4987	0.001302	0.03564	0.001302	1177.33	1416.3	2593.7	1184.49	1605.2	2789.7	2.9750	2.9551	5.9301
275	5.9418	0.001317	0.03279	0.001317	1202.23	1387.9	2590.2	1210.05	1574.9	2785.0	3.0208	2.8730	5.8937
280	6.4117	0.001332	0.03017	0.001332	1227.43	1358.7	2586.1	1235.97	1543.6	2779.5	3.0667	2.7903	5.8570
285	6.9094	0.001348	0.02777	0.001348	1252.98	1328.4	2581.4	1262.29	1511.0	2773.3	3.1129	2.7069	5.8198
290	7.4360	0.001366	0.02557	0.001366	1278.89	1297.1	2576.0	1289.04	1477.1	2766.1	3.1593	2.6227	5.7821
295	7.9928	0.001384	0.02354	0.001384	1305.21	1264.7	2569.9	1316.27	1441.8	2758.0	3.2061	2.5375	5.7436
300	8.5810	0.001405	0.02167	0.001405	1331.97	1231.0	2563.0	1344.01	1404.9	2748.9	3.2533	2.4511	5.7044
305	9.2018	0.001427	0.01995	0.001427	1359.22	1195.9	2555.2	1372.33	1366.4	2738.7	3.3009	2.3633	5.6642
310	9.8566	0.001447	0.01835	0.001447	1387.03	1159.4	2546.4	1401.29	1326.0	2727.3	3.3492	2.2737	5.6229
315	10.547	0.001472	0.01687	0.001472	1415.44	1121.1	2536.6	1430.97	1283.5	2714.4	3.3981	2.1821	5.5803
320	11.274	0.001499	0.01549	0.001499	1444.55	1080.9	2525.5	1461.45	1238.6	2700.1	3.4479	2.0882	5.5361
330	12.845	0.001561	0.01296	0.001561	1505.24	993.7	2498.9	1525.29	1140.6	2665.8	3.5506	1.8909	5.4416
340	14.586	0.001638	0.010797	0.001638	1570.26	894.3	2464.5	1594.15	1027.9	2622.0	3.6593	1.6763	5.3356
350	16.514	0.001740	0.008813	0.001740	1641.81	776.6	2418.4	1670.54	893.4	2563.9	3.7776	1.4336	5.2111
360	18.651	0.001892	0.006945	0.001892	1725.19	626.3	2351.5	1760.48	720.5	2481.0	3.9146	1.1379	5.0525
370	21.028	0.002213	0.004926	0.002213	1843.84	384.7	2228.5	1890.37	441.8	2332.1	4.1104	0.6868	4.7972
374.14	22.089	0.003155	0.003155	0.003155	2029.58	0	2029.6	2099.26	0	2099.3	4.4297	0	4.4297

TABLA A.1.2SI Agua saturada: tabla de presión (unidades SI)

Presión kPa P	Temp. °C T	Volumen específico, m³/kg			Energía interna, kJ/kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado v <sub>f</sub>	Vapor saturado v <sub>g</sub>	Vapor saturado v <sub>fg</sub>	Líquido saturado u <sub>f</sub>	Evap. u <sub>fg</sub>	Vapor saturado u <sub>g</sub>	Líquido saturado h <sub>f</sub>	Evap. h <sub>fg</sub>	Vapor saturado h <sub>g</sub>	Líquido saturado s <sub>f</sub>	Evap. s <sub>fg</sub>	Vapor saturado s <sub>g</sub>
0.6113	0.01	0.001000	206.132	0	2375.3	2375.3	2375.3	0.00	2501.3	2501.3	0	9.1562	9.1562
1.0	6.98	0.001000	129.208	29.29	2355.7	2385.0	2385.0	29.29	2484.9	2514.2	0.1059	8.8697	8.9756
1.5	13.03	0.001001	87.980	54.70	2338.6	2393.3	2393.3	54.70	2470.6	2525.3	0.1956	8.6322	8.8278
2.0	17.50	0.001001	67.004	73.47	2326.0	2399.5	2399.5	73.47	2460.0	2533.5	0.2607	8.4629	8.7236
2.5	21.08	0.001002	54.254	88.47	2315.9	2404.4	2404.4	88.47	2451.6	2540.0	0.3120	8.3311	8.6431
3.0	24.08	0.001003	45.665	101.03	2307.5	2408.5	2408.5	101.03	2444.5	2545.5	0.3545	8.2231	8.5775
4.0	28.96	0.001004	34.800	121.44	2293.7	2415.2	2415.2	121.44	2432.9	2554.4	0.4226	8.0520	8.4746
5.0	32.88	0.001005	28.193	137.79	2282.7	2420.5	2420.5	137.79	2423.7	2561.4	0.4763	7.9187	8.3950
7.5	40.29	0.001008	19.238	168.76	2261.7	2430.5	2430.5	168.76	2406.0	2574.8	0.5763	7.6751	8.2514
10.0	45.81	0.001010	14.674	191.79	2246.1	2437.9	2437.9	191.81	2392.8	2584.6	0.6492	7.5010	8.1501
15.0	53.97	0.001014	10.022	225.90	2222.8	2448.7	2448.7	225.91	2373.1	2599.1	0.7548	7.2536	8.0084
20.0	60.06	0.001017	7.649	251.35	2205.4	2456.7	2456.7	251.38	2358.3	2609.7	0.8319	7.0766	7.9085
25.0	64.97	0.001020	6.204	271.88	2191.2	2463.1	2463.1	271.90	2346.3	2618.2	0.8930	6.9383	7.8313
30.0	69.10	0.001022	5.229	289.18	2179.2	2468.4	2468.4	289.21	2336.1	2625.3	0.9439	6.8247	7.7686
40.0	75.87	0.001026	3.993	317.51	2159.5	2477.0	2477.0	317.55	2319.2	2636.7	1.0258	6.6441	7.6700
50.0	81.33	0.001030	3.240	340.42	2143.4	2483.8	2483.8	340.47	2305.4	2645.9	1.0910	6.5029	7.5939
75.0	91.77	0.001037	2.217	384.29	2112.4	2496.7	2496.7	384.36	2278.6	2663.0	1.2129	6.2434	7.4563
<b>MPa</b>													
0.100	99.62	0.001043	1.6940	417.33	2088.7	2506.1	2506.1	417.44	2258.0	2675.5	1.3025	6.0568	7.3593
0.125	105.99	0.001048	1.3749	444.16	2069.3	2513.5	2513.5	444.30	2241.1	2685.3	1.3739	5.9104	7.2843
0.150	111.37	0.001053	1.1593	466.92	2052.7	2519.6	2519.6	467.08	2226.5	2693.5	1.4335	5.7897	7.2232
0.175	116.06	0.001057	1.0036	486.78	2038.1	2524.9	2524.9	486.97	2213.6	2700.5	1.4848	5.6868	7.1717
0.200	120.23	0.001061	0.8857	504.47	2025.0	2529.5	2529.5	504.68	2202.0	2706.6	1.5300	5.5970	7.1271
0.225	124.00	0.001064	0.7933	520.45	2013.1	2533.6	2533.6	520.69	2191.3	2712.0	1.5705	5.5173	7.0878
0.250	127.43	0.001067	0.7187	535.08	2002.1	2537.2	2537.2	535.34	2181.5	2716.9	1.6072	5.4455	7.0526

Presión MPa P	Temp. °C T	Volumen específico, m³/kg			Energía interna, kJ/kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado v <sub>f</sub>	Vapor saturado v <sub>g</sub>	Vapor saturado v <sub>fg</sub>	Líquido saturado u <sub>f</sub>	Evap. u <sub>fg</sub>	Vapor saturado u <sub>g</sub>	Líquido saturado h <sub>f</sub>	Evap. h <sub>fg</sub>	Vapor saturado h <sub>g</sub>	Líquido saturado s <sub>f</sub>	Evap. s <sub>fg</sub>	Vapor saturado s <sub>g</sub>
0.275	130.60	0.001070	0.6573	548.57	1992.0	2540.5	2540.5	548.87	2172.4	2721.3	1.6407	5.3801	7.0208
0.300	133.55	0.001073	0.6058	561.13	1982.4	2543.6	2543.6	561.45	2163.9	2725.3	1.6717	5.3201	6.9918
0.325	136.30	0.001076	0.5620	572.88	1973.5	2546.3	2546.3	573.23	2155.8	2729.0	1.7005	5.2646	6.9651
0.350	138.88	0.001079	0.5243	583.93	1965.0	2548.9	2548.9	584.31	2148.1	2732.4	1.7274	5.2130	6.9404
0.375	141.32	0.001081	0.4914	594.38	1956.9	2551.3	2551.3	594.79	2140.8	2735.6	1.7527	5.1647	6.9174
0.40	143.63	0.001084	0.4625	604.29	1949.3	2553.6	2553.6	604.73	2133.8	2738.5	1.7766	5.1193	6.8958
0.45	147.93	0.001088	0.4140	622.75	1934.9	2557.6	2557.6	623.24	2120.7	2743.9	1.8206	5.0359	6.8565
0.50	151.86	0.001093	0.3749	639.66	1921.6	2561.2	2561.2	640.21	2108.5	2748.7	1.8606	4.9606	6.8212
0.55	155.48	0.001097	0.3427	655.30	1909.2	2564.5	2564.5	655.91	2097.0	2752.9	1.8972	4.8920	6.7892
0.60	158.85	0.001101	0.3157	669.88	1897.5	2567.4	2567.4	670.54	2086.3	2756.8	1.9311	4.8289	6.7600
0.65	162.01	0.001104	0.2927	683.55	1886.5	2570.1	2570.1	684.26	2076.0	2760.3	1.9627	4.7704	6.7330
0.70	164.97	0.001108	0.2729	696.43	1876.1	2572.5	2572.5	697.20	2066.3	2763.5	1.9922	4.7158	6.7080
0.75	167.77	0.001111	0.2556	708.62	1866.1	2574.7	2574.7	709.45	2057.0	2766.4	2.0199	4.6647	6.6846
0.80	170.43	0.001115	0.2404	720.20	1856.6	2576.8	2576.8	721.10	2048.0	2769.1	2.0461	4.6166	6.6627
0.85	172.96	0.001118	0.2270	731.25	1847.4	2578.7	2578.7	732.00	2039.4	2771.6	2.0709	4.5711	6.6421
0.90	175.38	0.001121	0.2150	741.81	1838.7	2580.5	2580.5	742.82	2031.1	2773.9	2.0946	4.5280	6.6225
0.95	177.69	0.001124	0.2042	751.94	1830.2	2582.1	2582.1	753.00	2023.1	2776.1	2.1171	4.4869	6.6040
1.00	184.09	0.001133	0.19444	761.67	1822.0	2583.6	2583.6	762.79	2015.3	2778.1	2.1386	4.4478	6.5864
1.20	187.99	0.001139	0.16333	797.27	1791.6	2588.8	2588.8	798.64	1986.2	2784.8	2.2165	4.3067	6.5233
1.30	191.64	0.001144	0.15125	813.42	1777.5	2590.9	2590.9	814.91	1972.7	2787.6	2.2514	4.2438	6.4953
1.40	195.07	0.001149	0.14084	828.68	1764.1	2592.8	2592.8	830.29	1959.7	2790.0	2.2842	4.1850	6.4692
1.50	198.32	0.001154	0.13177	843.14	1751.3	2594.5	2594.5	844.87	1947.3	2792.1	2.3150	4.1298	6.4448
1.75	205.76	0.001166	0.11349	876.44	1721.4	2597.8	2597.8	878.48	1918.0	2796.4	2.3851	4.0044	6.3895
2.00	212.42	0.001177	0.09963	906.42	1693.8	2600.3	2600.3	908.77	1890.7	2799.5	2.4473	3.8935	6.3408
2.25	218.45	0.001187	0.08875	933.81	1668.2	2602.0	2602.0	936.48	1865.2	2801.7	2.5034	3.7938	6.2971

TABLA A.1.2SI (Continuación) Agua saturada: tabla de presión (unidades SI)

Presión MPa <i>P</i>	Temp. °C <i>T</i>	Volumen específico, m³/kg			Energía interna, kJ/kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado <i>v<sub>f</sub></i>	Vapor saturado <i>v<sub>g</sub></i>	Líquido saturado <i>u<sub>f</sub></i>	Evap. <i>u<sub>fg</sub></i>	Vapor saturado <i>u<sub>g</sub></i>	Líquido saturado <i>h<sub>f</sub></i>	Evap. <i>h<sub>fg</sub></i>	Vapor saturado <i>h<sub>g</sub></i>	Líquido saturado <i>s<sub>f</sub></i>	Evap. <i>s<sub>fg</sub></i>	Vapor saturado <i>s<sub>g</sub></i>	
2.50	223.99	0.001197	0.07998	959.09	1644.0	2603.1	962.09	1841.0	2803.1	2.5546	3.7028	6.2574	
2.75	229.12	0.001207	0.07275	982.65	1621.2	2603.8	985.97	1817.9	2803.9	2.6018	3.6190	6.2208	
3.00	233.90	0.001216	0.06668	1004.76	1599.3	2604.1	1008.41	1795.7	2804.1	2.6456	3.5412	6.1869	
3.25	238.38	0.001226	0.06152	1025.62	1578.4	2604.0	1029.60	1774.4	2804.0	2.6866	3.4685	6.1551	
3.50	242.60	0.001235	0.05707	1045.41	1558.3	2603.7	1049.73	1753.7	2803.4	2.7252	3.4000	6.1252	
4.0	250.40	0.001252	0.04978	1082.28	1520.0	2602.3	1087.29	1714.1	2801.4	2.7963	3.2737	6.0700	
5.0	263.99	0.001286	0.03944	1147.78	1449.3	2597.1	1154.21	1640.1	2794.3	2.9201	3.0532	5.9733	
6.0	275.64	0.001319	0.03240	1205.41	1384.3	2589.7	1213.32	1571.0	2784.3	3.0266	2.8625	5.8891	
7.0	285.88	0.001351	0.02730	1257.51	1323.0	2580.5	1266.97	1505.1	2772.1	3.1210	2.6922	5.8132	
8.0	295.06	0.001384	0.02351	1305.54	1264.3	2569.8	1316.61	1441.3	2757.9	3.2067	2.5365	5.7431	
9.0	303.40	0.001418	0.02048	1350.47	1207.3	2557.8	1363.23	1378.9	2742.1	3.2857	2.3915	5.6771	
10.0	311.06	0.001452	0.01802	1393.00	1151.4	2544.4	1407.53	1317.1	2724.7	3.3595	2.2545	5.6140	
11.0	318.15	0.001489	0.01598	1433.68	1096.1	2529.7	1450.05	1255.5	2705.6	3.4294	2.1233	5.5527	
12.0	324.75	0.001527	0.01426	1472.92	1040.8	2513.7	1491.24	1193.6	2684.8	3.4961	1.9962	5.4923	
13.0	330.93	0.001567	0.01278	1511.09	985.0	2496.1	1531.46	1130.8	2662.2	3.5604	1.8718	5.4323	
14.0	336.75	0.001611	0.01148	1548.53	928.2	2476.8	1571.08	1066.5	2637.5	3.6231	1.7485	5.3716	
15.0	342.24	0.001658	0.01038	1585.58	869.8	2455.4	1610.45	1000.0	2610.5	3.6847	1.6250	5.3097	
16.0	347.43	0.001711	0.00930	1622.63	809.1	2431.7	1650.00	930.6	2580.6	3.7460	1.4995	5.2454	
17.0	352.37	0.001770	0.00836	1660.16	744.8	2405.0	1690.25	856.9	2547.2	3.8078	1.3698	5.1776	
18.0	357.06	0.001840	0.00749	1698.86	675.4	2374.3	1731.97	777.1	2509.1	3.8713	1.2330	5.1044	
19.0	361.54	0.001924	0.00665	1739.87	598.2	2338.1	1776.43	688.1	2464.5	3.9387	1.0841	5.0227	
20.0	365.81	0.002035	0.00583	1785.47	507.6	2299.1	1826.18	583.6	2409.7	4.0137	0.9132	4.9269	
21.0	369.89	0.002206	0.00495	1841.97	388.7	2230.7	1888.30	446.4	2334.7	4.1073	0.6942	4.8015	
22.0	373.80	0.002808	0.00352	1973.16	108.2	2081.4	2034.92	124.0	2159.0	4.3307	0.1917	4.5224	
22.09	374.14	0.003155	0.00315	2029.58	0	2029.6	2099.26	0	2099.3	4.4297	0	4.4297	

TABLA A.1.3SI Vapor de agua sobrecalentado (unidades SI)

<i>T</i>	<i>P</i> = 10 kPa (45.81)			<i>P</i> = 50 kPa (81.33)			<i>P</i> = 100 kPa (99.62)			<i>P</i> = 400 kPa (143.63)			
	<i>v</i>	<i>u</i>	<i>h</i>	<i>v</i>	<i>u</i>	<i>h</i>	<i>v</i>	<i>u</i>	<i>h</i>	<i>v</i>	<i>u</i>	<i>h</i>	<i>s</i>
Sat.	14.674	2437.9	2584.6	8.1501	3.240	2483.8	2645.9	7.5939	1.6940	2506.1	2673.5	7.3593	
50	14.869	2443.9	2592.6	8.1749									
100	17.196	2515.5	2687.5	8.4479	3.418	2511.6	2682.5	7.6947	1.6958	2506.6	2676.2	7.3614	
150	19.513	2587.9	2783.0	8.6881	3.889	2585.6	2780.1	7.9400	1.9364	2582.7	2776.4	7.6133	
200	21.825	2661.3	2879.5	8.9037	4.356	2659.8	2877.6	8.1579	2.1723	2658.0	2875.3	7.8342	
250	24.136	2736.0	2977.3	9.1002	4.821	2735.0	2976.0	8.3555	2.4060	2733.7	2974.3	8.0332	
300	26.445	2812.1	3076.5	9.2812	5.284	2811.3	3075.5	8.5372	2.6388	2810.4	3074.3	8.2157	
400	31.063	2968.9	3279.5	9.6076	6.209	2968.4	3278.9	8.8641	3.1026	2967.8	3278.1	8.5434	
500	35.679	3132.3	3489.0	9.8977	7.134	3131.9	3488.6	9.1545	3.5655	3131.5	3488.1	8.8341	
600	40.295	3302.5	3705.4	10.1608	8.058	3479.5	3705.1	9.4177	4.0278	3301.9	3704.7	9.0975	
700	44.911	3479.6	3928.7	10.4028	8.981	3663.7	4158.9	9.6599	4.4899	3479.2	3928.2	9.3398	
800	49.526	3663.8	4159.1	10.6281	9.904	3854.9	4396.3	9.8852	4.9517	3663.5	4158.7	9.5652	
900	54.141	3855.0	4396.4	10.8395	10.828	4052.9	4640.5	10.0967	5.4135	3854.8	4396.1	9.7767	
1000	58.757	4053.0	4640.6	11.0392	11.751	4257.4	4891.1	10.2964	5.8753	4052.8	4640.3	9.9764	
1100	63.372	4257.5	4891.2	11.2287	12.674	4467.8	5147.7	10.4858	6.3370	4257.3	4890.9	10.1658	
1200	67.987	4467.9	5147.8	11.4090	13.597	4683.6	5409.6	10.6662	6.7986	4467.7	5147.6	10.3462	
1300	72.603	4683.7	5409.7	11.5810	14.521	4963.6	5809.6	10.8382	7.2603	4683.5	5409.5	10.5182	
Sat.	0.88573	2529.5	2706.6	7.1271	0.60582	2543.6	2725.3	6.9918	0.46246	2553.6	2738.5	6.8958	
150	0.95964	2576.9	2768.8	7.2795	0.63388	2570.8	2761.0	7.0778	0.47084	2564.5	2752.8	6.9299	
200	1.08034	2654.4	2870.5	7.5066	0.71629	2650.7	2865.5	7.3115	0.53422	2646.8	2860.5	7.1706	
250	1.19880	2731.2	2971.0	7.7085	0.79636	2728.7	2967.6	7.5165	0.59512	2726.1	2964.2	7.3788	
300	1.31616	2808.6	3071.8	7.8926	0.87529	2806.7	3069.3	7.7022	0.65484	2804.8	3066.7	7.5661	
400	1.54930	2966.7	3276.5	8.2217	1.03151	2965.0	3275.0	8.0329	0.77262	2964.4	3273.4	7.8984	
500	1.78139	3130.7	3487.0	8.5132	1.18669	3130.0	3486.0	8.3250	0.88934	3129.2	3484.9	8.1912	
600	2.01297	3301.4	3704.0	8.7769	1.34136	3300.8	3703.2	8.5892	1.00555	3300.2	3702.4	8.4557	
700	2.24426	3478.8	3927.7	9.0194	1.49573	3478.4	3927.1	8.8319	1.12147	3477.9	3926.5	8.6987	
800	2.47539	3663.2	4158.3	9.2450	1.64994	3662.9	4157.8	9.0575	1.23722	3662.5	4157.4	8.9244	



■ TABLA A.1.SI (Continuación) Vapor de agua sobrecalentado (unidades SI)

T	P = 2.50 MPa (223.99)				P = 3.00 MPa (233.90)				P = 3.50 MPa (242.60)			
	v	u	h	s	v	u	h	s	v	u	h	s
800	0.19716	3655.3	4148.2	8.0720	0.16414	3653.6	4146.0	7.9862	0.14056	3651.8	4143.8	7.9135
900	0.21590	3847.9	4387.6	8.2853	0.17980	3846.5	4385.9	8.1999	0.15402	3845.0	4384.1	8.1275
1000	0.23458	4046.7	4633.1	8.4860	0.19541	4045.4	4631.6	8.4009	0.16743	4044.1	4630.1	8.3288
1100	0.25322	4251.5	4884.6	8.6761	0.21098	4250.3	4883.3	8.5911	0.18080	4249.1	4881.9	8.5191
1200	0.27185	4462.1	5141.7	8.8569	0.22652	4460.9	5140.5	8.7719	0.19415	4459.8	5139.3	8.7000
1300	0.29046	4677.8	5404.0	9.0291	0.24206	4676.6	5402.8	8.9442	0.20749	4675.5	5401.7	8.8723

  

T	P = 4.00 MPa (250.40)				P = 4.50 MPa (257.48)				P = 5.00 MPa (263.99)			
	v	u	h	s	v	u	h	s	v	u	h	s
Sat.	0.04978	2602.3	2801.4	6.0700	0.04406	2600.0	2798.3	6.0198	0.03944	2597.1	2794.3	5.9733
275	0.05457	2667.9	2886.2	6.2284	0.04730	2650.3	2863.1	6.1401	0.04141	2631.2	2838.3	6.0543
300	0.05884	2725.3	2960.7	6.3614	0.05135	2712.0	2943.1	6.2827	0.04532	2697.9	2924.5	6.2083
350	0.06645	2826.6	3092.4	6.5820	0.05840	2817.8	3080.6	6.5130	0.05194	2808.7	3068.4	6.4492
400	0.07341	2919.9	3213.5	6.7689	0.06475	2913.3	3204.7	6.7046	0.05781	2906.6	3195.6	6.6458
450	0.08003	3010.1	3330.2	6.9362	0.07074	3004.9	3323.2	6.8745	0.06330	2999.6	3316.1	6.8185
500	0.08643	3099.5	3445.2	7.0900	0.07651	3095.2	3439.5	7.0300	0.06857	3090.9	3433.8	6.9758
600	0.09885	3279.1	3674.4	7.3688	0.08765	3276.0	3670.5	7.3109	0.07869	3273.0	3666.5	7.2588
700	0.11095	3462.1	3905.9	7.6198	0.09847	3459.9	3903.0	7.5631	0.08849	3457.7	3900.1	7.5122
800	0.12287	3650.1	4141.6	7.8502	0.10911	3648.4	4139.4	7.7942	0.09811	3646.6	4137.2	7.7440
900	0.13469	3843.6	4382.3	8.0647	0.11965	3842.1	4380.6	8.0091	0.10762	3840.7	4378.8	7.9593
1000	0.14645	4042.9	4628.7	8.2661	0.13013	4041.6	4627.2	8.2108	0.11707	4040.3	4625.7	8.1612
1100	0.15817	4248.0	4880.6	8.4566	0.14056	4246.8	4879.3	8.4014	0.12648	4245.6	4878.0	8.3519
1200	0.16987	4458.6	5138.1	8.6376	0.15098	4457.4	5136.9	8.5824	0.13587	4456.3	5135.7	8.5330
1300	0.18156	4674.3	5400.5	8.8099	0.16139	4673.1	5399.4	8.7548	0.14526	4672.0	5398.2	8.7055

  

T	P = 6.00 MPa (275.64)				P = 7.00 MPa (285.88)				P = 8.00 MPa (295.06)			
	v	u	h	s	v	u	h	s	v	u	h	s
Sat.	0.03244	2589.7	2784.3	5.8891	0.02737	2580.5	2772.1	5.8132	0.02352	2569.8	2757.9	5.7431
300	0.03616	2667.2	2884.2	6.0673	0.02947	2632.1	2838.4	5.9304	0.02426	2590.9	2785.0	5.7905
350	0.04223	2789.6	3043.0	6.3334	0.03524	2769.3	3016.0	6.2282	0.02995	2747.7	2987.3	6.1300
400	0.04739	2892.8	3177.2	6.5407	0.03993	2878.6	3158.1	6.4477	0.03432	2863.8	3138.3	6.3633
450	0.05214	2988.9	3301.8	6.7192	0.04416	2977.9	3287.0	6.6326	0.03817	2966.7	3272.0	6.5550
500	0.05665	3082.2	3422.1	6.8802	0.04814	3073.3	3410.3	6.7974	0.04175	3064.3	3398.3	6.7239

T	P = 6.00 MPa (275.64)				P = 7.00 MPa (285.88)				P = 8.00 MPa (295.06)			
	v	u	h	s	v	u	h	s	v	u	h	s
550	0.06101	3174.6	3540.6	7.0287	0.05195	3167.2	3530.9	6.9486	0.04516	3159.8	3521.0	6.8778
600	0.06525	3266.9	3658.4	7.1676	0.05565	3260.7	3650.3	7.0894	0.04845	3254.4	3642.0	7.0205
700	0.07352	3453.2	3894.3	7.4234	0.06283	3448.6	3888.4	7.3476	0.05481	3444.0	3882.5	7.2812
800	0.08160	3643.1	4132.7	7.6566	0.06981	3639.6	4128.3	7.5822	0.06097	3636.1	4123.8	7.5173
900	0.08958	3837.8	4375.3	7.8727	0.07669	3835.0	4371.8	7.7991	0.06702	3832.1	4368.3	7.7350
1000	0.09749	4037.8	4622.7	8.0751	0.08350	4035.3	4619.8	8.0020	0.07301	4032.8	4616.9	7.9384
1100	0.10536	4243.3	4875.4	8.2661	0.09027	4240.9	4872.8	8.1933	0.07896	4238.6	4870.3	8.1299
1200	0.11321	4454.0	5133.3	8.4473	0.09703	4451.7	5130.9	8.3747	0.08489	4449.4	5128.5	8.3115
1300	0.12106	4669.6	5396.0	8.6199	0.10377	4667.3	5393.7	8.5472	0.09080	4665.0	5391.5	8.4842

  

T	P = 9.00 MPa (303.40)				P = 10.00 MPa (311.06)				P = 12.50 MPa (327.89)			
	v	u	h	s	v	u	h	s	v	u	h	s
Sat.	0.02048	2557.8	2742.1	5.6771	0.01803	2544.4	2724.7	5.6140	0.01350	2505.1	2673.8	5.4623
325	0.02327	2646.5	2855.9	5.8711	0.01986	2610.4	2809.0	5.7568	—	—	—	—
350	0.02580	2724.4	2956.5	6.0361	0.02242	2699.2	2923.4	5.9442	0.01613	2624.6	2826.2	5.7117
400	0.02993	2848.4	3117.8	6.2853	0.02641	2832.4	3096.5	6.2119	0.02000	2789.3	3039.3	6.0416
450	0.03350	2955.1	3256.6	6.4843	0.02975	2943.3	3240.8	6.4189	0.02299	2912.4	3199.8	6.2718
500	0.03677	3055.1	3386.1	6.6575	0.03279	3045.8	3373.6	6.5965	0.02560	3021.7	3341.7	6.4617
550	0.03987	3152.2	3511.0	6.8141	0.03564	3144.5	3500.9	6.7561	0.02801	3124.9	3475.1	6.6289
600	0.04285	3248.1	3633.7	6.9588	0.03837	3241.7	3625.3	6.9028	0.03029	3225.4	3604.0	6.7810
650	0.04574	3343.7	3755.3	7.0943	0.04101	3338.2	3748.3	7.0397	0.03248	3324.4	3730.4	6.9218
700	0.04857	3439.4	3876.5	7.2221	0.04358	3434.7	3870.5	7.1687	0.03460	3422.9	3855.4	7.0536
800	0.05409	3632.5	4119.4	7.4597	0.04859	3629.0	4114.9	7.4077	0.03869	3620.0	4103.7	7.2965
900	0.05950	3829.2	4364.7	7.6782	0.05349	3826.3	4361.2	7.6272	0.04267	3819.1	4352.5	7.5181
1000	0.06485	4030.3	4613.9	7.8821	0.05832	4027.8	4611.0	7.8315	0.04658	4021.6	4603.8	7.7237
1100	0.07016	4236.3	4867.7	8.0739	0.06312	4234.0	4865.1	8.0236	0.05045	4228.2	4858.8	7.9165
1200	0.07544	4447.2	5126.2	8.2556	0.06789	4444.9	5123.8	8.2054	0.05430	4439.3	5118.0	8.0987
1300	0.08072	4662.7	5389.2	8.4283	0.07265	4660.4	5387.0	8.3783	0.05813	4654.8	5381.4	8.2717

  

T	P = 15 MPa (342.24)				P = 17.5 MPa (354.75)				P = 20 MPa (365.81)			
	v	u	h	s	v	u	h	s	v	u	h	s
Sat.	0.10338	2455.4	2610.5	5.3097	0.079204	2390.2	2528.8	5.1418	.0058342	2293.1	2409.7	4.9269
350	0.11470	2520.4	2692.4	5.4420	—	—	—	—	—	—	—	—
400	0.15649	2740.7	2975.4	5.8810	0.124477	2685.0	2902.8	5.7212	0.099423	2619.2	2818.1	5.5539
450	0.18446	2879.5	3156.2	6.1403	0.151740	2844.2	3109.7	6.0182	0.126953	2806.2	3060.1	5.9016
500	0.20800	2996.5	3308.5	6.3442	0.173585	2970.3	3274.0	6.2382	0.147683	2942.8	3238.2	6.1400
550	0.22927	3104.7	3448.6	6.5198	0.192877	3083.8	3421.4	6.4229	0.165553	3062.3	3393.5	6.3347
600	0.24911	3208.6	3582.3	6.6775	0.210640	3191.5	3560.1	6.5866	0.181781	3174.0	3537.6	6.5048
650	0.26797	3310.4	3712.3	6.8223	0.227372	3296.9	3693.9	6.7356	0.196929	3281.5	3675.3	6.6582

TABLA A.1.3SI (Continuación) Vapor de agua sobrecalentado (unidades SI)

T	P = 15 MPa (342.24)					P = 17.5 MPa (354.75)					P = 20 MPa (365.81)				
	v	u	h	s		v	u	h	s		v	u	h	s	
700	.028612	3410.9	3840.1	6.9572	.0243365	3398.8	3824.7	6.8736	.0211311	3386.5	3809.1	6.7993			
800	.032096	3611.0	4092.4	7.2040	.0273849	3601.9	4081.1	7.1245	.0238532	3592.7	4069.8	7.0544			
900	.035457	3811.9	4343.8	7.4279	.0303071	3804.7	4335.1	7.3507	.0264463	3797.4	4326.4	7.2830			
1000	.038748	4015.4	4596.6	7.6347	.0331580	4009.3	4589.5	7.5588	.0289666	4003.1	4582.5	7.4925			
1100	.042001	4222.6	4852.6	7.8282	.0359695	4216.9	4846.4	7.7530	.0314471	4211.3	4840.2	7.6874			
1200	.045233	4433.8	5112.3	8.0108	.0387605	4428.3	5106.6	7.9359	.0339071	4422.8	5101.0	7.8706			
1300	.048455	4649.1	5375.9	8.1839	.0415417	4643.5	5370.5	8.1093	.0363574	4638.0	5365.1	8.0441			
	P = 25 MPa					P = 30 MPa					P = 35 MPa				
375	.001973	1798.6	1847.9	4.0319	.001789	1737.8	1791.4	3.9303	.001700	1702.9	1762.4	3.8721			
400	.006004	2430.1	2580.2	5.1418	.002790	2067.3	2151.0	4.4728	.002100	1914.0	1987.5	4.2124			
425	.007882	2609.2	2806.3	5.4722	.005304	2455.1	2614.2	5.1503	.003428	2253.4	2373.4	4.7747			
450	.009162	2720.7	2949.7	5.6743	.006735	2619.3	2821.4	5.4423	.004962	2498.7	2672.4	5.1962			
500	.011124	2884.3	3162.4	5.9592	.008679	2820.7	3081.0	5.7904	.006927	2751.9	2994.3	5.6281			
550	.012724	3017.5	3335.6	6.1764	.010168	2970.3	3275.4	6.0342	.008345	2920.9	3213.0	5.9025			
600	.014138	3137.9	3491.4	6.3602	.011446	3100.5	3443.9	6.2330	.009527	3062.0	3395.5	6.1178			
650	.015433	3251.6	3637.5	6.5229	.012596	3221.0	3598.9	6.4057	.010575	3189.8	3559.9	6.3010			
700	.016647	3361.4	3777.6	6.6707	.013661	3335.8	3745.7	6.5606	.011533	3309.9	3713.5	6.4631			
800	.018913	3574.3	4047.1	6.9345	.015623	3555.6	4024.3	6.8332	.013278	3536.8	4001.5	6.7450			
900	.021045	3783.0	4309.1	7.1679	.017448	3768.5	4291.9	7.0717	.014883	3754.0	4274.9	6.9886			
1000	.023102	3990.9	4568.5	7.3801	.019196	3978.8	4554.7	7.2867	.016410	3966.7	4541.1	7.2063			
1100	.025119	4200.2	4828.2	7.5765	.020903	4189.2	4816.3	7.4845	.017895	4178.3	4804.6	7.4056			
1200	.027115	4412.0	5089.9	7.7604	.022589	4401.3	5079.0	7.6691	.019360	4390.7	5068.4	7.5910			
1300	.029101	4626.9	5354.4	7.9342	.024266	4616.0	5344.0	7.8432	.020815	4605.1	5333.6	7.7652			
	P = 40 MPa					P = 50 MPa					P = 60 MPa				
375	.0016406	1677.1	1742.7	3.8289	.0015593	1638.6	1716.5	3.7638	.0015027	1609.3	1699.5	3.7140			
400	.0019077	1854.5	1930.8	4.1134	.0017309	1798.0	1874.6	4.0030	.0016335	1745.3	1843.4	3.9317			
425	.0025319	2096.8	2198.1	4.5028	.0020071	1959.6	2060.0	4.2733	.0018165	1892.7	2001.7	4.1625			
450	.0036931	2365.1	2512.8	4.9459	.0024862	2159.6	2283.9	4.5883	.0020850	2035.9	2179.0	4.4119			
500	.0056225	2678.4	2903.3	5.4699	.0038924	2525.5	2720.1	5.1725	.0029557	2390.5	2567.9	4.9320			

TABLA A.1.4SI Agua líquida comprimida (unidades SI)

T	P = 5.00 MPa (263.99)					P = 10.00 MPa (311.06)					P = 15.00 MPa (342.24)				
	v	u	h	s		v	u	h	s		v	u	h	s	
600	.0080943	3022.6	3346.4	6.0113	.0061123	2942.0	3247.6	5.8177	.0048345	2861.1	3151.2	5.6451			
650	.0090636	3158.0	3520.6	6.2054	.0069657	3093.6	3441.8	6.0342	.0055953	3028.8	3364.6	5.8829			
700	.0099415	3283.6	3681.3	6.3750	.0077274	3230.5	3616.9	6.2189	.0062719	3177.3	3553.6	6.0824			
800	.0115228	3517.9	3978.8	6.6662	.0090761	3479.8	3933.6	6.5290	.0074588	3441.6	3889.1	6.4110			
900	.0129626	3739.4	4257.9	6.9150	.0102831	3710.3	4224.4	6.7882	.0085083	3681.0	4191.5	6.6805			
1000	.0143238	3954.6	4527.6	7.1356	.0114113	3930.5	4501.1	7.0146	.0094800	3906.4	4475.2	6.9126			
1100	.0156426	4167.4	4793.1	7.3364	.0124966	4145.7	4770.6	7.2183	.0104091	4124.1	4748.6	7.1194			
1200	.0169403	4380.1	5057.7	7.5224	.0135606	4359.1	5037.2	7.4058	.0113167	4338.2	5017.2	7.3082			
1300	.0182292	4594.3	5323.5	7.6969	.0146159	4572.8	5303.6	7.5807	.0122155	4551.4	5284.3	7.4837			
	P = 5.00 MPa (263.99)					P = 10.00 MPa (311.06)					P = 15.00 MPa (342.24)				
Sat.	.0012859	1147.78	1154.21	2.9201	.0014524	1393.00	1407.53	3.3595	.0016581	1585.58	1610.45	3.6847			
0	.0009977	0.03	5.02	0.0001	.0009952	0.10	10.05	0.0003	.0009928	0.15	15.04	0.0004			
20	.0009995	83.64	88.64	0.2955	.0009972	83.35	93.32	0.2945	.0009950	83.05	97.97	0.2934			
40	.0010056	166.93	171.95	0.5705	.0010034	166.33	176.36	0.5685	.0010013	165.73	180.75	0.5665			
60	.0010149	250.21	255.28	0.8284	.0010127	249.34	259.47	0.8258	.0010105	248.49	263.65	0.8231			
80	.0010268	333.69	338.83	1.0719	.0010245	332.56	342.81	1.0687	.0010222	331.46	346.79	1.0655			
100	.0010410	417.50	422.71	1.3030	.0010385	416.09	426.48	1.2992	.0010361	414.72	430.26	1.2954			
120	.0010576	501.79	507.07	1.5232	.0010549	500.07	510.61	1.5188	.0010522	498.39	514.17	1.5144			
140	.0010768	586.74	592.13	1.7342	.0010737	584.67	595.40	1.7291	.0010707	582.64	598.70	1.7241			
160	.0010988	672.61	678.10	1.9374	.0010953	670.11	681.07	1.9316	.0010918	667.69	684.07	1.9259			
180	.0011240	759.62	765.24	2.1341	.0011199	756.63	767.83	2.1274	.0011159	753.74	770.48	2.1209			
200	.0011530	848.08	853.85	2.3254	.0011480	844.49	855.97	2.3178	.0011433	841.04	858.18	2.3103			
220	.0011866	938.43	944.36	2.5128	.0011805	934.07	945.88	2.5038	.0011748	929.89	947.52	2.4952			
240	.0012264	1031.34	1037.47	2.6978	.0012187	1025.94	1038.13	2.6872	.0012114	1020.82	1038.99	2.6770			

TABLA A.1.4SI (Continuación) Agua líquida comprimida (unidades SI)

T	P = 5.00 MPa (263.99)					P = 10.00 MPa (311.06)					P = 15.00 MPa (342.24)				
	v	u	h	s		v	u	h	s		v	u	h	s	
	m³/kg	kJ/kg	kJ/kg	kJ/kg·K		m³/kg	kJ/kg	kJ/kg	kJ/kg·K		m³/kg	kJ/kg	kJ/kg	kJ/kg·K	
260	.0012748	1127.92	1134.30	2.8829	.0012645	1121.03	1133.68	2.8698	.0012550	1114.59	1133.41	2.8575			
280	.0013216	1220.90	1234.11	3.0547	.0013216	1220.90	1234.11	3.0547	.0013084	1212.47	1232.09	3.0392			
300	.0013972	1328.34	1342.31	3.2468	.0013972	1328.34	1342.31	3.2468	.0013770	1316.58	1337.23	3.2259			
320	.0014724	1431.05	1453.13	3.4246	.0014724	1431.05	1453.13	3.4246	.0014724	1431.05	1453.13	3.4246			
340	.0016311	1567.42	1591.88	3.6545	.0016311	1567.42	1591.88	3.6545	.0016311	1567.42	1591.88	3.6545			
P = 20 MPa (365.81)															
Sat.	.0020353	1785.47	1826.18	4.0137	—	—	—	—	—	—	—	—	—	—	
0	.0009904	0.20	20.00	0.0004	.0009856	0.25	29.82	0.0001	.0009766	0.20	49.03	-0.0014			
20	.0009928	82.75	102.61	0.2922	.0009886	82.16	111.82	0.2898	.0009804	80.98	130.00	0.2847			
40	.0009992	165.15	185.14	0.5646	.0009951	164.01	193.87	0.5606	.0009872	161.84	211.20	0.5526			
60	.0010084	247.66	267.82	0.8205	.0010042	246.03	276.16	0.8153	.0009962	242.96	292.77	0.8051			
80	.0010199	330.38	350.78	1.0623	.0010156	328.28	358.75	1.0561	.0010073	324.32	374.68	1.0439			
100	.0010337	413.37	434.04	1.2917	.0010290	410.76	441.63	1.2844	.0010201	405.86	456.87	1.2703			
120	.0010496	496.75	517.74	1.5101	.0010445	493.58	524.91	1.5017	.0010348	487.63	539.37	1.4857			
140	.0010678	580.67	602.03	1.7192	.0010621	576.86	608.73	1.7097	.0010515	569.76	622.33	1.6915			
160	.0010885	665.34	687.11	1.9203	.0010821	660.81	693.27	1.9095	.0010703	652.39	705.91	1.8890			
180	.0011120	750.94	773.18	2.1146	.0011047	745.57	778.71	2.1024	.0010912	735.68	790.24	2.0793			
200	.0011387	837.70	860.47	2.3031	.0011302	831.34	865.24	2.2892	.0011146	819.73	875.46	2.2634			
220	.0011693	925.89	949.27	2.4869	.0011590	918.32	953.09	2.4710	.0011408	904.67	961.71	2.4419			
240	.0012046	1015.94	1040.04	2.6673	.0011920	1006.84	1042.60	2.6489	.0011702	990.69	1049.20	2.6158			
260	.0012462	1108.53	1133.45	2.8459	.0012303	1097.38	1134.29	2.8242	.0012034	1078.06	1138.23	2.7860			
280	.0012965	1204.69	1230.62	3.0248	.0012755	1190.69	1228.96	2.9985	.0012415	1167.19	1229.26	2.9536			
300	.0013596	1306.10	1333.29	3.2071	.0013304	1287.89	1327.80	3.1740	.0012860	1258.66	1322.95	3.1200			
320	.0014437	1415.66	1444.53	3.3978	.0013997	1390.64	1432.63	3.3538	.0013388	1353.23	1420.17	3.2867			
340	.0015683	1539.64	1571.01	3.6074	.0014919	1501.71	1546.47	3.5425	.0014032	1451.91	1522.07	3.4556			
360	.0018226	1702.78	1739.23	3.8770	.0016265	1626.57	1675.36	3.7492	.0014838	1555.97	1630.16	3.6290			
380	—	—	—	—	.0018691	1781.35	1837.43	4.0010	.0015883	1667.13	1746.54	3.8100			

TABLA A.1.5SI Agua sólida saturado-vapor saturado (unidades SI)

Temp. °C T	Volumen específico, m³/kg			Energía interna, kJ/kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
	Presión kPa, P	Sólido saturado v <sub>f</sub> × 10 <sup>-3</sup>	Vapor saturado v <sub>g</sub>	Sólido saturado u <sub>f</sub>	Vapor saturado u <sub>g</sub>		Sólido saturado h <sub>f</sub>	Vapor saturado h <sub>g</sub>		Sólido saturado s <sub>f</sub>	Vapor saturado s <sub>g</sub>	
0.01	0.6113	1.0908	206.153	-333.40	2708.7	2375.3	-333.40	2834.7	2501.3	-1.2210	10.3772	9.1562
0	0.6108	1.0908	206.315	-333.42	2708.7	2375.3	-333.42	2834.8	2501.3	-1.2211	10.3776	9.1565
-2	0.5177	1.0905	241.663	-337.61	2710.2	2372.5	-337.61	2835.3	2497.6	-1.2369	10.4562	9.2193
-4	0.4376	1.0901	283.799	-341.78	2711.5	2369.8	-341.78	2835.7	2494.0	-1.2526	10.5358	9.2832
-6	0.3689	1.0898	334.139	-345.91	2712.9	2367.0	-345.91	2836.2	2490.3	-1.2683	10.6165	9.3482
-8	0.3102	1.0894	394.414	-350.02	2714.2	2364.2	-350.02	2836.6	2486.6	-1.2839	10.6982	9.4143
-10	0.2601	1.0891	466.757	-354.09	2715.5	2361.4	-354.09	2837.0	2479.2	-1.2995	10.7809	9.4815
-12	0.2176	1.0888	553.803	-358.14	2716.8	2358.7	-358.14	2837.3	2475.5	-1.3150	10.8648	9.5498
-14	0.1815	1.0884	658.824	-362.16	2718.0	2355.9	-362.16	2837.6	2471.8	-1.3306	10.9498	9.6192
-16	0.1510	1.0881	785.907	-366.14	2719.2	2353.1	-366.14	2837.9	2468.1	-1.3461	11.0359	9.6898
-18	0.1252	1.0878	940.183	-370.10	2720.4	2350.3	-370.10	2838.2	2464.3	-1.3617	11.1233	9.7616
-20	0.10355	1.0874	1128.113	-374.03	2721.6	2347.5	-374.03	2838.4	2460.6	-1.3772	11.2120	9.8348
-22	0.08535	1.0871	1357.864	-377.93	2722.7	2344.7	-377.93	2838.6	2456.9	-1.3928	11.3020	9.9093
-24	0.07012	1.0868	1639.753	-381.80	2723.7	2342.0	-381.80	2838.7	2453.2	-1.4083	11.3935	9.9852
-26	0.05741	1.0864	1986.776	-385.64	2724.8	2339.2	-385.64	2838.9	2449.5	-1.4239	11.4864	10.0625
-28	0.04684	1.0861	2415.201	-389.45	2725.8	2336.4	-389.45	2839.0	2445.8	-1.4394	11.5808	10.1413
-30	0.03810	1.0858	2945.228	-393.23	2726.8	2333.6	-393.23	2839.0	2442.1	-1.4550	11.6765	10.2215
-32	0.03090	1.0854	3601.823	-396.98	2727.8	2330.8	-396.98	2839.1	2438.4	-1.4705	11.7733	10.3028
-34	0.02499	1.0851	4416.253	-400.71	2728.7	2328.0	-400.71	2839.1	2434.7	-1.4860	11.8713	10.3853
-36	0.02016	1.0848	5430.116	-404.40	2729.6	2325.2	-404.40	2839.1	2431.0	-1.5014	11.9704	10.4690
-38	0.01618	1.0844	6707.022	-408.06	2730.5	2322.4	-408.06	2839.0	2431.0	-1.5168	12.0714	10.5546
-40	0.01286	1.0841	8366.396	-411.70	2731.3	2319.6	-411.70	2838.9	2427.2	-1.5321	12.1768	10.6447



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

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

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

TABLA A.2.SI Amoniaco sobrecalentado (unidades SI)

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

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

TABLA A.2.SI (Continuación) *Amoniaco sobrecalentado (unidades SI)*

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

TABLA A.3.SI *Propiedades termodinámicas del refrigerante-12 (diclorodifluorometano)*  
 TABLA A.3.SI *R-12 saturado (unidades SI)*

Temp. °C	Presión abs. MPa, <i>P</i>	Volumen específico, m <sup>3</sup> /kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado <i>v<sub>f</sub></i>	Líquido saturado <i>v<sub>g</sub></i>	Vapor saturado <i>v<sub>g</sub></i>	Líquido saturado <i>h<sub>f</sub></i>	Evap. <i>h<sub>fg</sub></i>	Vapor saturado <i>h<sub>g</sub></i>	Líquido saturado <i>s<sub>f</sub></i>	Evap. <i>s<sub>fg</sub></i>	Vapor saturado <i>s<sub>g</sub></i>
-90	0.00284	0.000608	4.414937	4.415545	-43.284	189.748	146.464	-0.20863	1.03593	0.82730
-85	0.00424	0.000612	3.036704	3.037316	-39.005	187.737	148.731	-0.18558	0.99771	0.81213
-80	0.00617	0.000617	2.137728	2.138345	-34.721	185.740	151.018	-0.16312	0.96155	0.79843
-75	0.00879	0.000622	1.537030	1.537651	-30.430	183.751	153.321	-0.14119	0.92725	0.78606
-70	0.01227	0.000627	1.126654	1.127280	-26.128	181.764	155.636	-0.11977	0.89465	0.77489
-65	0.01680	0.000632	0.840534	0.841166	-21.814	179.774	157.960	-0.09880	0.86361	0.76480
-60	0.02262	0.000637	0.637274	0.637911	-17.485	177.775	160.289	-0.07827	0.83397	0.75570
-55	0.02998	0.000642	0.490358	0.491000	-13.141	175.762	162.621	-0.05815	0.80563	0.74748
-50	0.03915	0.000648	0.382457	0.383105	-8.779	173.730	164.951	-0.03841	0.77848	0.74007
-45	0.05044	0.000654	0.302029	0.302682	-4.400	171.676	167.276	-0.01903	0.75241	0.73338
-40	0.06417	0.000659	0.241251	0.241910	0	169.595	169.595	0	0.72735	0.72735
-35	0.08071	0.000666	0.194732	0.195398	4.420	167.482	171.903	0.01871	0.70322	0.72193
-30	0.10041	0.000672	0.158703	0.159375	8.862	165.335	174.197	0.03711	0.67993	0.71704
-25	0.12368	0.000679	0.130487	0.131166	13.327	163.149	176.476	0.05522	0.65742	0.71264
-20	0.15093	0.000685	0.108162	0.108847	17.816	160.920	178.736	0.07306	0.63563	0.70869
-15	0.18260	0.000693	0.090326	0.091018	22.331	158.643	180.974	0.09063	0.61450	0.70513
-10	0.21912	0.000700	0.075946	0.076646	26.874	156.314	183.188	0.10796	0.59397	0.70194
-5	0.26096	0.000708	0.064255	0.064963	31.446	153.928	185.375	0.12506	0.57400	0.69907
0	0.30861	0.000716	0.054673	0.055389	36.052	151.479	187.531	0.14196	0.55453	0.69649
5	0.36255	0.000724	0.046761	0.047485	40.694	148.961	189.654	0.15865	0.53551	0.69416
10	0.42330	0.000733	0.040180	0.040914	45.375	146.365	191.740	0.17517	0.51689	0.69206
15	0.49137	0.000743	0.034671	0.035413	50.100	143.684	193.784	0.19154	0.49862	0.69015
20	0.56729	0.000752	0.030028	0.030780	54.874	140.909	195.783	0.20777	0.48064	0.68841
25	0.65162	0.000763	0.026091	0.026854	59.702	138.028	197.730	0.22388	0.46292	0.68680
30	0.74490	0.000774	0.022734	0.023508	64.592	135.028	199.620	0.23991	0.44539	0.68530
35	0.84772	0.000786	0.019855	0.020641	69.551	131.896	201.446	0.25587	0.42800	0.68387
40	0.96065	0.000798	0.017373	0.018171	74.587	128.613	203.200	0.27179	0.41068	0.68248
45	1.08432	0.000811	0.015220	0.016032	79.712	125.160	204.872	0.28771	0.39338	0.68109
50	1.21932	0.000826	0.013344	0.014170	84.936	121.514	206.450	0.30366	0.37601	0.67967
55	1.36630	0.000841	0.011701	0.012542	90.274	117.645	207.920	0.31967	0.35849	0.67817
60	1.52592	0.000858	0.010253	0.011111	95.743	113.521	209.264	0.33580	0.34073	0.67653
65	1.69884	0.000877	0.008971	0.009847	101.362	109.099	210.460	0.35209	0.32262	0.67471

TABLA A.3SI (Continuación) *Propiedades termodinámicas del refrigerante-12 (diclorodifluorometano)*  
 TABLA A.3.1SI (Continuación) *R-12 saturado (unidades SI)*

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

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

Temp. °C	0.05 MPa		0.10 MPa		0.15 MPa	
	v m <sup>3</sup> /kg	h kJ/kg	v m <sup>3</sup> /kg	h kJ/kg	v m <sup>3</sup> /kg	h kJ/kg
-20	0.341859	181.170	0.167702	179.987	0.74064	—
-10	0.356228	186.889	0.175223	185.839	0.76331	184.753
0	0.370509	192.705	0.182648	191.765	0.78541	190.800
10	0.384717	198.614	0.189995	197.770	0.80700	196.906
20	0.398864	204.617	0.197277	203.855	0.82812	203.077
30	0.412960	210.710	0.204507	210.018	0.84879	209.314
40	0.427014	216.891	0.211692	216.262	0.86905	215.621
50	0.441031	223.160	0.218839	222.583	0.8892	221.998
60	0.455018	229.512	0.225956	228.982	0.90842	228.446
70	0.468980	235.946	0.233045	235.457	0.92757	234.963
80	0.482919	242.460	0.240112	242.007	0.94638	241.549
90	0.496839	249.050	0.247160	248.629	0.96487	248.204

Temp. °C	0.20 MPa		0.25 MPa		0.30 MPa	
	v m <sup>3</sup> /kg	h kJ/kg	v m <sup>3</sup> /kg	h kJ/kg	v m <sup>3</sup> /kg	h kJ/kg
0	0.088609	189.805	0.069752	188.779	0.71437	187.718
10	0.092550	196.020	0.073024	195.109	0.73713	194.173
20	0.096419	202.281	0.076219	201.468	0.75920	200.636
30	0.100229	208.597	0.079351	207.866	0.78066	207.119
40	0.103990	214.971	0.082432	214.309	0.80157	213.635
50	0.107710	221.405	0.085470	220.803	0.82198	220.191
60	0.111397	227.902	0.088474	227.351	0.84193	226.793
70	0.115056	234.462	0.091449	233.956	0.86147	233.444
80	0.118691	241.087	0.094399	240.620	0.88061	240.147
90	0.122305	247.775	0.097328	247.341	0.89937	246.904
100	0.125902	254.525	0.100239	254.122	0.91779	253.716
110	0.129484	261.338	0.103135	260.962	0.93588	260.582

  

Temp. °C	0.40 MPa		0.50 MPa		0.60 MPa	
	v m <sup>3</sup> /kg	h kJ/kg	v m <sup>3</sup> /kg	h kJ/kg	v m <sup>3</sup> /kg	h kJ/kg
20	0.045837	198.906	0.035646	197.077	0.70043	—
30	0.047971	205.577	0.037464	203.963	0.72352	202.263
40	0.050046	212.250	0.039215	210.810	0.74574	209.307
50	0.052072	218.939	0.040912	217.643	0.76722	216.300
60	0.054059	225.653	0.042566	224.479	0.78806	223.268
70	0.056014	232.401	0.044185	231.330	0.80832	230.231
80	0.057941	239.188	0.045775	238.206	0.82807	237.201
90	0.059846	246.017	0.047341	245.112	0.84735	244.188
100	0.061731	252.892	0.048886	252.054	0.86621	251.200
110	0.063601	259.815	0.050415	259.035	0.88467	258.242
120	0.065456	266.786	0.051929	266.057	0.90276	265.318
130	0.067299	273.806	0.053430	273.123	0.92050	272.431

  

Temp. °C	0.70 MPa		0.80 MPa		0.90 MPa	
	v m <sup>3</sup> /kg	h kJ/kg	v m <sup>3</sup> /kg	h kJ/kg	v m <sup>3</sup> /kg	h kJ/kg
40	0.026761	207.732	0.022830	206.074	0.70210	204.320
50	0.028100	214.903	0.024068	213.446	0.72527	211.921
60	0.029387	222.017	0.025247	220.720	0.74744	219.373
70	0.030632	229.099	0.026380	227.934	0.76878	226.730
80	0.031843	236.171	0.027477	235.114	0.78940	234.028
90	0.033028	243.244	0.028545	242.279	0.80941	241.290

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

Temp. °C	0.70 MPa		0.80 MPa		1.00 MPa		1.20 MPa		1.40 MPa		
	v m³/kg	h kJ/kg	s kJ/kg K	v m³/kg	h kJ/kg	s kJ/kg K	v m³/kg	h kJ/kg	s kJ/kg K	v m³/kg	
100	0.034189	250.330	0.83976	0.029588	249.443	0.82887	0.026005	248.537	0.81901	0.026005	248.537
110	0.035332	257.436	0.85855	0.030612	256.616	0.84784	0.026937	255.781	0.83817	0.026937	255.781
120	0.036459	264.568	0.87693	0.031619	263.806	0.86636	0.027852	263.032	0.85685	0.027852	263.032
130	0.037572	271.730	0.89492	0.032612	271.019	0.88448	0.028751	270.298	0.87510	0.028751	270.298
140	0.038673	278.925	0.91254	0.033592	278.259	0.90221	0.029639	277.585	0.89295	0.029639	277.585
150	0.039765	286.155	0.92984	0.034563	285.529	0.91960	0.030515	284.896	0.91043	0.030515	284.896
		1.00 MPa			1.20 MPa			1.40 MPa			1.40 MPa
50	0.018366	210.317	0.70259	0.014483	206.813	0.68165	—	—	—	—	—
60	0.019410	217.970	0.72591	0.015463	214.964	0.70649	0.012579	211.613	0.68806	0.012579	211.613
70	0.020397	225.485	0.74814	0.016368	222.851	0.72982	0.013448	219.984	0.71281	0.013448	219.984
80	0.021341	232.910	0.76946	0.017221	230.568	0.75198	0.014247	228.059	0.73601	0.014247	228.059
90	0.022251	240.278	0.79004	0.018032	238.171	0.77321	0.014997	235.940	0.75802	0.014997	235.940
100	0.023133	247.612	0.80996	0.018812	245.699	0.79366	0.015710	243.692	0.77907	0.015710	243.692
110	0.023993	254.931	0.82931	0.019567	253.180	0.81344	0.016393	251.355	0.79934	0.016393	251.355
120	0.024835	262.246	0.84816	0.020301	260.632	0.83265	0.017053	258.961	0.81893	0.017053	258.961
130	0.025661	269.567	0.86655	0.021018	268.072	0.85133	0.017695	266.530	0.83795	0.017695	266.530
140	0.026474	276.902	0.88452	0.021721	275.509	0.86955	0.018321	274.078	0.85644	0.018321	274.078
150	0.027275	284.255	0.90211	0.022412	282.952	0.88735	0.018934	281.618	0.87447	0.018934	281.618
160	0.028068	291.632	0.91933	0.023093	290.408	0.90477	0.019535	289.158	0.89208	0.019535	289.158
		1.60 MPa			1.80 MPa			2.00 MPa			2.00 MPa
70	0.011208	216.810	0.69641	0.009406	213.208	0.67992	—	—	—	—	—
80	0.011984	225.344	0.72092	0.010187	222.363	0.70622	0.008704	219.024	0.69143	0.008704	219.024
90	0.012698	233.563	0.74387	0.010884	231.007	0.73036	0.009406	228.226	0.71713	0.009406	228.226
100	0.013366	241.575	0.76564	0.011525	239.332	0.75297	0.010035	236.936	0.74079	0.010035	236.936
110	0.014000	249.448	0.78646	0.012126	247.446	0.77443	0.010615	245.336	0.76300	0.010615	245.336
120	0.014608	257.225	0.80649	0.012697	255.417	0.79497	0.011159	253.528	0.78411	0.011159	253.528
130	0.015195	264.937	0.82586	0.013244	263.288	0.81474	0.011676	261.577	0.80433	0.011676	261.577
140	0.015765	272.606	0.84465	0.013772	271.090	0.83385	0.012172	269.526	0.82380	0.012172	269.526
150	0.016320	280.250	0.86293	0.014284	278.847	0.85240	0.012651	277.405	0.84265	0.012651	277.405

Temp. °C	1.60 MPa		1.80 MPa		3.00 MPa		3.50 MPa	
	v m³/kg	h kJ/kg	s kJ/kg K	v m³/kg	h kJ/kg	s kJ/kg K	v m³/kg	h kJ/kg
160	0.016864	287.880	0.88076	0.014784	286.574	0.87045	0.013116	285.237
170	0.017398	295.506	0.89816	0.015272	294.284	0.88805	0.013570	293.037
180	0.017923	303.136	0.91519	0.015752	301.988	0.90524	0.014013	300.819
		2.50 MPa			3.00 MPa			3.50 MPa
90	0.006595	219.736	0.68284	—	—	—	—	—
100	0.007264	230.029	0.71081	0.005231	220.723	0.67755	—	—
110	0.007837	239.453	0.73573	0.005886	232.256	0.70806	0.004324	222.360
120	0.008351	248.379	0.75873	0.006419	242.398	0.73420	0.004959	235.086
130	0.008827	256.986	0.78035	0.006887	251.825	0.75788	0.005456	245.865
140	0.009273	265.377	0.80091	0.007313	260.818	0.77991	0.005884	255.728
150	0.009697	273.616	0.82062	0.007709	269.521	0.80072	0.006270	265.053
160	0.010104	281.748	0.83961	0.008083	278.024	0.82059	0.006626	274.027
170	0.010497	289.802	0.85799	0.008439	286.384	0.83967	0.006961	282.759
180	0.010879	297.802	0.87584	0.008782	294.640	0.85809	0.007279	291.319
190	0.011250	305.764	0.89322	0.009114	302.820	0.87594	0.007584	299.752
200	0.011614	313.701	0.91018	0.009436	310.946	0.89330	0.007878	308.092
		4.00 MPa			5.00 MPa			
120	0.003736	225.180	0.67769	0.001369	176.303	0.54710	—	—
130	0.004325	238.691	0.71164	0.002501	216.458	0.64811	—	—
140	0.004781	249.930	0.73918	0.003139	235.004	0.69359	—	—
150	0.005172	260.124	0.76357	0.003585	248.416	0.72568	—	—
160	0.005522	269.710	0.78596	0.003950	259.910	0.75253	—	—
170	0.005845	278.903	0.80694	0.004268	270.400	0.77648	—	—
180	0.006147	287.825	0.82685	0.004555	280.276	0.79851	—	—
190	0.006434	296.552	0.84590	0.004821	289.740	0.81917	—	—
200	0.006708	305.136	0.86424	0.005071	298.916	0.83877	—	—
210	0.006972	313.614	0.88197	0.005308	307.882	0.85753	—	—
220	0.007228	322.013	0.89917	0.005535	316.690	0.87557	—	—
230	0.007477	330.352	0.91592	0.005753	325.380	0.89301	—	—

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

Temp. °C	Presión abs. MPa, P	Volumen específico, m³/kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado v <sub>f</sub>	Vapor saturado v <sub>g</sub>	Líquido saturado h <sub>f</sub>	Evap. h <sub>fg</sub>	Vapor saturado h <sub>g</sub>	Líquido saturado s <sub>f</sub>	Evap. s <sub>fg</sub>	Vapor saturado s <sub>g</sub>	
-70	0.0205	0.000670	0.940938	-30.607	249.425	218.818	-0.1401	1.2277	1.0876	
-65	0.0280	0.000676	0.705472	-25.658	246.925	221.267	-0.1161	1.1862	1.0701	
-60	0.0375	0.000682	0.536470	-20.652	244.354	223.702	-0.0924	1.1463	1.0540	
-55	0.0495	0.000689	0.414138	-15.585	241.703	226.117	-0.0689	1.1079	1.0390	
-50	0.0644	0.000695	0.323862	-10.456	238.965	228.509	-0.0457	1.0708	1.0251	
-45	0.0827	0.000702	0.256288	-5.262	236.132	230.870	-0.0227	1.0349	1.0122	
-40	0.1049	0.000709	0.205036	0	233.198	233.197	0	1.0002	1.0002	
-35	0.1317	0.000717	0.165683	5.328	230.156	235.484	0.0225	0.9664	0.9889	
-30	0.1635	0.000725	0.135844	10.725	227.001	237.726	0.0449	0.9335	0.9784	
-25	0.2010	0.000733	0.111859	16.191	223.727	239.918	0.0670	0.9015	0.9685	
-20	0.2448	0.000741	0.092843	21.728	220.327	242.055	0.0890	0.8703	0.9593	
-15	0.2957	0.000750	0.077625	27.334	216.798	244.132	0.1107	0.8398	0.9505	
-10	0.3543	0.000759	0.0665340	33.012	213.132	246.144	0.1324	0.8099	0.9422	
-5	0.4213	0.000768	0.058339	38.762	209.323	248.085	0.1538	0.7806	0.9344	
0	0.4976	0.000778	0.046571	44.586	205.364	249.949	0.1751	0.7518	0.9269	
5	0.5838	0.000789	0.039567	50.485	201.246	251.731	0.1963	0.7235	0.9197	
10	0.6807	0.000800	0.033914	56.463	196.960	253.423	0.2173	0.6956	0.9129	
15	0.7891	0.000812	0.029176	62.523	192.495	255.018	0.2382	0.6680	0.9062	
20	0.9099	0.000824	0.025179	68.670	187.836	256.506	0.2590	0.6407	0.8997	
25	1.0439	0.000838	0.021787	74.910	182.968	257.877	0.2797	0.6137	0.8934	
30	1.1919	0.000852	0.018890	81.250	177.869	259.119	0.3004	0.5867	0.8871	
35	1.3548	0.000867	0.016401	87.700	172.516	260.216	0.3210	0.5598	0.8809	
40	1.5335	0.000884	0.014251	94.272	166.877	261.149	0.3417	0.5329	0.8746	
45	1.7290	0.000902	0.012382	100.982	160.914	261.896	0.3624	0.5058	0.8682	
50	1.9423	0.000922	0.010747	107.851	154.576	262.428	0.3832	0.4783	0.8615	
55	2.1744	0.000944	0.009308	114.905	147.800	262.705	0.4042	0.4504	0.8546	
60	2.4266	0.000969	0.008032	122.180	140.497	262.678	0.4255	0.4217	0.8472	
65	2.6999	0.000997	0.006890	129.729	132.547	262.276	0.4472	0.3920	0.8391	

Temp. °C	Presión abs. MPa, P	Volumen específico, m³/kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado v <sub>f</sub>	Vapor saturado v <sub>g</sub>	Líquido saturado h <sub>f</sub>	Evap. h <sub>fg</sub>	Vapor saturado h <sub>g</sub>	Líquido saturado s <sub>f</sub>	Evap. s <sub>fg</sub>	Vapor saturado s <sub>g</sub>	
70	2.9959	0.001030	0.006889	137.625	123.772	261.397	0.4695	0.3607	0.8302	
75	3.3161	0.001069	0.005983	145.986	113.902	259.888	0.4927	0.3272	0.8198	
80	3.6623	0.001118	0.004031	155.011	102.475	257.486	0.5173	0.2902	0.8075	
85	4.0368	0.001183	0.003175	165.092	88.598	253.690	0.5445	0.2474	0.7918	
90	4.4425	0.001282	0.003564	177.204	70.037	247.241	0.5767	0.1929	0.7695	
95	4.8835	0.001521	0.002551	196.359	34.925	231.284	0.6273	0.0949	0.7222	
96.006	4.9773	0.001906	0.001906	212.546	0	212.546	0.6708	0	0.6708	

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

Temp. °C	v m³/kg	h kJ/kg	s kJ/kg K	0.10 MPa			0.15 MPa		
				v m³/kg	h kJ/kg	s kJ/kg K	v m³/kg	h kJ/kg	s kJ/kg K
-40	0.440633	234.724	1.07616	0.216331	233.337	1.00523	—	—	—
-30	0.460641	240.602	1.10084	0.226754	239.359	1.03052	0.148723	238.078	0.98773
-20	0.480543	246.586	1.12495	0.237064	245.466	1.05513	0.155851	244.319	1.01288
-10	0.500357	252.676	1.14855	0.247279	251.665	1.07914	0.162879	250.631	1.03733
0	0.520095	258.874	1.17166	0.257415	257.956	1.10261	0.169823	257.022	1.06116
10	0.539771	265.180	1.19433	0.267485	264.345	1.12558	0.176699	263.496	1.08444
20	0.559393	271.594	1.21659	0.277500	270.831	1.14809	0.183516	270.057	1.10721
30	0.578970	278.115	1.23846	0.287467	277.416	1.17017	0.190284	276.709	1.12952
40	0.598507	284.743	1.25998	0.297394	284.101	1.19187	0.197011	283.452	1.15140
50	0.618011	291.478	1.28114	0.307287	290.887	1.21320	0.203702	290.289	1.17289
60	0.637485	298.319	1.30199	0.317149	297.772	1.23418	0.210362	297.220	1.19402
70	0.656935	305.265	1.32253	0.326986	304.757	1.25484	0.216997	304.246	1.21479
80	0.676362	312.314	1.34278	0.336801	311.842	1.27519	0.223608	311.368	1.23525
90	0.695771	319.465	1.36275	0.346596	319.026	1.29524	0.230200	318.584	1.25540
0.20 MPa									
-20	0.115203	243.140	0.98184	—	—	—	—	—	—
-10	0.120647	249.574	1.00676	0.093280	248.492	0.98231	0.078344	247.382	0.96170
0	0.126003	256.069	1.03098	0.099689	255.097	1.00695	0.082128	254.104	0.98677
10	0.131286	262.633	1.05458	0.104022	261.755	1.03089	0.085832	260.861	1.01106
0.30 MPa									

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

Temp. °C	0.20 MPa			0.25 MPa			0.30 MPa		
	v m³/kg	h kJ/kg	s kJ/kg K	v m³/kg	h kJ/kg	s kJ/kg K	v m³/kg	h kJ/kg	s kJ/kg K
20	0.136509	269.273	1.07763	0.108292	268.476	1.05421	0.089469	267.667	1.03468
30	0.141681	275.992	1.10016	0.112508	275.267	1.07699	0.093051	274.531	1.05771
40	0.146809	282.796	1.12224	0.116681	282.132	1.09927	0.096588	281.460	1.08019
50	0.151902	289.686	1.14390	0.120815	289.076	1.12109	0.100085	288.460	1.10220
60	0.156963	296.664	1.16516	0.124918	296.102	1.14250	0.103550	295.535	1.12376
70	0.161997	303.731	1.18607	0.128993	303.212	1.16353	0.106986	302.689	1.14491
80	0.167008	310.890	1.20663	0.133044	310.409	1.18420	0.110399	309.924	1.16569
90	0.171999	318.139	1.22687	0.137075	317.692	1.20454	0.113790	317.241	1.18612
100	0.176972	325.480	1.24681	0.141089	325.063	1.22456	0.117164	324.643	1.20623
110	0.181931	332.912	1.26646	0.145086	332.522	1.24428	0.120522	332.129	1.22603
		0.40 MPa			0.50 MPa			0.60 MPa	
0	0.060131	252.051	0.95359	—	—	—	—	—	—
10	0.063060	259.023	0.97866	0.049355	257.108	0.95223	0.040180	255.109	0.92945
20	0.065915	266.010	1.00291	0.051751	264.295	0.97717	0.042280	262.517	0.95517
30	0.068710	273.029	1.02646	0.054081	271.483	1.00128	0.044307	269.888	0.97989
40	0.071455	280.092	1.04938	0.056358	278.690	1.02467	0.046276	277.250	1.00378
50	0.074160	287.209	1.07175	0.058590	285.930	1.04743	0.048198	284.622	1.02695
60	0.076830	294.386	1.09362	0.060786	293.215	1.06963	0.050081	292.020	1.04950
70	0.079470	301.630	1.11504	0.062951	300.552	1.09133	0.051931	299.456	1.07149
80	0.082085	308.944	1.13605	0.065090	307.949	1.11257	0.053754	306.938	1.09298
90	0.084679	316.332	1.15668	0.067206	315.410	1.13340	0.055553	314.475	1.11403
100	0.087254	323.796	1.17695	0.069303	322.939	1.15386	0.057332	322.071	1.13466
110	0.089813	331.339	1.19690	0.071384	330.539	1.17395	0.059094	329.731	1.15492
120	0.092358	338.961	1.21654	0.073450	338.213	1.19373	0.060842	337.458	1.17482
130	0.094890	346.664	1.23588	0.075503	345.963	1.21319	0.062576	345.255	1.19441
		0.70 MPa			0.80 MPa			0.90 MPa	
20	0.035487	260.667	0.93565	0.030366	258.737	0.91787	0.026355	256.713	0.90132
30	0.037305	268.240	0.96105	0.032034	266.533	0.94402	0.027915	264.760	0.92831
40	0.039059	275.769	0.98549	0.033632	274.243	0.96905	0.029397	272.670	0.95398

Temp. °C	0.70 MPa			0.80 MPa			0.90 MPa		
	v m³/kg	h kJ/kg	s kJ/kg K	v m³/kg	h kJ/kg	s kJ/kg K	v m³/kg	h kJ/kg	s kJ/kg K
50	0.040763	283.282	1.00910	0.035175	281.907	0.99314	0.030819	280.497	0.97859
60	0.042424	290.800	1.03201	0.036674	289.553	1.01644	0.032193	288.278	1.00230
70	0.044052	298.339	1.05431	0.038136	297.202	1.03906	0.033528	296.042	1.02526
80	0.045650	305.912	1.07606	0.039568	304.868	1.06108	0.034832	303.807	1.04757
90	0.047224	313.527	1.09732	0.040974	312.565	1.08257	0.036108	311.590	1.06930
100	0.048778	321.192	1.11815	0.042359	320.303	1.10359	0.037363	319.401	1.09052
110	0.050313	328.914	1.13856	0.043725	328.087	1.12417	0.038598	327.251	1.11128
120	0.051834	336.696	1.15861	0.045076	335.925	1.14437	0.039817	335.147	1.13162
130	0.053341	344.541	1.17832	0.046413	343.821	1.16420	0.041022	343.094	1.15158
140	0.054836	352.454	1.19770	0.047738	351.778	1.18369	0.042215	351.097	1.17119
150	0.056321	360.435	1.21679	0.049052	359.799	1.20288	0.043398	359.159	1.19047
		1.00 MPa			1.20 MPa			1.40 MPa	
30	0.024600	262.912	0.91358	—	—	—	—	—	—
40	0.025995	271.042	0.93996	0.020851	267.602	0.91411	0.017120	263.861	0.89010
50	0.027323	279.046	0.96512	0.022051	276.011	0.94055	0.018247	272.766	0.91809
60	0.028601	286.973	0.98928	0.023191	284.263	0.96570	0.019299	281.401	0.94441
70	0.029836	294.859	1.01260	0.024282	292.415	0.98981	0.020295	289.858	0.96942
80	0.031038	302.727	1.03520	0.025336	300.508	1.01305	0.021248	298.202	0.99339
90	0.032213	310.599	1.05718	0.026359	308.570	1.03556	0.022167	306.473	1.01649
100	0.033364	318.488	1.07861	0.027357	316.623	1.05744	0.023058	314.703	1.03884
110	0.034495	326.405	1.09955	0.028334	324.682	1.07875	0.023926	322.916	1.06056
120	0.035609	334.360	1.12004	0.029292	332.762	1.09957	0.024775	331.128	1.08172
130	0.036709	342.360	1.14014	0.030236	340.871	1.11994	0.025608	339.354	1.10238
140	0.037797	350.410	1.15986	0.031166	349.019	1.13990	0.026426	347.603	1.12259
150	0.038873	358.514	1.17924	0.032084	357.210	1.15949	0.027233	355.885	1.14240
160	0.039940	366.677	1.19831	0.032993	365.450	1.17873	0.028029	364.206	1.16183
		1.60 MPa			1.80 MPa			2.00 MPa	
50	0.015351	269.262	0.89689	0.013052	265.423	0.87625	—	—	—
60	0.016351	278.358	0.92461	0.014028	275.097	0.90573	0.012135	271.563	0.88729
70	0.017284	287.171	0.95068	0.014921	284.331	0.93304	0.013008	281.310	0.91612
80	0.018167	295.797	0.97546	0.015755	293.282	0.95876	0.013811	290.640	0.94292
90	0.019011	304.301	0.99920	0.016546	302.046	0.98323	0.014563	299.697	0.96821
100	0.019825	312.725	1.02209	0.017303	310.683	1.00669	0.015277	308.571	0.99232

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

Temp. °C	1.60 MPa			1.80 MPa			2.00 MPa		
	v m³/kg	h kJ/kg	s kJ/kg K	v m³/kg	h kJ/kg	s kJ/kg K	v m³/kg	h kJ/kg	s kJ/kg K
110	0.020614	321.103	1.04424	0.018032	319.239	1.02932	0.015960	317.322	1.01546
120	0.021382	329.457	1.06576	0.018738	327.745	1.05123	0.016619	325.991	1.03780
130	0.022133	337.805	1.08673	0.019427	336.224	1.07253	0.017258	334.610	1.05944
140	0.022869	346.162	1.10721	0.020099	344.695	1.09329	0.017881	343.201	1.08049
150	0.023592	354.540	1.12724	0.020759	353.172	1.11356	0.018490	351.783	1.10102
160	0.024305	362.945	1.14688	0.021407	361.666	1.13340	0.019087	360.369	1.12107
170	0.025008	371.386	1.16614	0.022045	370.186	1.15284	0.019673	368.970	1.14070
180	0.025703	379.869	1.18507	0.022675	378.738	1.17193	0.020251	377.595	1.15995
2.50 MPa									
70	0.009459	272.677	0.87476	—	—	—	—	—	—
80	0.010243	283.332	0.90537	0.007747	274.530	0.86780	0.005765	262.739	0.82489
90	0.010948	293.338	0.93332	0.008465	286.042	0.89995	0.006597	277.268	0.86548
100	0.011598	302.935	0.95939	0.009098	296.663	0.92881	0.007257	289.504	0.89872
110	0.012208	312.261	0.98405	0.009674	306.744	0.95547	0.007829	300.640	0.92818
120	0.012788	321.400	1.00760	0.010211	316.470	0.98053	0.008346	311.129	0.95520
130	0.013343	330.412	1.03023	0.010717	325.955	1.00435	0.008825	321.196	0.98049
140	0.013880	339.336	1.05210	0.011200	335.270	1.02718	0.009276	330.976	1.00445
150	0.014400	348.205	1.07331	0.011665	344.467	1.04918	0.009704	340.554	1.02736
160	0.014907	357.040	1.09395	0.012114	353.584	1.07047	0.010114	349.989	1.04940
170	0.015402	365.860	1.11408	0.012550	362.647	1.09116	0.010510	359.324	1.07071
180	0.015877	374.679	1.13376	0.012976	371.679	1.11131	0.010894	368.590	1.09138
190	0.016364	383.508	1.15303	0.013392	380.695	1.13099	0.011268	377.810	1.11151
200	0.016834	392.354	1.17192	0.013801	389.708	1.15024	0.011634	387.004	1.13115
4.00 MPa									
90	0.005037	265.629	0.82544	—	—	—	—	—	—
100	0.005804	280.997	0.86721	0.003334	253.042	0.78005	—	—	—
110	0.006405	293.748	0.90094	0.004255	275.919	0.84064	0.002432	243.278	0.74674
120	0.006924	305.273	0.93064	0.004851	291.362	0.88045	0.003333	272.385	0.82185
130	0.007391	316.080	0.95778	0.005335	304.469	0.91337	0.003899	290.253	0.86675
5.00 MPa									
90	0.005037	265.629	0.82544	—	—	—	—	—	—
100	0.005804	280.997	0.86721	0.003334	253.042	0.78005	—	—	—
110	0.006405	293.748	0.90094	0.004255	275.919	0.84064	0.002432	243.278	0.74674
120	0.006924	305.273	0.93064	0.004851	291.362	0.88045	0.003333	272.385	0.82185
130	0.007391	316.080	0.95778	0.005335	304.469	0.91337	0.003899	290.253	0.86675
6.00 MPa									
90	0.005037	265.629	0.82544	—	—	—	—	—	—
100	0.005804	280.997	0.86721	0.003334	253.042	0.78005	—	—	—
110	0.006405	293.748	0.90094	0.004255	275.919	0.84064	0.002432	243.278	0.74674
120	0.006924	305.273	0.93064	0.004851	291.362	0.88045	0.003333	272.385	0.82185
130	0.007391	316.080	0.95778	0.005335	304.469	0.91337	0.003899	290.253	0.86675

Temp. °C	4.00 MPa			5.00 MPa			6.00 MPa		
	v m³/kg	h kJ/kg	s kJ/kg K	v m³/kg	h kJ/kg	s kJ/kg K	v m³/kg	h kJ/kg	s kJ/kg K
140	0.007822	326.422	0.98312	0.005757	316.379	0.94256	0.004345	304.757	0.90230
150	0.008226	336.446	1.00710	0.006139	327.563	0.96931	0.004728	317.633	0.93310
160	0.008610	346.246	1.02999	0.006493	338.266	0.99431	0.005071	329.553	0.96094
170	0.008978	355.885	1.05199	0.006826	348.633	1.01797	0.005386	340.849	0.98673
180	0.009332	365.409	1.07324	0.007142	358.760	1.04057	0.005680	351.715	1.01098
190	0.009675	374.853	1.09386	0.007444	368.713	1.06230	0.005958	362.271	1.03402
200	0.010009	384.240	1.11391	0.007735	378.537	1.08328	0.006222	372.602	1.05609
210	0.010335	393.593	1.13347	0.008018	388.268	1.10363	0.006477	382.764	1.07734
220	0.010654	402.925	1.15259	0.008292	397.932	1.12343	0.006722	392.801	1.09790

TABLA A.5SI Propiedades termodinámicas del refrigerante-134a (1,1,1,2-tetrafluoroetano)

Temp. °C	Presión abs. MPa, P	Volumen específico, m³/kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado v <sub>f</sub>	Evap. v <sub>fg</sub>	Vapor saturado v <sub>g</sub>	Líquido saturado h <sub>f</sub>	Evap. h <sub>fg</sub>	Vapor saturado h <sub>g</sub>	Líquido saturado s <sub>f</sub>	Evap. s <sub>fg</sub>	Vapor saturado s <sub>g</sub>
-33	0.0737	0.000718	0.25574	0.25646	157.417	220.491	377.908	0.8346	0.9181	1.7528
-30	0.0851	0.000722	0.22330	0.22402	161.118	218.683	379.802	0.8499	0.8994	1.7493
-26.25	0.1013	0.000728	0.18947	0.19020	165.802	216.360	382.162	0.8690	0.8763	1.7453
-25	0.1073	0.000730	0.17956	0.18029	167.381	215.569	382.950	0.8754	0.8687	1.7441
-20	0.1337	0.000738	0.14575	0.14649	173.744	212.340	386.083	0.9007	0.8388	1.7395
-15	0.1650	0.000746	0.11932	0.12007	180.193	209.004	389.197	0.9258	0.8096	1.7354
-10	0.2017	0.000755	0.098454	0.099209	186.721	205.564	392.285	0.9507	0.7812	1.7319
-5	0.2445	0.000764	0.081812	0.082576	193.324	202.016	395.340	0.9755	0.7534	1.7288
0	0.2940	0.000773	0.068420	0.069193	200.000	198.356	398.356	1.0000	0.7262	1.7262
5	0.3509	0.000783	0.057551	0.058334	206.751	194.572	401.323	1.0243	0.6995	1.7239
10	0.4158	0.000794	0.048658	0.049451	213.580	190.652	404.233	1.0485	0.6733	1.7218
15	0.4895	0.000805	0.041326	0.042131	220.492	186.582	407.075	1.0725	0.6475	1.7200
20	0.5728	0.000817	0.035238	0.036055	227.493	182.345	409.838	1.0963	0.6220	1.7183
25	0.6663	0.000829	0.030148	0.030977	234.590	177.920	412.509	1.1201	0.5967	1.7168
30	0.7710	0.000843	0.025865	0.026707	241.790	173.285	415.075	1.1437	0.5716	1.7153
35	0.8876	0.000857	0.022237	0.023094	249.103	168.415	417.518	1.1673	0.5465	1.7139
40	1.0171	0.000873	0.019147	0.020020	256.539	163.282	419.821	1.1909	0.5214	1.7123





TABLA A.5.2SI (Continuación) Refrigerante-134a sobrecalentado

Temp. °C	0.80 MPa		0.90 MPa		1.00 MPa	
	v m³/kg	h kJ/kg	s kJ/kg K	v m³/kg	h kJ/kg	s kJ/kg K
40	0.027 113	424.860	1.74457	0.023 446	422.642	1.72943
50	0.028 611	435.114	1.77680	0.024 868	433.235	1.76273
60	0.030 024	445.223	1.80761	0.026 192	443.595	1.79431
70	0.031 375	455.270	1.83732	0.027 447	453.835	1.82459
80	0.032 678	465.308	1.86616	0.028 649	464.025	1.85387
90	0.033 944	475.375	1.89427	0.029 810	474.216	1.88232
100	0.035 180	485.499	1.92177	0.030 940	484.441	1.91010
110	0.036 392	495.698	1.94874	0.032 043	494.726	1.93730
120	0.037 584	505.988	1.97525	0.033 126	505.088	1.96399
130	0.038 760	516.379	2.00135	0.034 190	515.542	1.99025
140	0.039 921	526.880	2.02708	0.035 241	526.096	2.01611
150	0.041 071	537.496	2.05247	0.036 278	536.760	2.04161
1.20 MPa						
50	0.017 243	426.845	1.72373	—	—	—
60	0.018 439	438.210	1.75837	0.015 032	434.079	1.73597
70	0.019 530	449.179	1.79081	0.016 083	445.720	1.77040
80	0.020 548	459.925	1.82168	0.017 040	456.944	1.80265
90	0.021 512	470.551	1.85135	0.017 931	467.931	1.83333
100	0.022 436	481.128	1.88009	0.018 775	478.790	1.86282
110	0.023 329	491.702	1.90805	0.019 583	489.589	1.89139
120	0.024 197	502.307	1.93537	0.020 362	500.379	1.91918
130	0.025 044	512.965	1.96214	0.021 118	511.192	1.94634
140	0.025 874	523.697	1.98844	0.021 856	522.054	1.97296
150	0.026 691	534.514	2.01431	0.022 579	532.984	1.99910
160	0.027 495	545.426	2.03980	0.023 289	543.994	2.02481
170	0.028 289	556.443	2.06494	0.023 988	555.097	2.05015
1.40 MPa						
50	—	—	—	—	—	—
60	—	—	—	0.012 392	429.322	1.71349
70	—	—	—	0.013 449	441.888	1.75066
80	—	—	—	0.014 378	453.722	1.78466
90	—	—	—	0.015 225	465.145	1.81656
100	—	—	—	0.016 015	476.333	1.84695
110	—	—	—	0.016 763	487.390	1.87619
120	—	—	—	0.017 479	498.387	1.90452
130	—	—	—	0.018 169	509.371	1.93211
140	—	—	—	0.018 840	520.376	1.95908
150	—	—	—	0.019 493	531.427	1.98551
160	—	—	—	0.020 133	542.542	2.01147
170	—	—	—	0.020 761	553.735	2.03702
1.60 MPa						
50	—	—	—	—	—	—
60	—	—	—	—	—	—
70	—	—	—	—	—	—
80	—	—	—	—	—	—
90	—	—	—	—	—	—
100	—	—	—	—	—	—
110	—	—	—	—	—	—
120	—	—	—	—	—	—
130	—	—	—	—	—	—
140	—	—	—	—	—	—
150	—	—	—	—	—	—
160	—	—	—	—	—	—
170	—	—	—	—	—	—

Temp. °C	1.80 MPa		2.0 MPa		2.50 MPa	
	v m³/kg	h kJ/kg	s kJ/kg K	v m³/kg	h kJ/kg	s kJ/kg K
70	0.011 341	437.562	1.73085	0.009 581	432.531	1.71011
80	0.012 273	450.202	1.76717	0.010 550	446.304	1.74968
90	0.013 099	462.164	1.80057	0.011 374	458.951	1.78500
100	0.013 854	473.741	1.83202	0.012 111	470.996	1.81772
110	0.014 560	485.095	1.86205	0.012 789	482.693	1.84866
120	0.015 230	496.325	1.89098	0.013 424	494.187	1.87827
130	0.015 871	507.498	1.91905	0.014 028	505.569	1.90686
140	0.016 490	518.659	1.94639	0.014 608	516.900	1.93463
150	0.017 091	529.841	1.97314	0.015 168	528.224	1.96171
160	0.017 677	541.068	1.99936	0.015 712	539.571	1.98821
170	0.018 251	552.357	2.02513	0.016 242	550.963	2.01421
180	0.018 814	563.724	2.05049	0.016 762	562.418	2.03977
190	0.019 369	575.177	2.07549	0.017 272	573.950	2.06494
3.0 MPa						
90	0.005 755	436.193	1.69950	—	—	—
100	0.006 653	453.731	1.74717	0.004 839	440.433	1.70386
110	0.007 339	468.500	1.78623	0.005 667	459.211	1.75355
120	0.007 924	482.043	1.82113	0.006 289	474.697	1.79346
130	0.008 446	494.915	1.85347	0.006 813	488.771	1.82881
140	0.008 926	507.388	1.88403	0.007 279	502.079	1.86142
150	0.009 375	519.618	1.91328	0.007 706	514.928	1.89216
160	0.009 801	531.704	1.94151	0.008 103	527.496	1.92151
170	0.010 208	543.713	1.96892	0.008 480	539.890	1.94980
180	0.010 601	555.690	1.99565	0.008 839	552.185	1.97724
190	0.010 982	567.670	2.02180	0.009 185	564.430	2.00397
200	0.011 353	579.678	2.04745	0.009 519	576.665	2.03010
4.0 MPa						
90	—	—	—	—	—	—
100	—	—	—	—	—	—
110	—	—	—	0.004 277	446.844	1.71480
120	—	—	—	0.005 005	465.987	1.76415
130	—	—	—	0.005 559	481.865	1.80404
140	—	—	—	0.006 027	496.295	1.83940
150	—	—	—	0.006 444	509.925	1.87200
160	—	—	—	0.006 825	523.072	1.90271
170	—	—	—	0.007 181	535.917	1.93203
180	—	—	—	0.007 517	548.573	1.96028
190	—	—	—	0.007 837	561.117	1.98766
200	—	—	—	0.008 145	573.601	2.01432

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

Temp. K	Presión abs. MPa P	Volumen específico, m <sup>3</sup> /kg			Entalpía, kJ/kg			Entropía, kJ/kg K		
		Líquido saturado v <sub>f</sub>	Evap. v <sub>g</sub>	Vapor saturado v <sub>g</sub>	Líquido saturado h <sub>f</sub>	Evap. h <sub>fg</sub>	Vapor saturado h <sub>g</sub>	Líquido saturado s <sub>f</sub>	Evap. s <sub>fg</sub>	Vapor saturado s <sub>g</sub>
63.148	0.01252	0.001150	1.480099	1.481249	-150.911	215.392	64.482	2.4234	3.4108	5.8342
65	0.01741	0.001160	1.092665	1.093825	-147.172	213.384	66.212	2.4816	3.2829	5.7646
70	0.03858	0.001191	0.525015	0.526206	-137.088	207.788	70.700	2.6307	2.9683	5.5991
75	0.07610	0.001223	0.280499	0.281722	-126.949	201.816	74.867	2.7700	2.6909	5.4609
77.348	0.101325	0.001240	0.215145	0.216385	-122.150	198.839	76.689	2.8326	2.5707	5.4033
80	0.13699	0.001259	0.162485	0.163744	-116.689	195.319	78.630	2.9014	2.4415	5.3429
85	0.22903	0.001299	0.100204	0.101503	-106.252	188.149	81.898	3.0266	2.2136	5.2401
90	0.36066	0.001343	0.064803	0.066146	-95.577	180.137	84.560	3.1466	2.0016	5.1482
95	0.54082	0.001393	0.043398	0.044792	-84.593	171.075	86.482	3.2627	1.8009	5.0636
100	0.77881	0.001452	0.029764	0.031216	-73.199	160.691	87.493	3.3761	1.6070	4.9831
105	1.08423	0.001522	0.020673	0.022195	-61.238	148.597	87.359	3.4883	1.4153	4.9036
110	1.46717	0.001610	0.014342	0.015952	-48.446	134.165	85.719	3.6017	1.2197	4.8215
115	1.93875	0.001729	0.009717	0.011445	-34.508	116.212	81.904	3.7204	1.0106	4.7310
120	2.51248	0.001915	0.006083	0.007998	-17.605	91.930	74.324	3.8536	0.7661	4.6197
125	3.20886	0.002353	0.002530	0.004883	6.677	48.762	55.438	4.0395	0.3901	4.4296
126.193	3.39780	0.003194	0	0.003194	29.791	0	29.791	4.2193	0	4.2193

TABLA A.6.2SI Nitrógeno sobrecalentado (unidades SI)

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

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

Presión abs. MPa	Temperatura, K									
	150	175	200	225	250	275	300	350	400	
6.0	<i>v</i>	0.004421	0.006909	0.008771	0.010412	0.011937	0.013393	0.014803	0.017532	0.020187
	<i>h</i>	87.298	139.945	177.293	210.125	240.822	270.294	298.988	354.951	409.83
	<i>s</i>	4.5685	4.8956	5.0955	5.2503	5.3797	5.4921	5.5920	5.7646	5.9112
8.0	<i>v</i>	0.002914	0.004861	0.006387	0.007701	0.008905	0.010042	0.011135	0.013236	0.015264
	<i>h</i>	61.924	125.326	167.469	202.833	235.145	265.761	295.318	352.511	408.237
	<i>s</i>	4.3522	4.7460	4.9717	5.1385	5.2748	5.3916	5.4945	5.6709	5.8197
10.0	<i>v</i>	0.002388	0.003752	0.005014	0.006112	0.007113	0.008053	0.008952	0.01067	0.01232
	<i>h</i>	48.659	112.363	158.553	196.022	229.841	261.532	291.902	350.260	406.790
	<i>s</i>	4.2290	4.6233	4.8697	5.0474	5.1901	5.3109	5.4167	5.5967	5.7477
15.0	<i>v</i>	0.001955	0.002598	0.003365	0.004109	0.004804	0.005461	0.006088	0.007280	0.008416
	<i>h</i>	36.805	91.928	140.599	181.908	218.586	252.470	284.565	345.466	403.791
	<i>s</i>	4.0790	4.4191	4.6796	4.8745	5.0292	5.1585	5.2702	5.4581	5.6139
20.0	<i>v</i>	0.001782	0.002187	0.002687	0.003213	0.003729	0.004226	0.004704	0.005617	0.006487
	<i>h</i>	33.644	83.317	130.168	172.324	210.434	245.699	279.007	341.856	401.649
	<i>s</i>	3.9960	4.3024	4.5529	4.7517	4.9124	5.0469	5.1629	5.3568	5.5166

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

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

TABLA A.7.2SI Metano sobrecalentado (unidades SI)

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

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

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

TABLA A.8SI Constantes críticas (unidades SI)

Sustancia	Fórmula	Peso molecular	Temperatura K	Presión MPa	Volumen m <sup>3</sup> /kmol	Factor acéntrico
Amoniaco	NH <sub>3</sub>	17.031	405.5	11.35	0.0725	0.250
Argón	Ar	39.948	150.8	4.87	0.0749	0.001
Bromo	Br <sub>2</sub>	159.808	588	10.30	0.1272	0.108
Dióxido de carbono	CO <sub>2</sub>	44.01	304.1	7.38	0.0939	0.239
Monóxido de carbono	CO	28.01	132.9	3.50	0.0932	0.066
Cloro	Cl <sub>2</sub>	70.906	416.9	7.98	0.1238	0.090
Deuterio (normal)	D <sub>2</sub>	4.032	38.4	1.66	—	-0.160
Flúor	F <sub>2</sub>	37.997	144.3	5.22	0.0663	0.054
Helio	He	4.003	5.19	0.227	0.0574	-0.365
Helio <sup>3</sup>	He	3.017	3.31	0.114	0.0729	-0.473
Hidrógeno (normal)	H <sub>2</sub>	2.016	33.2	1.30	0.0651	-0.218
Kriptón	Kr	83.80	209.4	5.50	0.0912	0.005
Neón	Ne	20.183	44.4	2.76	0.0416	-0.029
Óxido nítrico	NO	30.006	180	6.48	0.0577	0.588
Nitrógeno	N <sub>2</sub>	28.013	126.2	3.39	0.0898	0.039
Dióxido de nitrógeno	NO <sub>2</sub>	46.006	431	10.1	0.1678	0.834
Óxido nitroso	N <sub>2</sub> O	44.013	309.6	7.24	0.0974	0.165
Oxígeno	O <sub>2</sub>	31.999	154.6	5.04	0.0734	0.025
Dióxido de azufre	SO <sub>2</sub>	64.063	430.8	7.88	0.1222	0.256
Agua	H <sub>2</sub> O	18.015	647.3	22.12	0.0571	0.344
Xenón	Xe	131.30	289.7	5.84	0.1184	0.008
Acetileno	C <sub>2</sub> H <sub>2</sub>	26.038	308.3	6.14	0.1127	0.190
Benceno	C <sub>6</sub> H <sub>6</sub>	78.114	562.2	4.89	0.2590	0.212
n-Butano	C <sub>3</sub> H <sub>10</sub>	58.124	425.2	3.80	0.2550	0.199
Tetracloruro de carbono	CCL <sub>4</sub>	153.823	556.4	4.56	0.2759	0.193
Clorodifluoroetano <sup>a</sup> (142b)	CH <sub>3</sub> CCLF <sub>2</sub>	100.495	410.3	4.25	0.2310	0.250
Clorodifluorometano (22)	CHCLF <sub>2</sub>	86.469	369.3	4.97	0.1656	0.221
Cloroformo	CHCL <sub>3</sub>	119.378	536.4	5.37	0.2389	0.218
Diclorofluorometano (12)	CCL <sub>2</sub> F <sub>2</sub>	120.914	385.0	4.14	0.2167	0.204
Diclorofluoroetano <sup>a</sup> (141)	CH <sub>3</sub> CCL <sub>2</sub> F	116.95	481.5	4.54	0.2520	0.215
Diclorofluorometano (21)	CHCL <sub>2</sub> F	102.923	451.6	5.18	0.1964	0.210
Diclorotrifluoroetano <sup>a</sup> (123)	CHCL <sub>2</sub> CF <sub>3</sub>	152.93	456.9	3.67	0.2781	0.282
Difluoroetano <sup>a</sup> (152a)	CHF <sub>2</sub> CH <sub>3</sub>	66.05	386.4	4.52	0.1795	0.275
Etano	C <sub>2</sub> H <sub>6</sub>	30.070	305.4	4.88	0.1483	0.099
Alcohol etílico	C <sub>2</sub> H <sub>5</sub> OH	46.069	513.9	6.14	0.1671	0.644
Etileno	C <sub>2</sub> H <sub>4</sub>	28.054	282.4	5.04	0.1304	0.089
n-Heptano	C <sub>7</sub> H <sub>16</sub>	100.205	540.3	2.74	0.4320	0.349
n-Hexano	C <sub>6</sub> H <sub>14</sub>	86.178	507.5	3.01	0.3700	0.299
Metano	CH <sub>4</sub>	16.043	190.4	4.60	0.0992	0.011
Alcohol metílico	CH <sub>3</sub> OH	32.042	512.6	8.09	0.1180	0.556

TABLA A.8SI (Continuación) Constantes críticas (unidades SI)

Sustancia	Fórmula	Peso molecular	Temperatura K	Presión MPa	Volumen m <sup>3</sup> /kmol	Factor acéntrico
Cloruro de metilo	CH <sub>3</sub> CL	50.488	416.3	6.70	0.1389	0.153
n-Octano	C <sub>8</sub> H <sub>18</sub>	114.232	568.8	2.49	0.4920	0.398
n-Pentano	C <sub>5</sub> H <sub>12</sub>	72.151	469.7	3.37	0.3040	0.251
Propano	C <sub>3</sub> H <sub>8</sub>	44.094	369.8	4.25	0.2030	0.153
Propeno	C <sub>3</sub> H <sub>6</sub>	42.081	364.9	4.60	0.1810	0.144
Propino	C <sub>3</sub> H <sub>4</sub>	40.065	402.4	5.63	0.1640	0.215
Tetrafluoroetano <sup>a</sup> (134a)	CF <sub>3</sub> CH <sub>2</sub> F	102.03	374.2	4.06	0.1980	0.327

Fuente: R. C. Reid, J. M. Prausnitz and B. E. Poling. *The properties of gases and liquids*, fourth edition, McGraw-Hill Book Company, New York.

<sup>a</sup> Datos de M. O. McLinden, NIST Thermophysics Division, 1989.

TABLA A.9SI Propiedades de diversos sólidos y líquidos a 25°C (unidades SI)

Sólido	C <sub>p</sub> kJ/kg K	ρ, kg/m <sup>3</sup>	Líquido	C <sub>p</sub> kJ/kg K	ρ, kg/m <sup>3</sup>
Aluminio	0.9	2700	Amoniaco	4.8	602
Concreto	0.65	2300	Benceno	1.72	879
Cobre	0.386	8900	Butano	2.469	556
Vidrio	0.8	2300	Etanol	2.456	783
Granito	1.017	2700	Glicerina	2.40	1200
Grafito	0.711	2500	Iso-octano	2.1	692
Hierro	0.450	7840	Mercurio	0.139	13560
Plomo	0.128	11310	Metanol	2.55	787
Hule (blando)	1.84	1100	Petróleo (ligero)	1.8	910
Arena (seca)	0.8	1450-1750	Propano	2.54	510
Plata	0.235	10470	R-12	0.971	1310
Acero (AISI302)	0.48	8050	R-134a	1.43	1206
Estaño	0.217	5730	Agua	4.184	997
Madera (la mayoría)	1.76	350-700			

TABLA A.10SI Propiedades de diversos gases ideales a 300 K (unidades SI)

Gas	Fórmula química	Masa molecular	R kJ/kg K	C <sub>po</sub> kJ/kg K	C <sub>vo</sub> kJ/kg K	k
Acetileno	C <sub>2</sub> H <sub>2</sub>	26.038	0.3193	1.6986	1.3793	1.231
Aire		28.97	0.2870	1.0035	0.7165	1.400
Amoniaco	NH <sub>3</sub>	17.031	0.48819	2.1300	1.6418	1.297
Argón	Ar	39.948	0.20813	0.5203	0.3122	1.667
Butano	C <sub>4</sub> H <sub>10</sub>	58.124	0.14304	1.7164	1.5734	1.091
Dióxido de carbono	CO <sub>2</sub>	44.01	0.18892	0.8418	0.6529	1.289
Monóxido de carbono	CO	28.01	0.29683	1.0413	0.7445	1.400

TABLA A.10SI (Continuación) Propiedades de diversos gases ideales a 300 K (unidades SI)

Gas	Fórmula química	Masa molecular	R kJ/kg K	C <sub>po</sub> kJ/kg K	C <sub>vo</sub> kJ/kg K	k
Etano	C <sub>2</sub> H <sub>6</sub>	30.07	0.27650	1.7662	1.4897	1.186
Etanol	C <sub>2</sub> H <sub>5</sub> OH	46.069	0.18048	1.427	1.246	1.145
Etileno	C <sub>2</sub> H <sub>4</sub>	28.054	0.29637	1.5482	1.2518	1.237
Helio	He	4.003	2.07703	5.1926	3.1156	1.667
Hidrógeno	H <sub>2</sub>	2.016	4.12418	14.2091	10.0849	1.409
Metano	CH <sub>4</sub>	16.04	0.51835	2.2537	1.7354	1.299
Metanol	CH <sub>3</sub> OH	32.042	0.25948	1.4050	1.1455	1.227
Neón	Ne	20.183	0.41195	1.0299	0.6179	1.667
Nitrógeno	N <sub>2</sub>	28.013	0.29680	1.0416	0.7448	1.400
Óxido nitroso	N <sub>2</sub> O	44.013	0.18891	0.8793	0.6904	1.274
n-Octano	C <sub>8</sub> H <sub>18</sub>	114.23	0.07279	1.7113	1.6385	1.044
Oxígeno	O <sub>2</sub>	31.999	0.25983	0.9216	0.6618	1.393
Propano	C <sub>3</sub> H <sub>8</sub>	44.097	0.18855	1.6794	1.4909	1.126
Vapor	H <sub>2</sub> O	18.015	0.46152	1.8723	1.4108	1.327
Dióxido de azufre	SO <sub>2</sub>	64.059	0.12979	0.6236	0.4938	1.263
Trióxido de azufre	SO <sub>3</sub>	80.058	0.10386	0.6346	0.5307	1.196

TABLA A.11SI Calores específicos a presión constante de diversos gases ideales (unidades SI)

Gas	C <sub>po</sub> = kJ/kmol K	θ = T (Kelvin)/100	Intervalo	Error máximo
			K	%
N <sub>2</sub>	$\bar{C}_{po} = 39.060 - 512.79 \theta^{-1.5} + 1072.7 \theta^{-2} - 820.40 \theta^{-3}$		300-3500	0.43
O <sub>2</sub>	$\bar{C}_{po} = 37.432 + 0.020 102 \theta^{1.5} - 178.57 \theta^{-1.5} + 236.88 \theta^{-2}$		300-3500	0.30
H <sub>2</sub>	$\bar{C}_{po} = 56.505 - 702.74 \theta^{-0.75} + 1165.0 \theta^{-1} - 560.70 \theta^{-1.5}$		300-3500	0.60
CO	$\bar{C}_{po} = 69.145 - 0.704 63 \theta^{0.75} - 200.77 \theta^{-0.5} + 176.76 \theta^{-0.75}$		300-3500	0.42
OH	$\bar{C}_{po} = 81.546 - 59.350 \theta^{0.25} + 17.329 \theta^{-0.75} - 4.2660 \theta$		300-3500	0.43
NO	$\bar{C}_{po} = 59.283 - 1.7096 \theta^{0.5} - 70.613 \theta^{-0.5} + 74.889 \theta^{-1.5}$		300-3500	0.34
H <sub>2</sub> O	$\bar{C}_{po} = 143.05 - 183.54 \theta^{0.25} + 82.751 \theta^{0.5} - 3.6989 \theta$		300-3500	0.43
CO <sub>2</sub>	$\bar{C}_{po} = -3.7357 + 30.529 \theta^{0.5} - 4.1034 \theta + 0.024 198 \theta^2$		300-3500	0.19
NO <sub>2</sub>	$\bar{C}_{po} = 46.045 + 216.10 \theta^{-0.5} - 363.66 \theta^{-0.75} + 232.550 \theta^{-2}$		300-3500	0.26
CH <sub>4</sub>	$\bar{C}_{po} = -672.87 + 439.74 \theta^{0.25} - 24.875 \theta^{0.75} + 323.88 \theta^{-0.5}$		300-2000	0.15
C <sub>2</sub> H <sub>4</sub>	$\bar{C}_{po} = -95.395 + 123.15 \theta^{0.5} - 35.641 \theta^{0.75} + 182.77 \theta^{-3}$		300-2000	0.07
C <sub>2</sub> H <sub>6</sub>	$\bar{C}_{po} = 6.895 + 17.26 \theta - 0.6402 \theta^2 + 0.007 28 \theta^3$		300-1500	0.83
C <sub>3</sub> H <sub>8</sub>	$\bar{C}_{po} = -4.042 + 30.46 \theta - 1.571 \theta^2 + 0.031 71 \theta^3$		300-1500	0.40
C <sub>4</sub> H <sub>10</sub>	$\bar{C}_{po} = 3.954 + 37.12 \theta - 1.833 \theta^2 + 0.034 98 \theta^3$		300-1500	0.54

Fuente: Tomado de T. C. Scott and R. E. Sonntag, University of Michigan, documento inédito 1971, excepto C<sub>2</sub>H<sub>6</sub>, C<sub>3</sub>H<sub>8</sub> y C<sub>4</sub>H<sub>10</sub> que provienen de K. A. Kobe, Petroleum Refiner, 28, No. 2, 113 (1949).

TABLA A.12SI Propiedades del aire como gas ideal, entropía estándar en unidades SI a la presión de 0.1 MPa (1 bar)

T K	u kJ/kg	h kJ/kg	s <sup>o</sup> kJ/kg K	P <sub>r</sub>	v <sub>r</sub>
200	142.768	200.174	6.46260	0.27027	493.466
220	157.071	220.218	6.55812	0.37700	389.150
240	171.379	240.267	6.64535	0.51088	313.274
260	185.695	260.323	6.72562	0.67573	256.584
280	200.022	280.390	6.79998	0.87556	213.257
290	207.191	290.430	6.83521	0.98990	195.361
298.15	213.036	298.615	6.86305	1.09071	182.288
300	214.364	300.473	6.86926	1.11458	179.491
320	228.726	320.576	6.93413	1.39722	152.728
340	243.113	340.704	6.99515	1.72814	131.200
360	257.532	360.863	7.05276	2.11226	113.654
380	271.988	381.060	7.10735	2.55479	99.1882
400	286.487	401.299	7.15926	3.06119	87.1367
420	301.035	421.589	7.20875	3.63727	77.0025
440	315.640	441.934	7.25607	4.28916	68.4088
460	330.306	462.340	7.30142	5.02333	61.0658
480	345.039	482.814	7.34499	5.84663	54.7479
500	359.844	503.360	7.38692	6.76629	49.2777
520	374.726	523.982	7.42736	7.78997	44.5143
540	389.689	544.686	7.46642	8.92569	40.3444
560	404.736	565.474	7.50422	10.18197	36.6765
580	419.871	586.350	7.54084	11.56771	33.4358
600	435.097	607.316	7.57638	13.09232	30.5609
620	450.415	628.375	7.61090	14.76564	28.0008
640	465.828	649.528	7.64448	16.59801	25.7132
660	481.335	670.776	7.67717	18.60025	23.6623
680	496.939	692.120	7.70903	20.78367	21.8182
700	512.639	713.561	7.74010	23.16010	20.1553
720	528.435	735.098	7.77044	25.74188	18.6519
740	544.328	756.731	7.80008	28.54188	17.2894
760	560.316	778.460	7.82905	31.57347	16.0518
780	576.400	800.284	7.85740	34.85061	14.9250
800	592.577	822.202	7.88514	38.38777	13.8972
850	633.422	877.397	7.95207	48.46828	11.6948
900	674.824	933.152	8.01581	60.51977	9.91692
950	716.756	989.436	8.07667	74.81519	8.46770
1000	759.189	1046.221	8.13493	91.65077	7.27604
1050	802.095	1103.478	8.19081	111.3467	6.28845
1100	845.445	1161.180	8.24449	134.2478	5.46408
1150	881.211	1219.298	8.29616	160.7245	4.77141

**TABLA A.12SI (Continuación) Propiedades del aire como gas ideal, entropía estándar en unidades SI a la presión de 0.1 MPa (1 bar)**

T K	u kJ/kg	h kJ/kg	s° kJ/kg K	P <sub>r</sub>	v <sub>r</sub>
1100	845.445	1161.180	8.24449	134.2478	5.46408
1120	862.903	1184.379	8.26539	144.3878	5.17272
1140	880.426	1207.642	8.28598	155.1245	4.90068
1160	898.012	1230.969	8.30626	166.4834	4.64642
1180	915.660	1254.357	8.32625	178.4908	4.40857
1200	933.367	1277.805	8.34596	191.1736	4.18586
1250	977.888	1336.677	8.39402	226.0192	3.68804
1300	1022.751	1395.892	8.44046	265.7145	3.26257
1350	1067.936	1455.429	8.48539	310.7426	2.89711
1400	1113.426	1515.270	8.52891	361.6192	2.58171
1450	1159.202	1575.398	8.57111	418.8942	2.30831
1500	1205.253	1635.800	8.61208	483.1554	2.07031
1550	1251.547	1696.446	8.65185	554.9577	1.86253
1600	1298.079	1757.329	8.69051	634.9670	1.68035
1650	1344.834	1818.436	8.72811	723.8560	1.52007
1700	1391.801	1879.755	8.76472	822.3320	1.37858
1750	1438.970	1941.275	8.80039	931.1376	1.25330
1800	1486.331	2002.987	8.83516	1051.051	1.14204
1850	1533.873	2064.882	8.86908	1182.888	1.04294
1900	1581.591	2126.951	8.90219	1327.498	0.95445
1950	1629.474	2189.186	8.93452	1485.772	0.87521
2000	1677.518	2251.581	8.96611	1658.635	0.80410
2050	1725.714	2314.128	8.99699	1847.077	0.74012
2100	1774.057	2376.823	9.02721	2052.109	0.68242
2150	1822.541	2439.659	9.05678	2274.789	0.63027
2200	1871.161	2502.630	9.08573	2516.217	0.58305
2250	1919.912	2565.733	9.11409	2777.537	0.54020
2300	1968.790	2628.962	9.14189	3059.939	0.50124
2350	2017.789	2692.313	9.16913	3364.658	0.46576
2400	2066.907	2755.782	9.19586	3692.974	0.43338
2450	2116.138	2819.366	9.22208	4046.215	0.40378
2500	2165.480	2883.059	9.24781	4425.759	0.37669
2550	2214.929	2946.859	9.27308	4833.031	0.35185
2600	2264.481	3010.763	9.29790	5269.505	0.32903
2650	2314.133	3074.767	9.32228	5736.707	0.30805
2700	2363.883	3138.868	9.34625	6236.215	0.28872
2750	2413.727	3203.064	9.36980	6769.657	0.27089
2800	2463.663	3267.351	9.39297	7338.715	0.25443
2850	2513.687	3331.726	9.41576	7945.124	0.23921
2900	2563.797	3396.188	9.43818	8590.676	0.22511
2950	2613.990	3460.733	9.46025	9277.216	0.21205
3000	2664.265	3525.359	9.48198	10006.645	0.19992

**TABLA A.13SI Propiedades de diversas sustancias como gases ideales (unidades SI), entropías a la presión de 0.1 MPa (1 bar)**

T K	Nitrógeno, diatómico (N <sub>2</sub> ) h <sub>f,298</sub> ° = 0 kJ/kmol M = 28.013		Nitrógeno, monoatómico (N) h <sub>f,298</sub> ° = 472 680 kJ/kmol M = 14.007	
	(h-h <sub>298</sub> °) kJ/kmol	s° kJ/kmol K	(h-h <sub>298</sub> °) kJ/kmol	s° kJ/kmol K
0	-8670	0	-6197	0
100	-5768	159.812	-4119	130.593
200	-2857	179.985	-2040	145.001
298	0	191.609	0	153.300
300	54	191.789	38	153.429
400	2971	200.181	2117	159.409
500	5911	206.740	4196	164.047
600	8894	212.177	6274	167.837
700	11937	216.865	8353	171.041
800	15046	221.016	10431	173.816
900	18223	224.757	12510	176.265
1000	21463	228.171	14589	178.455
1100	24760	231.314	16667	180.436
1200	28109	234.227	18746	182.244
1300	31503	236.943	20825	183.908
1400	34936	239.487	22903	185.448
1500	38405	241.881	24982	186.883
1600	41904	244.139	27060	188.224
1700	45430	246.276	29139	189.484
1800	48979	248.304	31218	190.672
1900	52549	250.234	33296	191.796
2000	56137	252.075	35375	192.863
2200	63362	255.518	39534	194.845
2400	70640	258.684	43695	196.655
2600	77963	261.615	47860	198.322
2800	85323	264.342	52033	199.868
3000	92715	266.892	56218	201.311
3200	100134	269.286	60420	202.667
3400	107577	271.542	64646	203.948
3600	115042	273.675	68902	205.164
3800	122526	275.698	73194	206.325
4000	130027	277.622	77532	207.437
4400	145078	281.209	86367	209.542
4800	160188	284.495	95457	211.519
5200	175352	287.530	104843	213.397
5600	190572	290.349	114550	215.195
6000	205848	292.984	124590	216.926



**TABLA A.13SI (Continuación) Propiedades de diversas sustancias como gases ideales (unidades SI), entropías a la presión de 0.1 MPa (1 bar)**

Oxígeno, diatómico (O <sub>2</sub> ) $h_{f,298}^{\circ} = 0$ kJ/kmol $M = 31.999$		Oxígeno, monoatómico (O) $h_{f,298}^{\circ} = 249\,170$ kJ/kmol $M = 16.00$		
$T$ K	$(\bar{h}-\bar{h}_{298}^{\circ})$ kJ/kmol	$\bar{s}^{\circ}$ kJ/kmol K	$(\bar{h}-\bar{h}_{298}^{\circ})$ kJ/kmol	$\bar{s}^{\circ}$ kJ/kmol K
0	-8683	0	-6725	0
100	-5777	173.308	-4518	135.947
200	-2868	193.483	-2186	152.153
298	0	205.148	0	161.059
300	54	205.329	41	161.194
400	3027	213.873	2207	167.431
500	6086	220.693	4343	172.198
600	9245	226.450	6462	176.060
700	12499	231.465	8570	179.310
800	15836	235.920	10671	182.116
900	19241	239.931	12767	184.585
1000	22703	243.579	14860	186.790
1100	26212	246.923	16950	188.783
1200	29761	250.011	19039	190.600
1300	33345	252.878	21126	192.270
1400	36958	255.556	23212	193.816
1500	40600	258.068	25296	195.254
1600	44267	260.434	27381	196.599
1700	47959	262.673	29464	197.862
1800	51674	264.797	31547	199.053
1900	55414	266.819	33630	200.179
2000	59176	268.748	35713	201.247
2200	66770	272.366	39878	203.232
2400	74453	275.708	44045	205.045
2600	82225	278.818	48216	206.714
2800	90080	281.729	52391	208.262
3000	98013	284.466	56574	209.705
3200	106022	287.050	60767	211.058
3400	114101	289.499	64971	212.332
3600	122245	291.826	69190	213.538
3800	130447	294.043	73424	214.682
4000	138705	296.161	77675	215.773
4400	155374	300.133	86234	217.812
4800	172240	303.801	94873	219.691
5200	189312	307.217	103592	221.435
5600	206618	310.423	112391	223.066
6000	224210	313.457	121264	224.597

**TABLA A.13SI (Continuación) Propiedades de diversas sustancias como gases ideales (unidades SI), entropías a la presión de 0.1 MPa (1 bar)**

Dióxido de carbono (CO <sub>2</sub> ) $h_{f,298}^{\circ} = -393\,522$ kJ/kmol $M = 44.01$		Monóxido de carbono (CO) $h_{f,298}^{\circ} = -110\,527$ kJ/kmol $M = 28.01$		
$T$ K	$(\bar{h}-\bar{h}_{298}^{\circ})$ kJ/kmol	$\bar{s}^{\circ}$ kJ/kmol K	$(\bar{h}-\bar{h}_{298}^{\circ})$ kJ/kmol	$\bar{s}^{\circ}$ kJ/kmol K
0	-9364	0	-8671	0
100	-6457	179.010	-5772	165.852
200	-3413	199.976	-2860	186.024
298	0	213.794	0	197.651
300	69	214.024	54	197.831
400	4003	225.314	2977	206.240
500	8305	234.902	5932	212.833
600	12906	243.284	8942	218.321
700	17754	250.752	12021	223.067
800	22806	257.496	15174	227.277
900	28030	263.646	18397	231.074
1000	33397	269.299	21686	234.538
1100	38885	274.528	25031	237.726
1200	44473	279.390	28427	240.679
1300	50148	283.931	31867	243.431
1400	55895	288.190	35343	246.006
1500	61705	292.199	38852	248.426
1600	67569	295.984	42388	250.707
1700	73480	299.567	45948	252.866
1800	79432	302.969	49529	254.913
1900	85420	306.207	53128	256.860
2000	91439	309.294	56743	258.716
2200	103562	315.070	64012	262.182
2400	115779	320.384	71326	265.361
2600	128074	325.307	78679	268.302
2800	140435	329.887	86070	271.044
3000	152853	334.170	93504	273.607
3200	165321	338.194	100962	276.012
3400	177836	341.988	108440	278.279
3600	190394	345.576	115938	280.422
3800	202990	348.981	123454	282.454
4000	215624	352.221	130989	284.387
4400	240992	358.266	146108	287.989
4800	266488	363.812	161285	291.290
5200	292112	368.939	176510	294.337
5600	317870	373.711	191782	297.167
6000	343782	378.180	207105	299.809

**TABLA A.13SI (Continuación) Propiedades de diversas sustancias como gases ideales (unidades SI), entropías a la presión de 0.1 MPa (1 bar)**

Agua (H <sub>2</sub> O) $\bar{h}_{f,298}^\circ = -241\,826\text{ kJ/kmol}$ $M = 18.015$		Hidróxilo (OH) $\bar{h}_{f,298}^\circ = 38\,987\text{ kJ/kmol}$ $M = 17.007$		
$T$ K	$(\bar{h}-\bar{h}_{298}^\circ)$ kJ/kmol	$\bar{s}^\circ$ kJ/kmol K	$(\bar{h}-\bar{h}_{298}^\circ)$ kJ/kmol	$\bar{s}^\circ$ kJ/kmol K
0	-9904	0	-9172	0
100	-6617	152.386	-6140	149.591
200	-3282	175.488	-2975	171.592
298	0	188.835	0	183.709
300	62	189.043	55	183.894
400	3450	198.787	3034	192.466
500	6922	206.532	5991	199.066
600	10499	213.051	8943	204.448
700	14190	218.739	11902	209.008
800	18002	223.826	14881	212.984
900	21937	228.460	17889	216.526
1000	26000	232.739	20935	219.735
1100	30190	236.732	24024	222.680
1200	34506	240.485	27159	225.408
1300	38941	244.035	30340	227.955
1400	43491	247.406	33567	230.347
1500	48149	250.620	36838	232.604
1600	52907	253.690	40151	234.741
1700	57757	256.631	43502	236.772
1800	62693	259.452	46890	238.707
1900	67706	262.162	50311	240.556
2000	72788	264.769	53763	242.328
2200	83153	269.706	60751	245.659
2400	93741	274.312	67840	248.743
2600	104520	278.625	75018	251.614
2800	115463	282.680	82268	254.301
3000	126548	286.504	89585	256.825
3200	137756	290.120	96960	259.205
3400	149073	293.550	104388	261.456
3600	160484	296.812	111864	263.592
3800	171981	299.919	119382	265.625
4000	183552	302.887	126940	267.563
4400	206892	308.448	142165	271.191
4800	230456	313.573	157522	274.531
5200	254216	318.328	173002	277.629
5600	278161	322.764	188598	280.518
6000	302295	326.926	204309	283.227

**TABLA A.13SI (Continuación) Propiedades de diversas sustancias como gases ideales (unidades SI), entropías a la presión de 0.1 MPa (1 bar)**

Hidrógeno (H <sub>2</sub> ) $\bar{h}_{f,298}^\circ = 0\text{ kJ/kmol}$ $M = 2.016$		Hidrógeno monoatómico (H) $\bar{h}_{f,298}^\circ = 217\,999\text{ kJ/kmol}$ $M = 1.008$		
$T$ K	$(\bar{h}-\bar{h}_{298}^\circ)$ kJ/kmol	$\bar{s}^\circ$ kJ/kmol K	$(\bar{h}-\bar{h}_{298}^\circ)$ kJ/kmol	$\bar{s}^\circ$ kJ/kmol K
0	-8467	0	-6197	0
100	-5467	100.727	-4119	92.009
200	-2774	119.410	-2040	106.417
298	0	130.678	0	114.716
300	53	130.856	38	114.845
400	2961	139.219	2117	120.825
500	5883	145.738	4196	125.463
600	8799	151.078	6274	129.253
700	11730	155.609	8353	132.457
800	14681	159.554	10431	135.233
900	17657	163.060	12510	137.681
1000	20663	166.225	14589	139.871
1100	23704	169.121	16667	141.852
1200	26785	171.798	18746	143.661
1300	29907	174.294	20825	145.324
1400	33073	176.637	22903	146.865
1500	36281	178.849	24982	148.299
1600	39533	180.946	27060	149.640
1700	42826	182.941	29139	150.900
1800	46160	184.846	31218	152.089
1900	49532	186.670	33296	153.212
2000	52942	188.419	35375	154.279
2200	59865	191.719	39532	156.260
2400	66915	194.789	43689	158.069
2600	74082	197.659	47847	159.732
2800	81355	200.355	52004	161.273
3000	88725	202.898	56161	162.707
3200	96187	205.306	60318	164.048
3400	103736	207.593	64475	165.308
3600	111367	209.773	68633	166.497
3800	119077	211.856	72790	167.620
4000	126864	213.851	76947	168.687
4400	142658	217.612	85261	170.668
4800	158730	221.109	93576	172.476
5200	175057	224.379	101890	174.140
5600	191607	227.447	110205	175.681
6000	208332	230.322	118519	177.114

**TABLA A.13SI (Continuación) Propiedades de diversas sustancias como gases ideales (unidades SI), entropías a la presión de 0.1 MPa (1 bar)**

Óxido nítrico (NO) $\bar{h}_{f,298}^{\circ} = 90\,291 \text{ kJ/kmol}$ $M = 30.006$		Dióxido de nitrógeno (NO <sub>2</sub> ) $\bar{h}_{f,298}^{\circ} = 33\,100 \text{ kJ/kmol}$ $M = 46.005$		
$T$ K	$(\bar{h}-\bar{h}_{298}^{\circ})$ kJ/kmol	$\bar{s}^{\circ}$ kJ/kmol K	$(\bar{h}-\bar{h}_{298}^{\circ})$ kJ/kmol	$\bar{s}^{\circ}$ kJ/kmol K
0	-9192	0	-10186	0
100	-6073	177.031	-6861	202.563
200	-2951	198.747	-3495	225.852
298	0	210.759	0	240.034
300	55	210.943	68	240.263
400	3040	219.529	3927	251.342
500	6059	226.263	8099	260.638
600	9144	231.886	12555	268.755
700	12308	236.762	17250	275.988
800	15548	241.088	22138	282.513
900	18858	244.985	27180	288.450
1000	22229	248.536	32344	293.889
1100	25653	251.799	37606	298.904
1200	29120	254.816	42946	303.551
1300	32626	257.621	48351	307.876
1400	36164	260.243	53808	311.920
1500	39729	262.703	59309	315.715
1600	43319	265.019	64846	319.289
1700	46929	267.208	70414	322.664
1800	50557	269.282	76008	325.861
1900	54201	271.252	81624	328.898
2000	57859	273.128	87259	331.788
2200	65212	276.632	98578	337.182
2400	72606	279.849	109948	342.128
2600	80034	282.822	121358	346.695
2800	87491	285.585	132800	350.934
3000	94973	288.165	144267	354.890
3200	102477	290.587	155756	358.597
3400	110000	292.867	167262	362.085
3600	117541	295.022	178783	365.378
3800	125099	297.065	190316	368.495
4000	132671	299.007	201860	371.456
4400	147857	302.626	224973	376.963
4800	163094	305.940	248114	381.997
5200	178377	308.998	271276	386.632
5600	193703	311.838	294455	390.926
6000	209070	314.488	317648	394.926

**TABLA A.14 Segundo y tercero coeficientes viriales reducidos y constantes de fuerza para el potencial de Lennard-Jones (6-12)**

**TABLA A.14.1**

Segundo y tercero coeficientes reducidos y sus derivadas

$T^*$	$B^*$	$B_1^* = T^* \frac{dB^*}{dT^*}$	$C^*$	$C_1^* = T^* \frac{dC^*}{dT^*}$
0.3	-27.88061	76.60701		
0.4	-13.79885	30.26698		
0.5	-8.72022	16.92367		
0.6	-6.19798	11.24883		
0.7	-4.71004	8.25711	-3.44223	29.02471
0.8	-3.73423	6.45414	-0.87753	11.80911
0.9	-3.04712	5.26492	0.06579	5.05023
1.0	-2.53809	4.42826	0.42600	2.12100
1.1	-2.14638	3.81063	0.55670	0.76761
1.2	-1.83595	3.33749	0.59235	0.12051
1.3	-1.58411	2.96421	0.58821	-0.18965
1.4	-1.37585	2.66262	0.56823	-0.33189
1.5	-1.20089	2.41414	0.54307	-0.38813
1.6	-1.05191	2.20602	0.51748	-0.39994
1.7	-0.92362	2.02926	0.49348	-0.38906
1.8	-0.81203	1.87733	0.47183	-0.36719
1.9	-0.71415	1.74537	0.45267	-0.34065
2.0	-0.62763	1.62972	0.43590	-0.31290
2.2	-0.48171	1.43663	0.40861	-0.26013
2.4	-0.36358	1.28190	0.38797	-0.21492
2.6	-0.26613	1.15517	0.37228	-0.17792
2.8	-0.18451	1.04948	0.36022	-0.14821
3.0	-0.11523	0.96000	0.35084	-0.12454
3.2	-0.05579	0.88328	0.34342	-0.10574
3.4	-0.00428	0.81676	0.33748	-0.09081
3.6	0.04072	0.75854	0.33264	-0.07895
3.8	0.08033	0.70716	0.32863	-0.06955
4.0	0.11542	0.66148	0.32526	-0.06209
4.2	0.14668	0.62060	0.32238	-0.05619
4.4	0.17469	0.58381	0.31988	-0.05154
4.6	0.19990	0.55051	0.31767	-0.04789
4.8	0.22268	0.52024	0.31569	-0.04506
5.0	0.24334	0.49260	0.31390	-0.04288
6.0	0.32290	0.38397	0.30661	-0.03831
7.0	0.37609	0.30826	0.30069	-0.03899
8.0	0.41343	0.25248	0.29533	-0.04152
9.0	0.44060	0.20970	0.29027	-0.04456
10.0	0.46088	0.17587	0.28541	-0.04758
20.0	0.52538	0.02866	0.24609	-0.06402
30.0	0.52693	-0.01749	0.21930	-0.06728

**TABLA A.14.2**

Constantes de fuerza a partir de los datos de coeficientes viriales experimentales

Sustancia	$\epsilon/k, \text{ K}$	$b_0, \text{ m}^3/\text{kmol}$
Ne	35.8	0.0262
Ar	119.0	0.0502
Kr	173.0	0.0583
Xe	225.3	0.0854
N <sub>2</sub>	95.05	0.0635
O <sub>2</sub>	117.5	0.0578
CO	100.2	0.0675
NO	131.0	0.0402
CO <sub>2</sub>	186.0	0.118
N <sub>2</sub> O	193.0	0.118
CH <sub>4</sub>	148.1	0.0698
CF <sub>4</sub>	152.0	0.131

TABLA A.15 Tablas generalizadas del factor de compresibilidad con tres parámetros ( $T_r$ ,  $P_r$ ,  $\omega$ ).  
 TABLA A.15.1 Presión de saturación generalizada, factor de compresibilidad, desviación de la entalpía, desviación de la entropía, coeficiente de fugacidad de un fluido simple

$T_r$	$\ln(P_r)$	$Z_f$	$Z_g$	$\left(\frac{h^* - h}{RT_c}\right)_f$	$\left(\frac{h^* - h}{RT_c}\right)_g$	$\left(\frac{s_p^* - s_p}{R}\right)_f$	$\left(\frac{s_p^* - s_p}{R}\right)_g$	$\ln\left(\frac{f}{P}\right)$
0.30	-13.14053	0.00000	0.99998	6.04616	0.00002	20.09953	0.00005	-0.00002
0.32	-11.89025	0.00000	0.99993	5.99061	0.00007	18.06562	0.00014	-0.00007
0.34	-10.79655	0.00001	0.99983	5.93515	0.00018	16.51869	0.00035	-0.00017
0.36	-9.83281	0.00002	0.99963	5.87895	0.00040	16.01837	0.00076	-0.00037
0.38	-8.97801	0.00003	0.99927	5.82177	0.00085	15.31191	0.00150	-0.00073
0.40	-8.21540	0.00006	0.99865	5.76367	0.00163	14.41129	0.00272	-0.00134
0.42	-7.53140	0.00012	0.99770	5.70481	0.00291	13.58378	0.00463	-0.00230
0.44	-6.91492	0.00022	0.99628	5.64539	0.00489	12.82092	0.00741	-0.00371
0.46	-6.35683	0.00038	0.99430	5.58558	0.00781	12.13784	0.01129	-0.00568
0.48	-5.84950	0.00061	0.99165	5.52553	0.01191	11.50344	0.01648	-0.00832
0.50	-5.38653	0.00095	0.98820	5.46534	0.01745	10.91801	0.02317	-0.01173
0.52	-4.96253	0.00141	0.98389	5.40509	0.02472	10.37636	0.03155	-0.01600
0.54	-4.57289	0.00204	0.97862	5.34481	0.03399	9.87361	0.04176	-0.02118
0.56	-4.21367	0.00286	0.97233	5.28447	0.04552	9.40554	0.05395	-0.02734
0.58	-3.88146	0.00390	0.96498	5.22403	0.05958	8.96810	0.06823	-0.03449
0.60	-3.57331	0.00521	0.95652	5.16343	0.07641	8.55883	0.08470	-0.04265
0.62	-3.28666	0.00682	0.94695	5.10255	0.09626	8.17415	0.10344	-0.05182
0.64	-3.01926	0.00877	0.93623	5.04126	0.11938	7.81156	0.12455	-0.06198
0.66	-2.76913	0.01110	0.92436	4.97940	0.14601	7.46873	0.14811	-0.07312
0.68	-2.53452	0.01384	0.91133	4.91678	0.17640	7.14358	0.17423	-0.08519
0.70	-2.31388	0.01705	0.89711	4.85318	0.21084	6.83415	0.20302	-0.09817
0.72	-2.10584	0.02077	0.88170	4.78832	0.24961	6.53867	0.23465	-0.11203
0.74	-1.90915	0.02504	0.86506	4.72190	0.29309	6.25549	0.26934	-0.12674
0.76	-1.72272	0.02994	0.84712	4.65355	0.34170	5.98304	0.30734	-0.14227
0.78	-1.54554	0.03552	0.82782	4.58283	0.39595	5.71981	0.34902	-0.15861
0.80	-1.37672	0.04186	0.80704	4.50922	0.45650	5.46432	0.39486	-0.17576
0.82	-1.21545	0.04906	0.78463	4.43203	0.52418	5.21508	0.44552	-0.19373
0.84	-1.06097	0.05725	0.76036	4.35043	0.60010	4.97049	0.50187	-0.21254
0.86	-0.91263	0.06658	0.73394	4.26329	0.68574	4.72880	0.56514	-0.23224
0.88	-0.76980	0.07727	0.70491	4.16906	0.78319	4.48793	0.63709	-0.25290
0.90	-0.63192	0.08961	0.67262	4.06548	0.89550	4.24517	0.72040	-0.27461
0.92	-0.49847	0.10407	0.63605	3.94904	1.02744	3.99668	0.81928	-0.29750
0.94	-0.36898	0.12143	0.59347	3.81358	1.18719	3.73613	0.94120	-0.32176
0.96	-0.24301	0.14328	0.54146	3.64643	1.39116	3.45088	1.10146	-0.34766
0.98	-0.12014	0.17412	0.47112	3.41136	1.68360	3.10521	1.34235	-0.37560
1.00	0.00000	0.29010	0.29010	2.58438	2.58438	2.17799	2.17799	-0.40639

TABLA A.15.2 Factor de compresibilidad de un fluido simple, Z

$T_r \backslash P_r$	0.10	0.20	0.40	0.60	0.80	1.00	1.20	1.40	1.70	2.00	2.50	3.00	5.00	7.00	10.00
0.30	0.0290	0.0579	0.1158	0.1737	0.2315	0.2892	0.3470	0.4047	0.4911	0.5775	0.7213	0.8648	1.4366	2.0048	2.8507
0.40	0.0239	0.0477	0.0953	0.1429	0.1904	0.2379	0.2853	0.3327	0.4036	0.4744	0.5921	0.7095	1.1758	1.6373	2.3211
0.50	0.0207	0.0413	0.0825	0.1236	0.1647	0.2056	0.2465	0.2873	0.3483	0.4092	0.5103	0.6110	1.0094	1.4017	1.9801
0.60	0.0186	0.0371	0.0741	0.1109	0.1476	0.1842	0.2207	0.2571	0.3115	0.3657	0.4554	0.5446	0.8959	1.2398	1.7440
0.70	0.0172	0.0344	0.0687	0.1027	0.1366	0.1703	0.2038	0.2372	0.2869	0.3364	0.4181	0.4991	0.8161	1.1241	1.5729
0.75	0.0165	0.0336	0.0670	0.1001	0.1330	0.1656	0.1981	0.2303	0.2784	0.3260	0.4046	0.4823	0.7854	1.0787	1.5047
0.80	0.0159	0.0330	0.0661	0.0985	0.1307	0.1626	0.1942	0.2255	0.2721	0.3182	0.3942	0.4690	0.7598	1.0400	1.4456
0.85	0.0156	0.0327	0.0658	0.0980	0.1301	0.1614	0.1924	0.2230	0.2684	0.3132	0.3868	0.4591	0.7388	1.0071	1.3943
0.90	0.0154	0.0325	0.0656	0.0978	0.1298	0.1610	0.1919	0.2223	0.2678	0.3114	0.3828	0.4527	0.7220	0.9793	1.3496
0.95	0.0153	0.0324	0.0655	0.0977	0.1297	0.1609	0.1918	0.2222	0.2677	0.3113	0.3827	0.4501	0.7092	0.9561	1.3108
1.00	0.0152	0.0323	0.0654	0.0976	0.1296	0.1608	0.1917	0.2221	0.2676	0.3112	0.3826	0.4475	0.7004	0.9372	1.2772
1.05	0.0151	0.0322	0.0653	0.0975	0.1295	0.1607	0.1916	0.2220	0.2675	0.3111	0.3825	0.4449	0.6956	0.9222	1.2481
1.10	0.0150	0.0321	0.0652	0.0974	0.1294	0.1606	0.1915	0.2219	0.2674	0.3110	0.3824	0.4423	0.6950	0.9110	1.2232
1.15	0.0149	0.0320	0.0651	0.0973	0.1293	0.1605	0.1914	0.2218	0.2673	0.3109	0.3823	0.4397	0.6987	0.9033	1.2021
1.20	0.0148	0.0319	0.0650	0.0972	0.1292	0.1604	0.1913	0.2217	0.2672	0.3108	0.3822	0.4371	0.7069	0.8990	1.1844
1.30	0.0146	0.0317	0.0648	0.0970	0.1290	0.1602	0.1911	0.2215	0.2670	0.3106	0.3820	0.4345	0.7358	0.8998	1.1580
1.40	0.0145	0.0316	0.0647	0.0969	0.1289	0.1601	0.1910	0.2214	0.2669	0.3105	0.3819	0.4319	0.7761	0.9112	1.1419
1.50	0.0144	0.0315	0.0646	0.0968	0.1288	0.1600	0.1909	0.2213	0.2668	0.3104	0.3818	0.4293	0.8200	0.9297	1.1339
1.60	0.0143	0.0314	0.0645	0.0967	0.1287	0.1599	0.1908	0.2212	0.2667	0.3103	0.3817	0.4267	0.8617	0.9518	1.1320
1.80	0.0141	0.0312	0.0643	0.0965	0.1285	0.1597	0.1906	0.2210	0.2665	0.3101	0.3815	0.4241	0.9297	0.9961	1.1391
2.00	0.0140	0.0311	0.0642	0.0964	0.1284	0.1596	0.1905	0.2209	0.2664	0.3100	0.3814	0.4215	0.9550	1.0328	1.1516
2.50	0.0138	0.0309	0.0640	0.0962	0.1282	0.1594	0.1903	0.2207	0.2662	0.3098	0.3812	0.4189	1.0031	1.0866	1.1763
3.00	0.0136	0.0307	0.0638	0.0960	0.1280	0.1592	0.1901	0.2205	0.2660	0.3096	0.3810	0.4163	1.0635	1.1075	1.1848
3.50	0.0135	0.0306	0.0637	0.0959	0.1279	0.1591	0.1900	0.2204	0.2659	0.3095	0.3809	0.4137	1.0723	1.1138	1.1834
4.00	0.0134	0.0305	0.0636	0.0958	0.1278	0.1590	0.1899	0.2203	0.2658	0.3094	0.3808	0.4111	1.0401	1.1136	1.1773
5.00	0.0132	0.0303	0.0634	0.0956	0.1276	0.1588	0.1897	0.2201	0.2656	0.3092	0.3806	0.4085	1.0405	1.1064	1.1611

**TABLA A.20 Masas atómicas y temperaturas de fusión y ebullición de los elementos basados en la masa atómica relativa asignada de  $^{12}\text{C} = 12$**

Nombre	Símbolo	Número atómico	Masa atómica	Temperatura de fusión, °C	Temperatura de ebullición, °C
Actinio	Ac	89	227.028 <sup>a</sup>	1050	3200 ± 300
Aluminio	Al	13	26.9815	660.37	2467
Americio	Am	95	(243)	994 ± 4	2607
Antimonio (estibium)	Sb	51	121.75	630.74	1750
Argón	Ar	18	39.948	-189.2	-185.7
Arsénico	As	33	74.9216	817 (28 atm)	613 (sub)
Astatino	At	85	(210)	302	337
Azufre	S	16	32.06	112.8	444.674
Bario	Ba	56	137.33	725	1640
Berkelio	Bk	97	(247)		
Berilio	Be	4	9.012 18	1278 ± 5	2970 (5 mm)
Bismuto	Bi	83	208.980	271.3	1560 ± 5
Boro	B	5	10.81	2079	2550 (sub)
Bromo	Br	35	79.904	-7.2	58.78
Cadmio	Cd	48	112.41	320.9	765
Calcio	Ca	20	40.08	839 ± 2	1484
Californio	Cf	98	(251)		
Carbón	C	6	12.011	3652 (sub)	t
Cerio	Ce	58	140.12	798 ± 2	3257
Cesio	Cs	55	132.905	28.40 ± 0.01	669.3
Cloro	Cl	17	35.453	-100.98	-34.6
Cromo	Cr	24	51.996	1857 ± 20	2672
Cobalto	Co	27	51.9332	1495	2870
Cobre	Cu	29	63.546	1083.4 ± 0.2	2567
Curio	Cm	96	(247)	1340 ± 40	
Disproscio	Dy	66	162.50	1409	2335
Einsteinio	Es	99	(252)		
Erbio	Er	68	167.26	1522	2510
Escandio	Sc	21	44.9559	1539	2832
Estaño	Sn	50	118.71	231.9681	2270
Estroncio	Sr	38	87.62	769	1384
Europio	Eu	63	151.96	822 ± 5	1597
Fermio	Fm	100	(257)		
Flúor	F	9	18.9984	-219.62	-188.14
Fósforo	P	15	30.9738	44.1 (blanco)	280 (blanco)
Francio	Fr	87	(223)	(27)	(677)
Gadolinio	Gd	64	157.25	1311 ± 1	3233

<sup>a</sup> Los valores se aplican a los elementos tal como existen en los materiales de origen terrestre y a ciertos elementos artificiales.  
Fuente: *Handbook of Chemistry and Physics*, sexagésima séptima edición, 1986-1987, CRC Press, Boca Raton, FL, 1986.

**TABLA A.20 (Continuación) Masas atómicas y temperaturas de fusión y ebullición de los elementos basados en la masa atómica relativa asignada de  $^{12}\text{C} = 12$**

Nombre	Símbolo	Número atómico	Masa atómica	Temperatura de fusión, °C	Temperatura de ebullición, °C
Galio	Ga	31	69.72	29.78	2403
Germanio	Ge	32	72.59	937.4	2830
Hafnio	Hf	72	178.49	2227 ± 20	4602
Helio	He	2	4.002 60	-272.2 <sup>26</sup> atm	-268.934
Hidrógeno	H	1	1.007 94	-259.14	-252.87
Hierro	Fe	26	55.847	1535	2750
Holmio	Ho	67	164.930	1470	2720
Indio	In	49	114.82	156.61	2080
Iridio	Ir	77	192.22	2410	4130
Kriptón	Kr	36	83.80	-156.6	-152.30 ± 0.10
Lantano	La	57	138.906	920 ± 5	3454
Lawrencio	Lr	103	(260)		
Litio	Li	3	6.941	180.54	1342
Lutecio	Lu	71	174.967	1656 ± 5	3315
Magnesio	Mg	12	24.305	648.8 ± 0.5	1090
Manganeso	Mn	25	54.9380	1244 ± 3	1962
Mendelevio	Md	101	(258)		
Mercurio	Hg	80	200.59	-38.87	356.58
Molibdeno	Mo	42	95.94	2617	4612
Neodimio	Nd	60	144.24	1010	3127
Neón	Ne	10	20.1179	-248.67	-246.048
Neptunio	Np	93	237.048	640 ± 1	3902
Niobio	Nb	41	92.9064	2468 ± 10	4742
Níquel	Ni	28	58.69	1453	2732
Nitrógeno	N	7	14.0067	-209.86	-195.8
Nobelio	No	102	(259)		
Oro	Au	79	196.967	1064.434	3080
Osmio	Os	76	190.2	3045 ± 30	5027 ± 100
Oxígeno	O	8	15.9994	-218.4	-182.962
Paladio	Pd	46	106.42	1554	3140
Plata	Ag	47	107.868	961.93	2212
Platino	Pt	78	195.08	1772	3827 ± 100
Plomo	Pb	82	207.2	327.502	1740
Plutonio	Pu	94	(244)	641	3232
Polonio	Po	84	(209)	254	962
Potasio	K	19	39.0983	63.25	759.9

**TABLA A.20 (Continuación) Masas atómicas y temperaturas de fusión y ebullición de los elementos basados en la masa atómica relativa asignada de <sup>12</sup>C = 12**

Nombre	Símbolo	Número atómico	Masa atómica	Temperatura de fusión, °C	Temperatura de ebullición, °C
Praseodimio	Pr	59	140.908	931 ± 4	3212
Prometio	Pm	61	(145)	1080 (aprox.)	2460 (?)
Protoactinio	Pa	91	231.0359	1600	
Radio	Ra	88	226.025	700	1140
Radón	Rn	86	(222)	-71	-61.8
Renio	Re	75	186.207	3180	5627 (est.)
Rodio	Rh	45	102.906	1965 ± 3	3727 ± 100
Rubidio	Rb	37	85.4678	38.89	686
Rutenio	Ru	44	101.07	2310	3900
Samario	Sm	62	150.36	1072 ± 5	1778
Selenio	Se	34	78.96	217	684.9 ± 1.0
Silicio	Si	14	28.0855	1410	2355
Sodio	Na	11	22.9898	97.81 ± 0.03	882.9
Talio	Tl	81	204.383	303.5	1457 ± 10
Tantalio	Ta	73	180.9479	2996	5425 ± 100
Tecnecio	Tc	43	(98)	2172	4877
Telurio	Te	52	127.60	449.5 ± 0.3	989.8 ± 3.8
Terbio	Tb	65	158.925	1360 ± 4	3041
Titanio	Ti	22	47.88	1660 ± 10	3287
Torio	Th	90	232.038	1750	4790 (aprox.)
Tulio	Tm	69	168.934	1545 ± 15	1727
Tungsteno	W	74	183.85	3410 ± 20	5660
Unnihexio	(Unh)	106	(263)		
Unnilcuadio	(Unq)	104	(261)		
Unnilpentio	(Unp)	105	(262)		
Unnilseptio	(Uns)	107	(262)		
Uranio	U	92	238.029	1132 ± 0.8	3818
Vanadio	V	23	50.9415	1890 ± 10	3380
Wolframio (ver tungsteno)					
Xenón	Xe	54	131.29	-111.9	-107.1 ± 3
Yodo	I	53	126.905	113.5	184.35
Yterbio	Yb	70	173.04	824 ± 5	1193
Ytrio	Y	39	88.9059	1523 ± 8	3337
Zinc	Zn	30	65.39	419.58	907
Zirconio	Zr	40	91.224	1852 ± 2	4377

**TABLA A.11 Propiedades termodinámicas del agua (unidades inglesas)**  
**TABLA A.1.11 Agua saturada: tabla de temperatura (unidades inglesas)**

Temp. °F T	Volumen específico, ft <sup>3</sup> /lb <sub>m</sub>		Energía interna, Btu/lbm		Entalpía, Btu/lbm		Entropía, Btu/lbm °R		
	Presión lbf/pulg <sup>2</sup> P	Líquido saturado v <sub>f</sub>	Vapor saturado v <sub>g</sub>	Líquido saturado u <sub>f</sub>	Vapor saturado u <sub>g</sub>	Líquido saturado h <sub>f</sub>	Vapor saturado h <sub>g</sub>	Líquido saturado s <sub>f</sub>	Vapor saturado s <sub>g</sub>
32	0.08867	0.016022	3301.9	0.00	1021.2	0.00	1075.4	0.00000	2.1869
35	0.09993	0.016021	2947.5	2.99	1019.2	2.99	1073.7	0.00607	2.1764
40	0.12167	0.016020	2445.1	8.01	1015.8	8.01	1070.9	0.01617	2.1591
45	0.14750	0.016021	2037.0	13.03	1012.5	13.03	1068.1	0.02617	2.1423
50	0.17805	0.016024	1704.0	18.05	1009.1	18.05	1065.2	0.03606	2.1259
60	0.25632	0.016034	1206.7	28.08	1002.4	28.08	1059.6	0.05554	2.0943
70	0.3632	0.016051	867.60	38.09	995.6	38.09	1054.0	0.07462	2.0642
80	0.5074	0.016072	632.69	48.08	988.9	48.08	1048.3	0.09331	2.0356
90	0.6989	0.016099	467.60	58.06	982.2	58.06	1042.7	0.11163	1.8966
100	0.9504	0.016130	349.98	68.04	975.4	68.04	1037.0	0.12962	1.8526
110	1.2765	0.016166	265.07	78.01	968.7	78.01	1031.3	0.14728	1.8101
120	1.6947	0.016205	203.03	87.99	961.9	87.99	1025.5	0.16464	1.7690
130	2.2254	0.016247	157.16	97.96	955.1	97.96	1019.8	0.18171	1.7292
140	2.892	0.016293	122.87	107.95	948.2	107.95	1014.0	0.19850	1.6907
150	3.722	0.016343	96.977	117.94	941.3	117.94	1008.1	0.21502	1.6533
160	4.745	0.016395	77.224	127.94	934.4	127.94	1002.2	0.23129	1.6171
170	5.997	0.016450	62.015	137.94	927.4	137.94	996.2	0.24731	1.5819
180	7.515	0.016509	50.199	147.96	920.4	147.96	990.2	0.26309	1.5478
190	9.344	0.016570	40.942	157.99	913.3	157.99	984.1	0.27865	1.5146
200	11.530	0.016634	33.631	168.03	906.2	168.03	977.9	0.29399	1.4822
210	14.126	0.016702	27.813	178.09	898.9	178.09	971.6	0.30912	1.4507
220	17.189	0.016772	23.149	188.16	891.7	188.16	965.3	0.32404	1.4201
230	20.780	0.016845	19.385	198.25	884.3	198.25	958.8	0.33878	1.3901
240	24.968	0.016922	16.326	208.36	876.9	208.36	952.3	0.35333	1.3609
250	29.823	0.017001	13.825	218.48	869.4	218.48	945.8	0.36771	1.3324
260	35.422	0.017084	11.767	228.64	861.8	228.64	938.6	0.38191	1.3044
270	41.848	0.017170	10.065	238.81	854.1	238.81	932.0	0.39596	1.2771
280	49.189	0.017259	8.650	249.02	846.4	249.02	924.9	0.40985	1.2504
290	57.535	0.017352	7.466	259.25	838.5	259.25	917.8	0.42359	1.2241
300	66.985	0.017448	6.471	269.51	830.5	269.51	910.4	0.43719	1.1984
310	77.641	0.017548	5.631	279.80	822.3	279.80	903.0	0.45065	1.1731
320	89.609	0.017652	4.919	290.13	814.1	290.13	895.3	0.46399	1.1483
330	103.00	0.017760	4.312	300.50	805.7	300.50	887.5	0.47720	1.1238
340	117.94	0.017871	3.792	310.90	797.1	310.90	879.5	0.49030	1.0997

### Oxígeno Sobrecalentado

Temp (K)	v (m³/kg)	h (kJ/kg)	s (kJ/kgK)	0.10 MPa			0.20 MPa			0.50 MPa		
				v (m³/kg)	h (kJ/kg)	s (kJ/kgK)	v (m³/kg)	h (kJ/kg)	s (kJ/kgK)	v (m³/kg)	h (kJ/kg)	s (kJ/kgK)
100	0.253503	88.828	5.4016	0.123394	86.864	5.2083						
125	0.320717	112.214	5.6107	0.158268	110.988	5.4241	0.060674	107.093	5.1650			
150	0.386914	135.301	5.7787	0.192016	134.440	5.5947	0.075039	131.788	5.3448			
175	0.452645	158.255	5.9202	0.225276	157.609	5.7376	0.088842	155.643	5.4919			
200	0.518127	181.145	6.0427	0.258282	180.638	5.8609	0.102371	179.105	5.6175			
225	0.583465	204.007	6.1502	0.291140	203.596	5.9688	0.115746	202.359	5.7268			
250	0.648711	226.869	6.2468	0.323906	226.529	6.0657	0.129025	225.506	5.8246			
275	0.713895	249.769	6.3369	0.356610	249.483	6.1560	0.142242	248.621	5.9156			
300	0.779036	272.720	6.4140	0.389271	272.475	6.2332	0.155415	271.740	5.9932			
<hr/>												
	1.00 MPa			2.00 MPa			4.00 MPa					
125	0.027869	99.653	4.9431									
150	0.035976	127.112	5.1433	0.016270	116.476	4.9130	0.005526	81.481	4.5475			
175	0.043341	152.269	5.2986	0.020544	145.112	5.0899	0.009029	128.618	4.8414			
200	0.050394	176.508	5.4283	0.024395	171.150	5.2293	0.011376	159.715	5.0080			
225	0.057282	200.280	5.5401	0.028051	196.052	5.3464	0.013444	187.333	5.1380			
250	0.064068	223.795	5.6394	0.031597	220.348	5.4491	0.015378	213.374	5.2480			
275	0.070790	247.185	5.7314	0.035073	244.309	5.5433	0.017233	238.560	5.3469			
300	0.077467	270.516	5.8098	0.038502	268.076	5.6263	0.019039	263.234	5.4300			
<hr/>												
	6.00 MPa			8.00 MPa			10.00 MPa					
175	0.005051	107.496	4.6431	0.003002	79.513	4.4384	0.002020	52.661	4.2573			
200	0.007027	147.232	4.8565	0.004864	133.760	4.7308	0.003603	119.767	4.6189			
225	0.008589	178.304	5.0029	0.006181	169.069	4.8973	0.004757	159.686	4.8072			
250	0.009991	206.340	5.1214	0.007316	199.317	5.0251	0.005730	192.401	4.9450			
275	0.011306	232.848	5.2253	0.008360	227.219	5.1344	0.006606	221.685	5.0572			
300	0.012570	258.464	5.3116	0.009351	253.797	5.2240	0.007432	249.262	5.1533			
<hr/>												
	20.00 MPa											
175	0.001343	24.551	4.0086									
200	0.001727	75.318	4.2798									
225	0.002236	122.595	4.5024									
250	0.002755	163.109	4.6739									
275	0.003241	198.021	4.8069									
300	0.003700	229.655	4.9174									

### Oxígeno Saturado

Temp (K)	P (MPa)	Volumen específico (m³/kg)			Entalpia (kJ/kg)			Entropia (kJ/kg.K)		
		v <sub>f</sub>	v <sub>g</sub>	v <sub>g</sub>	h <sub>f</sub>	h <sub>g</sub>	h <sub>g</sub>	s <sub>f</sub>	s <sub>g</sub>	s <sub>g</sub>
54.3507	0.00015	0.000765	92.9658	92.9666	-193.432	242.553	49.121	2.0938	4.4514	6.5452
60	0.00073	0.000780	21.3461	21.3469	-184.029	238.265	54.236	2.2585	3.9686	6.2271
70	0.00623	0.000808	2.9085	2.9093	-167.372	230.527	63.155	2.5151	3.2936	5.8087
80	0.03006	0.000840	0.68104	0.68188	-150.646	222.289	71.643	2.7381	2.7779	5.5161
90	0.09943	0.000876	0.22649	0.22736	-133.758	213.070	79.312	2.9364	2.3663	5.3027
100	0.25425	0.000917	0.094645	0.095562	-116.557	202.291	85.734	3.1161	2.0222	5.1383
110	0.54339	0.000966	0.045855	0.046821	-98.829	189.320	90.491	3.2823	1.7210	5.0033
120	1.0215	0.001027	0.024336	0.025363	-80.219	173.310	93.091	3.4401	1.4445	4.8846
130	1.7478	0.001108	0.013488	0.014596	-60.6093	152.887	92.794	3.5948	1.1766	4.7714
140	2.7866	0.001230	0.007339	0.008569	-37.045	125.051	88.006	3.7567	0.8935	4.6502
150	4.2190	0.001480	0.003180	0.004660	-7.038	79.459	72.421	3.9498	0.5301	4.4799
154.576	5.0427	0.002293	0.000000	0.002293	32.257	0.000	32.257	4.1977	0.0000	4.1977

**FIGURA A-30a**

Gráfica generalizada de compresibilidad de Nelson-Obert-bajas presiones. (Utilizadas con permiso del Dr. Edward E. Obert, University of Wisconsin.)

(a)  $0 < P_r < 1.0$

