

Table C.8a Superheated Refrigerant-134a Vapor (English Units) *continued*

T °F	v ft ³ /lbm	u Btu/lbm	h Btu/lbm	s Btu/(lbm · R)	v ft ³ /lbm	u Btu/lbm	h Btu/lbm	s Btu/(lbm · R)
	$P = 60$ psia ($T_{\text{sat}} = 49.89^\circ\text{F}$)				$P = 70$ psia ($T_{\text{sat}} = 58.35^\circ\text{F}$)			
Sat.	0.7887	99.96	108.72	0.2183	0.6778	101.05	109.83	0.2179
60	0.8135	102.03	111.06	0.2229	0.6814	101.40	110.23	0.2186
80	0.8604	106.11	115.66	0.2316	0.7239	105.58	114.96	0.2276
100	0.9051	110.21	120.26	0.2399	0.7640	109.76	119.66	0.2361
120	0.9482	114.35	124.88	0.2480	0.8023	113.96	124.36	0.2444
140	0.9900	118.54	129.53	0.2559	0.8393	118.20	129.07	0.2524
160	1.0308	122.79	134.23	0.2636	0.8752	122.49	133.82	0.2601
180	1.0707	127.10	138.98	0.2712	0.9103	126.83	138.62	0.2678
200	1.1100	131.47	143.79	0.2786	0.9446	131.23	143.46	0.2752
220	1.1488	135.91	148.66	0.2859	0.9784	135.69	148.36	0.2825
240	1.1871	140.42	153.60	0.2930	1.0118	140.22	153.33	0.2897
260	1.2251	145.00	158.60	0.3001	1.0448	144.82	158.35	0.2968
280	1.2627	149.65	163.67	0.3070	1.0774	149.48	163.44	0.3038
300	1.3001	154.38	168.81	0.3139	1.1098	154.22	168.60	0.3107
	$P = 80$ psia ($T_{\text{sat}} = 65.93^\circ\text{F}$)				$P = 90$ psia ($T_{\text{sat}} = 72.83^\circ\text{F}$)			
Sat.	0.5938	102.02	110.81	0.2175	0.5278	102.89	111.68	0.2172
80	0.6211	105.03	114.23	0.2239	0.5408	104.46	113.47	0.2205
100	0.6579	109.30	119.04	0.2327	0.5751	108.82	118.39	0.2295
120	0.6927	113.56	123.82	0.2411	0.6073	113.15	123.27	0.2380
140	0.7261	117.85	128.60	0.2492	0.6380	117.50	128.12	0.2463
160	0.7584	122.18	133.41	0.2570	0.6675	121.87	132.98	0.2542
180	0.7898	126.55	138.25	0.2647	0.6961	126.28	137.87	0.2620
200	0.8205	130.98	143.13	0.2722	0.7239	130.73	142.79	0.2696
220	0.8506	135.47	148.06	0.2796	0.7512	135.25	147.76	0.2770
240	0.8803	140.02	153.05	0.2868	0.7779	139.82	152.77	0.2843
260	0.9095	144.63	158.10	0.2940	0.8043	144.45	157.84	0.2914
280	0.9384	149.32	163.21	0.3010	0.8303	149.15	162.97	0.2984
300	0.9671	154.06	168.38	0.3079	0.8561	153.91	168.16	0.3054
320	0.9955	158.88	173.62	0.3147	0.8816	158.73	173.42	0.3122
	$P = 100$ psia ($T_{\text{sat}} = 79.17^\circ\text{F}$)				$P = 120$ psia ($T_{\text{sat}} = 90.54^\circ\text{F}$)			
Sat.	0.4747	103.68	112.46	0.2169	0.3941	105.06	113.82	0.2165
80	0.4761	103.87	112.68	0.2173	–	–	–	–
100	0.5086	108.32	117.73	0.2265	0.4080	107.26	116.32	0.2210
120	0.5388	112.73	122.70	0.2352	0.4355	111.84	121.52	0.2301
140	0.5674	117.13	127.63	0.2436	0.4610	116.37	126.61	0.2387
160	0.5947	121.55	132.55	0.2517	0.4852	120.89	131.66	0.2470
180	0.6210	125.99	137.49	0.2595	0.5082	125.42	136.70	0.2550
200	0.6466	130.48	142.45	0.2671	0.5305	129.97	141.75	0.2628
220	0.6716	135.02	147.45	0.2746	0.5520	134.56	146.82	0.2704
240	0.6960	139.61	152.49	0.2819	0.5731	139.20	151.92	0.2778
260	0.7201	144.26	157.59	0.2891	0.5937	143.89	157.07	0.2850
280	0.7438	148.98	162.74	0.2962	0.6140	148.63	162.26	0.2921
300	0.7672	153.75	167.95	0.3031	0.6339	153.43	167.51	0.2991
320	0.7904	158.59	173.21	0.3099	0.6537	158.29	172.81	0.3060

(Continued)

Table C.8a Superheated Refrigerant-134a Vapor (English Units) *continued*

T °F	v ft ³ /lbm	u Btu/lbm	h Btu/lbm	s Btu/(lbm · R)	v ft ³ /lbm	u Btu/lbm	h Btu/lbm	s Btu/(lbm · R)
	$P = 140$ psia ($T_{\text{sat}} = 100.56^\circ\text{F}$)				$P = 160$ psia ($T_{\text{sat}} = 109.55^\circ\text{F}$)			
Sat.	0.3358	106.25	114.95	0.2161	0.2916	107.28	115.91	0.2157
120	0.3610	110.90	120.25	0.2254	0.3044	109.88	118.89	0.2209
140	0.3846	115.58	125.24	0.2344	0.3269	114.73	124.41	0.2303
160	0.4066	120.21	130.74	0.2429	0.3474	119.49	129.78	0.2391
180	0.4274	124.82	135.89	0.2511	0.3666	124.20	135.06	0.2475
200	0.4474	129.44	141.03	0.2590	0.3849	128.90	140.29	0.2555
220	0.4666	134.09	146.18	0.2667	0.4023	133.61	145.52	0.2633
240	0.4852	138.77	151.34	0.2742	0.4192	138.34	150.75	0.2709
260	0.5034	143.50	156.54	0.2815	0.4356	143.11	156.00	0.2783
280	0.5212	148.28	161.78	0.2887	0.4516	147.92	161.29	0.2856
300	0.5387	153.11	167.06	0.2957	0.4672	152.78	166.61	0.2927
320	0.5559	157.99	172.39	0.3026	0.4826	157.69	171.98	0.2996
340	0.5730	162.93	177.78	0.3094	0.4978	162.65	177.39	0.3065
360	0.5898	167.93	183.21	0.3162	0.5128	167.67	182.85	0.3132
	$P = 180$ psia ($T_{\text{sat}} = 117.74^\circ\text{F}$)				$P = 200$ psia ($T_{\text{sat}} = 125.28^\circ\text{F}$)			
Sat.	0.2569	108.18	116.74	0.2154	0.2288	108.98	117.44	0.2151
120	0.2595	108.77	117.41	0.2166	–	–	–	–
140	0.2814	113.83	123.21	0.2264	0.2446	112.87	121.92	0.2226
160	0.3011	118.74	128.77	0.2355	0.2636	117.94	127.70	0.2321
180	0.3191	123.56	134.19	0.2441	0.2809	122.88	133.28	0.2410
200	0.3361	128.34	139.53	0.2524	0.2970	127.76	138.75	0.2494
220	0.3523	133.11	144.84	0.2603	0.3121	132.60	144.15	0.2575
240	0.3678	137.90	150.15	0.2680	0.3266	137.44	149.53	0.2653
260	0.3828	142.71	155.46	0.2755	0.3405	142.30	154.90	0.2728
280	0.3974	147.55	160.79	0.2828	0.3540	147.18	160.28	0.2802
300	0.4116	152.44	166.15	0.2899	0.3671	152.10	165.69	0.2874
320	0.4256	157.38	171.55	0.2969	0.3799	157.07	171.13	0.2945
340	0.4393	162.36	177.00	0.3038	0.3926	162.07	176.60	0.3014
360	0.4529	167.40	182.49	0.3106	0.4050	167.13	182.12	0.3082
	$P = 300$ psia ($T_{\text{sat}} = 156.17^\circ\text{F}$)				$P = 400$ psia ($T_{\text{sat}} = 179.95^\circ\text{F}$)			
Sat.	0.1424	111.72	119.62	0.2132	0.0965	112.77	119.91	0.2102
160	0.1462	112.95	121.07	0.2155	–	–	–	–
180	0.1633	118.93	128.00	0.2265	0.0965	112.79	119.93	0.2102
200	0.1777	124.47	134.34	0.2363	0.1143	120.14	128.60	0.2235
220	0.1905	129.79	140.36	0.2453	0.1275	126.35	135.79	0.2343
240	0.2021	134.99	146.21	0.2537	0.1386	132.12	142.38	0.2438
260	0.2130	140.12	151.95	0.2618	0.1484	137.65	148.64	0.2527
280	0.2234	145.23	157.63	0.2696	0.1575	143.06	154.72	0.2610
300	0.2333	150.33	163.28	0.2772	0.1660	148.39	160.67	0.2689
320	0.2428	155.44	168.92	0.2845	0.1740	153.69	166.57	0.2766
340	0.2521	160.57	174.56	0.2916	0.1816	158.97	172.42	0.2840
360	0.2611	165.74	180.23	0.2986	0.1890	164.26	178.26	0.2912
380	0.2699	170.94	185.92	0.3055	0.1962	169.57	184.09	0.2983
400	0.2786	176.18	191.64	0.3122	0.2032	174.90	189.94	0.3051

Table C.8b Superheated Refrigerant-134a Vapor (Metric Units)

T °C	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/(kg · K)	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/(kg · K)
	$P = 0.06$ MPa ($T_{\text{sat}} = -37.07^\circ\text{C}$)				$P = 0.10$ MPa ($T_{\text{sat}} = -26.43^\circ\text{C}$)			
Sat.	0.31003	206.12	224.72	0.9520	0.19170	212.18	231.35	0.9395
-20	0.33536	217.86	237.98	1.0062	0.19770	216.77	236.54	0.9602
-10	0.34992	224.97	245.96	1.0371	0.20686	224.01	244.70	0.9918
0	0.36433	232.24	254.10	1.0675	0.21587	231.41	252.99	1.0227
10	0.37861	239.69	262.41	1.0973	0.22473	238.96	261.43	1.0531
20	0.39279	247.32	270.89	1.1267	0.23349	246.67	270.02	1.0829
30	0.40688	255.12	279.53	1.1557	0.24216	254.54	278.76	1.1122
40	0.42091	263.10	288.35	1.1844	0.25076	262.58	287.66	1.1411
50	0.43487	271.25	297.34	1.2126	0.25930	270.79	296.72	1.1696
60	0.44879	279.58	306.51	1.2405	0.26779	279.16	305.94	1.1977
70	0.46266	288.08	315.84	1.2681	0.27623	287.70	315.32	1.2254
80	0.47650	296.75	325.34	1.2954	0.28464	296.40	324.87	1.2528
90	0.49031	305.58	335.00	1.3224	0.29302	305.27	334.57	1.2799
	$P = 0.14$ MPa ($T_{\text{sat}} = -18.80^\circ\text{C}$)				$P = 0.18$ MPa ($T_{\text{sat}} = -12.73^\circ\text{C}$)			
Sat.	0.13945	216.52	236.04	0.9322	0.10983	219.94	239.71	0.9273
-10	0.14549	223.03	243.40	0.9606	0.11135	222.02	242.06	0.9362
0	0.15219	230.55	251.86	0.9922	0.11678	229.67	250.69	0.9684
10	0.15875	238.21	260.43	1.0230	0.12207	237.44	259.41	0.9998
20	0.16520	246.01	269.13	1.0532	0.12723	245.33	268.23	1.0304
30	0.17155	253.96	277.97	1.0828	0.13230	253.36	277.17	1.0604
40	0.17783	262.06	286.96	1.1120	0.13730	261.53	286.24	1.0898
50	0.18404	270.32	296.09	1.1407	0.14222	269.85	295.45	1.1187
60	0.19020	278.74	305.37	1.1690	0.14710	278.31	304.79	1.1472
70	0.19633	287.32	314.80	1.1969	0.15193	286.93	314.28	1.1753
80	0.20241	296.06	324.39	1.2244	0.15672	295.71	323.92	1.2030
90	0.20846	304.95	334.14	1.2516	0.16148	304.63	333.70	1.2303
100	0.21449	314.01	344.04	1.2785	0.16622	313.72	343.63	1.2573
	$P = 0.20$ MPa ($T_{\text{sat}} = -10.09^\circ\text{C}$)				$P = 0.24$ MPa ($T_{\text{sat}} = -5.37^\circ\text{C}$)			
Sat.	0.09933	221.43	241.30	0.9253	0.08343	224.07	244.09	0.9222
-10	0.09938	221.50	241.38	0.9256	–	–	–	–
0	0.10438	229.23	250.10	0.9582	0.08574	228.31	248.89	0.9399
10	0.10922	237.05	258.89	0.9898	0.08993	236.26	257.84	0.9721
20	0.11394	244.99	267.78	1.0206	0.09399	244.30	266.85	1.0034
30	0.11856	253.06	276.77	1.0508	0.09794	252.45	275.95	1.0339
40	0.12311	261.26	285.88	1.0804	0.10181	260.72	285.16	1.0637
50	0.12758	269.61	295.12	1.1094	0.10562	269.12	294.47	1.0930
60	0.13201	278.10	304.50	1.1380	0.10937	277.67	303.91	1.1218
70	0.13639	286.74	314.02	1.1661	0.11307	286.35	313.49	1.1501
80	0.14073	295.53	323.68	1.1939	0.11674	295.18	323.19	1.1780
90	0.14504	304.47	333.48	1.2212	0.12037	304.15	333.04	1.2055
100	0.14932	313.57	343.43	1.2483	0.12398	313.27	343.03	1.2326
	$P = 0.28$ MPa ($T_{\text{sat}} = -1.23^\circ\text{C}$)				$P = 0.32$ MPa ($T_{\text{sat}} = 2.48^\circ\text{C}$)			
Sat.	0.07193	226.38	246.52	0.9197	0.06322	228.43	248.66	0.9177
0	0.07240	227.37	247.64	0.9238	–	–	–	–
10	0.07613	235.44	256.76	0.9566	0.06576	234.61	255.65	0.9427
20	0.07972	243.59	265.91	0.9883	0.06901	242.87	264.95	0.9749
30	0.08320	251.83	275.12	1.0192	0.07214	251.19	274.28	1.0062

(Continued)

Table C.8b Superheated Refrigerant-134a Vapor (Metric Units) *continued*

T °C	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/(kg · K)	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/(kg · K)
40	0.08660	260.17	284.42	1.0494	0.07518	259.61	283.67	1.0367
50	0.08992	268.64	293.81	1.0789	0.07815	268.14	293.15	1.0665
60	0.09319	277.23	303.32	1.1079	0.08106	276.79	302.72	1.0957
70	0.09641	285.96	312.95	1.1364	0.08392	285.56	312.41	1.1243
80	0.09960	294.82	322.71	1.1644	0.08674	294.46	322.22	1.1525
90	0.10275	303.83	332.60	1.1920	0.08953	303.50	332.15	1.1802
100	0.10587	312.98	342.62	1.2193	0.09229	312.68	342.21	1.2076
110	0.10897	322.27	352.78	1.2461	0.09503	322.00	352.40	1.2345
120	0.11205	331.71	363.08	1.2727	0.09774	331.45	362.73	1.2611
	$P = 0.40$ MPa ($T_{\text{sat}} = 8.93^\circ\text{C}$)				$P = 0.50$ MPa ($T_{\text{sat}} = 15.74^\circ\text{C}$)			
Sat.	0.05089	231.97	252.32	0.9145	0.04086	235.64	256.07	0.9117
10	0.05119	232.87	253.35	0.9182	–	–	–	–
20	0.05397	241.37	262.96	0.9515	0.04188	239.40	260.34	0.9264
30	0.05662	249.89	272.54	0.8937	0.04416	248.20	270.28	0.9597
40	0.05917	258.47	282.14	1.0148	0.04633	256.99	280.16	0.9918
50	0.06164	267.13	291.79	1.0452	0.04842	265.83	290.04	1.0229
60	0.06405	275.89	301.51	1.0748	0.05043	274.73	299.95	1.0531
70	0.06641	284.75	311.32	1.1038	0.05240	283.72	309.92	1.0825
80	0.06873	293.73	321.23	1.1322	0.05432	292.80	319.96	1.1114
90	0.07102	302.84	331.25	1.1602	0.05620	302.00	330.10	1.1397
100	0.07327	312.07	341.38	1.1878	0.05805	311.31	340.33	1.1675
110	0.07550	321.44	351.64	1.2149	0.05988	320.74	350.68	1.1949
120	0.07771	330.94	362.03	1.2417	0.06168	330.30	361.14	1.2218
130	0.07991	340.58	372.54	1.2681	0.06347	339.98	371.72	1.2484
140	0.08208	350.35	383.18	1.2941	0.06524	349.79	382.42	1.2746
	$P = 0.60$ MPa ($T_{\text{sat}} = 21.58^\circ\text{C}$)				$P = 0.70$ MPa ($T_{\text{sat}} = 26.72^\circ\text{C}$)			
Sat.	0.03408	238.74	259.19	0.9097	0.02918	241.42	261.85	0.9080
30	0.03581	246.41	267.89	0.9388	0.02979	244.51	265.37	0.9197
40	0.03774	255.45	278.09	0.9719	0.03157	253.83	275.93	0.9539
50	0.03958	264.48	288.23	1.0037	0.03324	263.08	286.35	0.9867
60	0.04134	273.54	298.35	1.0346	0.03482	272.31	296.69	1.0182
70	0.04304	282.66	308.48	1.0645	0.03634	281.57	307.01	1.0487
80	0.04469	291.86	318.67	1.0938	0.03781	290.88	317.35	1.0784
90	0.04631	301.14	328.93	1.1225	0.03924	300.27	327.74	1.1074
100	0.04790	310.53	339.27	1.1505	0.04064	309.74	338.19	1.1358
110	0.04946	320.03	349.70	1.1781	0.04201	319.31	348.71	1.1637
120	0.05099	329.64	360.24	1.2053	0.04335	328.98	359.33	1.1910
130	0.05251	339.38	370.88	1.2320	0.04468	338.76	370.04	1.2179
140	0.05402	349.23	381.64	1.2584	0.04599	348.66	380.86	1.2444
150	0.05550	359.21	392.52	1.2844	0.04729	358.68	391.79	1.2706
160	0.05698	369.32	403.51	1.3100	0.04857	368.82	402.82	1.2963
	$P = 0.80$ MPa ($T_{\text{sat}} = 31.33^\circ\text{C}$)				$P = 0.90$ MPa ($T_{\text{sat}} = 35.53^\circ\text{C}$)			
Sat.	0.02547	243.78	264.15	0.9066	0.02255	245.88	266.18	0.9054
40	0.02691	252.13	273.66	0.9374	0.02325	250.32	271.25	0.9217
50	0.02846	261.62	284.39	0.9711	0.02472	260.09	282.34	0.9566
60	0.02992	271.04	294.98	1.0034	0.02609	269.72	293.21	0.9897
70	0.03131	280.45	305.50	1.0345	0.02738	279.30	303.94	1.0214
80	0.03264	289.89	316.00	1.0647	0.02861	288.87	314.62	1.0521

Table C.8b Superheated Refrigerant-134a Vapor (Metric Units) *continued*

T °C	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/(kg · K)	v m ³ /kg	u kJ/kg	h kJ/kg	s kJ/(kg · K)
90	0.03393	299.37	326.52	1.0940	0.02980	298.46	325.28	1.0819
100	0.03519	308.93	337.08	1.1227	0.03095	308.11	335.96	1.1109
110	0.03642	318.57	347.71	1.1508	0.03207	317.82	346.68	1.1392
120	0.03762	328.31	358.40	1.1784	0.03316	327.62	357.47	1.1670
130	0.03881	338.14	369.19	1.2055	0.03423	337.52	368.33	1.1943
140	0.03997	348.09	380.07	1.2321	0.03529	347.51	379.27	1.2211
150	0.04113	358.15	391.05	1.2584	0.03633	357.61	390.31	1.2475
160	0.04227	368.32	402.14	1.2843	0.03736	367.82	401.44	1.2735
170	0.04340	378.61	413.33	1.3098	0.03838	378.14	412.68	1.2992
180	0.04452	389.02	424.63	1.3351	0.03939	388.57	424.02	1.3245
	$P = 1.00$ MPa ($T_{\text{sat}} = 39.39$°C)				$P = 1.20$ MPa ($T_{\text{sat}} = 46.32$°C)			
Sat.	0.02020	247.77	267.97	0.9043	0.01663	251.03	270.99	0.9023
40	0.02029	248.39	268.68	0.9066	–	–	–	–
50	0.02171	258.48	280.19	0.9428	0.01712	254.98	275.52	0.9164
60	0.02301	268.35	291.36	0.9768	0.01835	265.42	287.44	0.9527
70	0.02423	278.11	302.34	1.0093	0.01947	275.59	298.96	0.9868
80	0.02538	287.82	313.20	1.0405	0.02051	285.62	310.24	1.0192
90	0.02649	297.53	324.01	1.0707	0.02150	295.59	321.39	1.0503
100	0.02755	307.27	334.82	1.1000	0.02244	305.54	332.47	1.0804
110	0.02858	317.06	345.65	1.1286	0.02335	315.50	343.52	1.1096
120	0.02959	326.93	356.52	1.1567	0.02423	325.51	354.58	1.1381
130	0.03058	336.88	367.46	1.1841	0.02508	335.58	365.68	1.1660
140	0.03154	346.92	378.46	1.2111	0.02592	345.73	376.83	1.1933
150	0.03250	357.06	389.56	1.2376	0.02674	355.95	388.04	1.2201
160	0.03344	367.31	400.74	1.2638	0.02754	366.27	399.33	1.2465
170	0.03436	377.66	412.02	1.2895	0.02834	376.69	410.70	1.2724
180	0.03528	388.12	423.40	1.3149	0.02912	387.21	422.16	1.2980
	$P = 1.40$ MPa ($T_{\text{sat}} = 52.43$°C)				$P = 1.60$ MPa ($T_{\text{sat}} = 57.92$°C)			
Sat.	0.01405	253.74	273.40	0.9003	0.01208	256.00	275.33	0.8982
60	0.01495	262.17	283.10	0.9297	0.01233	258.48	278.20	0.9069
70	0.01603	272.87	295.31	0.9658	0.01340	269.89	291.33	0.9457
80	0.01701	283.29	307.10	0.9997	0.01435	280.78	303.74	0.9813
90	0.01792	293.55	318.63	1.0319	0.01521	291.39	315.72	1.0148
100	0.01878	303.73	330.02	1.0628	0.01601	301.84	327.46	1.0467
110	0.01960	313.88	341.32	1.0927	0.01677	312.20	339.04	1.0773
120	0.02039	324.05	352.59	1.1218	0.01750	322.53	350.53	1.1069
130	0.02115	334.25	363.86	1.1501	0.01820	332.87	361.99	1.1357
140	0.02189	344.50	375.15	1.1777	0.01887	343.24	373.44	1.1638
150	0.02262	354.82	386.49	1.2048	0.01953	353.66	384.91	1.1912
160	0.02333	365.22	397.89	1.2315	0.02017	364.15	396.43	1.2181
170	0.02403	375.71	409.36	1.2576	0.02080	374.71	407.99	1.2445
180	0.02472	386.29	420.90	1.2834	0.02142	385.35	419.62	1.2704
190	0.02541	396.96	432.53	1.3088	0.02203	396.08	431.33	1.2960
200	0.02608	407.73	444.24	1.3338	0.02263	406.90	443.11	1.3212

Table C.9a Saturated Refrigerant-22, Temperature Table (English Units)

Temp. °F T	Abs. press. psia p	Specific volume (ft ³ /lbm)			Internal energy (Btu/lbm)		
		Sat. liq. v_f	Evap. v_{fg}	Sat. vap. v_g	Sat. liq. u_f	Evap. u_{fg}	Sat. vap. u_g
-150	0.2716	0.01018	141.22	141.23	-25.98	106.40	80.42
-140	0.4469	0.01027	88.522	88.532	-23.73	105.09	81.36
-130	0.7106	0.01037	57.346	57.356	-21.46	103.77	83.31
-120	1.0954	0.01046	38.270	38.280	-10.19	102.45	83.26
-110	1.6417	0.01056	26.231	26.242	-16.89	101.11	84.22
-100	2.3989	0.01066	18.422	18.433	-14.57	99.76	85.19
-90	3.4229	0.01077	13.224	13.235	-12.22	98.38	86.16
-80	4.7822	0.01088	9.6840	9.6949	-9.85	96.98	87.13
-70	6.5522	0.01100	7.2208	7.2318	-7.49	95.59	88.10
-60	8.8180	0.01111	5.4733	5.4844	-5.01	94.08	89.07
-50	11.674	0.01124	4.2112	4.2224	-2.54	92.56	90.02
-40	15.222	0.01136	3.2843	3.2957	-0.03	91.01	90.97
-30	19.773	0.01150	2.5934	2.6049	2.51	89.40	91.91
-20	24.845	0.01163	2.0710	2.0826	5.13	87.82	92.95
-10	31.162	0.01178	1.6707	1.6825	7.68	86.07	93.75
0	38.657	0.01193	1.3604	1.3723	10.32	84.33	94.65
10	47.464	0.01209	1.1169	1.1290	13.00	82.53	95.53
20	57.727	0.01226	0.92405	0.93631	15.71	80.67	96.38
30	69.591	0.01243	0.76956	0.78208	18.45	78.76	97.21
40	83.206	0.01262	0.64491	0.65753	21.23	76.79	98.02
50	98.727	0.01281	0.54325	0.55606	24.04	74.75	98.79
60	116.31	0.01302	0.45970	0.47272	26.80	72.65	99.54
70	136.12	0.01325	0.39048	0.40373	29.78	70.46	100.24
80	158.33	0.01349	0.33272	0.34621	32.71	68.20	100.91
90	183.09	0.01375	0.28414	0.29789	35.69	65.84	101.53
100	210.60	0.01404	0.24298	0.25702	38.72	63.37	102.09
110	241.04	0.01435	0.20787	0.22222	41.81	60.78	102.59
120	274.60	0.01469	0.17768	0.19238	44.96	58.05	103.01
130	311.50	0.01508	0.15153	0.16661	48.19	55.14	103.33
140	351.94	0.01552	0.12866	0.14418	51.52	52.02	103.54
150	396.19	0.01602	0.10846	0.12448	54.97	48.63	103.60
160	444.53	0.01663	0.09038	0.10701	58.58	44.88	103.46
170	497.26	0.01737	0.07391	0.09128	62.42	40.62	103.04
180	554.78	0.01833	0.05846	0.07679	66.62	35.57	102.19
190	617.59	0.01973	0.04311	0.06284	71.46	29.09	100.55
200	686.36	0.02244	0.02500	0.04744	78.30	19.13	97.43
204.81	721.91	0.03053	0	0.03053	87.25	0	87.25

Table C.9a Saturated Refrigerant-22, Temperature Table (English Units) *continued*

Temp. °F T	Enthalpy (Btu/lbm)*			Entropy (Btu/(lbm · R))*		
	Sat. liq. h_f	Evap. h_{fg}	Sat. vapor h_g	Sat. liq. s_f	Evap. s_{fg}	Sat. vapor s_g
-150	-25.97	113.49	87.52	-0.07147	0.36648	0.29501
-140	-23.72	112.40	88.68	-0.06432	0.35161	0.28729
-130	-21.46	111.31	89.85	-0.05736	0.33763	0.28027
-120	-19.19	110.21	91.02	-0.05055	0.32443	0.27388
-110	-16.89	109.09	92.20	-0.04389	0.31194	0.26805
-100	-14.56	107.93	93.37	-0.03734	0.30008	0.26274
-90	-12.22	106.76	94.54	-0.03091	0.28878	0.25787
-80	-9.84	105.55	95.71	-0.02457	0.27799	0.25342
-70	-7.43	104.30	96.87	-0.01832	0.26764	0.24932
-60	-4.99	103.00	98.01	-0.01214	0.25770	0.24556
-50	-2.51	101.65	99.14	-0.00604	0.24813	0.24209
-40	0	100.26	100.26	0.00000	0.23888	0.23888
-30	2.55	98.80	101.35	0.00598	0.22993	0.23591
-20	5.13	97.29	102.42	0.01189	0.22126	0.23315
-10	7.75	95.70	103.45	0.01776	0.21282	0.23058
0	10.41	94.06	104.47	0.02357	0.20460	0.22817
10	13.10	92.34	105.44	0.02932	0.19660	0.22592
20	15.84	90.54	106.38	0.03503	0.18876	0.22379
30	18.61	88.67	107.28	0.04070	0.18108	0.22178
40	21.42	86.72	108.14	0.04632	0.17354	0.21986
50	24.27	84.68	108.95	0.05190	0.16613	0.21803
60	27.17	82.54	109.71	0.05745	0.15882	0.21627
70	30.12	80.29	110.41	0.06296	0.15160	0.21456
80	33.11	77.94	111.05	0.06846	0.14442	0.21288
90	36.16	75.46	111.62	0.07394	0.13728	0.21122
100	39.27	72.84	112.11	0.07942	0.13014	0.20956
110	42.45	70.05	112.50	0.08491	0.12296	0.20787
120	45.70	67.08	112.78	0.09042	0.11571	0.20613
130	49.06	63.88	112.94	0.09598	0.10833	0.20431
140	52.53	60.40	112.93	0.10163	0.10072	0.20235
150	56.14	56.59	112.73	0.10739	0.09281	0.20020
160	59.95	52.31	112.26	0.11334	0.08442	0.19776
170	64.02	47.40	111.42	0.11959	0.07531	0.19490
180	68.50	41.57	110.07	0.12635	0.06498	0.19133
190	73.71	34.02	107.73	0.13409	0.05237	0.18646
200	80.86	21.99	102.85	0.14460	0.03334	0.17794
204.81	91.33	0	91.33	0.16016	0	0.16016

* The enthalpy and entropy of saturated liquid R-22 are taken as zero at a temperature of -40°F .
Source: Reprinted by permission from Haberman, W. L., John, J. E. A., 1980. *Engineering Thermodynamics*. Allyn & Bacon, Boston, MA, pp. 414–415 (Table A.10).

Table C.9b Saturated Refrigerant-22, Temperature Table (Metric Units)

Temp. °C <i>T</i>	Abs. press. (kPa) <i>p</i>	Specific volume (m ³ /kg)			Internal energy (kJ/kg)		
		Sat. liq. <i>v_f</i>	Evap. <i>v_{fg}</i>	Sat. vapor <i>v_g</i>	Sat. liq. <i>u_f</i>	Evap. <i>u_{fg}</i>	Sat. vapor <i>u_g</i>
-100	2.0750	0.0006366	8.0083	8.0089	-59.37	246.86	187.49
-95	3.2323	0.0006418	5.2845	5.2851	-54.66	244.12	189.46
-90	4.8994	0.0006470	3.5804	3.5810	-49.92	241.36	191.36
-85	7.2412	0.0006525	2.4847	2.4854	-45.16	238.59	193.43
-80	10.461	0.0006581	1.7626	1.7633	-40.36	235.80	195.44
-75	14.794	0.0006638	1.2757	1.2764	-35.52	233.00	197.48
70	20.523	0.0006697	0.94033	0.94100	-30.62	230.13	199.51
-65	27.965	0.0006758	0.69876	0.70552	-25.68	227.21	201.53
-60	37.480	0.0006821	0.53649	0.53717	-20.68	224.25	203.57
-55	49.474	0.0006885	0.41416	0.41485	-15.62	221.22	205.60
-50	63.139	0.0006952	0.32387	0.32457	-10.50	218.52	208.02
-45	82.701	0.0007022	0.25630	0.25700	-5.32	214.94	209.62
-40	104.943	0.0007093	0.20505	0.20576	-0.07	211.68	211.61
-35	131.669	0.0007168	0.16569	0.16569	5.24	208.33	213.57
-30	163.470	0.0007245	0.13513	0.13585	10.60	204.91	215.51
-25	200.968	0.0007325	0.11113	0.11186	16.01	203.45	217.44
-20	244.814	0.0007409	0.092106	0.092847	21.55	197.77	219.32
-15	295.686	0.0007496	0.076878	0.077628	27.11	194.07	221.18
-10	354.284	0.0007587	0.064583	0.065342	32.74	190.25	222.99
-5	421.330	0.0007683	0.054573	0.055341	35.52	189.24	224.76
0	497.567	0.0007783	0.046359	0.047137	44.20	182.30	226.50
5	583.756	0.0007889	0.039568	0.040357	50.02	178.15	228.17
10	680.673	0.0008000	0.033915	0.034715	55.92	173.87	229.79
15	789.117	0.0008118	0.029177	0.029989	61.88	169.48	231.36
20	909.899	0.0008243	0.025180	0.026004	67.92	164.92	232.84
25	1043.856	0.0008376	0.021787	0.022625	74.04	160.22	234.26
30	1191.842	0.0008519	0.018891	0.019743	80.23	155.36	235.59
35	1354.741	0.0008673	0.016400	0.017267	86.52	150.30	236.82
40	1533.466	0.0008839	0.014859	0.015137	92.90	145.04	237.94
45	1728.969	0.0009020	0.012384	0.013286	99.40	139.53	238.93
50	1942.254	0.0009219	0.010751	0.011672	106.04	133.73	239.77
55	2174.382	0.0009440	0.009440	0.010257	112.81	127.62	240.43
60	2426.496	0.0009687	0.0080321	0.0090008	119.83	121.01	240.84
65	2699.843	0.0009970	0.0068907	0.0078877	127.04	113.93	240.97
70	2995.810	0.0010298	0.0058593	0.0068891	134.53	106.23	240.76
75	3316.03	0.0010691	0.0049144	0.0059835	142.43	97.62	240.05
80	3662.29	0.0011181	0.0040307	0.0051488	150.92	87.70	238.62
85	4036.81	0.0011832	0.0031751	0.0043583	160.31	75.79	236.10
90	4442.50	0.0012822	0.0022823	0.0035645	171.50	59.90	231.40
95	4883.49	0.0015205	0.0010311	0.0025516	188.92	29.92	218.84
96.006	4977.39	0.0019056	0	0.0019056	203.09	0	203.09

* The enthalpy and entropy of saturated liquid R-22 are taken as zero at a temperature of -40°F.

Source: Reprinted by permission from Haberman, W. L., John, J. E. A., 1980. *Engineering Thermodynamics*. Allyn & Bacon, Boston, MA, pp. 472-473 (Table B.10).

Table C.9b Saturated Refrigerant-22, Temperature Table (Metric Units) *continued*

Temp. °C T	Enthalpy (kJ/kg)*			Entropy (kJ/(kg · K))*		
	Sat. liq. h_f	Evap. h_{fg}	Sat. vapor h_g	Sat. liq. s_f	Evap. s_{fg}	Sat. vapor s_g
-100	-59.37	263.48	204.11	-0.29317	1.52159	1.22842
-95	-54.66	261.20	206.54	-0.26426	1.46397	1.19971
-90	-49.92	258.91	208.98	-0.24016	1.41356	1.17340
-85	-45.16	256.59	211.43	-0.21447	1.36369	1.14922
-80	-40.35	254.25	213.89	-0.18928	1.31624	1.12696
-75	-35.51	251.87	216.36	-0.16452	1.27098	1.10646
-70	-30.61	249.42	218.82	-0.14012	1.22771	1.08759
-65	-25.66	246.92	221.26	-0.11611	1.18621	1.07010
-60	-20.65	244.35	223.70	-0.09234	1.14629	1.05395
-55	-15.59	241.70	226.12	-0.06891	1.10792	1.03901
-50	-10.46	238.96	228.51	-0.04569	1.07081	1.02512
-45	-5.26	236.13	230.87	-0.02276	1.03495	1.01219
-40	0.00	233.20	233.20	0.00000	1.00014	1.00014
-35	5.33	230.15	235.48	0.02251	0.96638	0.98889
-30	10.72	227.00	237.72	0.04485	0.93354	0.97839
-25	16.19	223.72	239.92	0.06699	0.90152	0.96851
-20	21.73	220.33	242.05	0.08895	0.87032	0.95927
-15	27.33	216.79	244.13	0.11075	0.83977	0.95052
-10	33.01	213.13	246.14	0.13234	0.80990	0.94224
-5	38.76	209.32	248.08	0.15380	0.78057	0.93437
0	44.59	205.36	249.95	0.17178	0.75178	0.92688
5	50.48	201.24	251.73	0.19627	0.72346	0.91973
10	56.46	196.96	253.42	0.21727	0.69559	0.91286
15	62.52	192.49	255.02	0.23819	0.66802	0.90621
20	68.67	187.84	256.50	0.25899	0.64074	0.89973
25	74.91	182.97	257.88	0.27970	0.61367	0.89337
30	81.25	177.87	259.12	0.30037	0.58676	0.88713
35	87.69	172.52	260.22	0.32104	0.55982	0.88086
40	94.26	166.89	261.15	0.34167	0.53291	0.87458
45	100.96	160.94	261.90	0.36233	0.50585	0.86818
50	107.83	154.62	262.44	0.38313	0.47844	0.86157
55	114.86	147.86	262.73	0.40409	0.45058	0.85467
60	122.18	140.50	262.68	0.42547	0.42171	0.84718
65	129.73	132.54	262.27	0.44714	0.39200	0.83914
70	137.62	123.77	261.40	0.46944	0.36071	0.83015
75	145.98	113.90	259.89	0.49267	0.32714	0.81981
80	155.01	102.47	257.48	0.51735	0.29016	0.80751
85	165.09	88.60	253.69	0.54446	0.24736	0.79182
90	177.04	70.04	247.24	0.57664	0.19288	0.76952
95	196.35	34.96	231.30	0.62731	0.09493	0.72224
96.006	212.57	0	212.57	0.67090	0	0.67090

* The enthalpy and the entropy of saturated liquid R-22 are taken as zero at a temperature of -40°C .

Source: Reprinted by permission from Haberman, W. L., John, J. E. A., 1980. *Engineering Thermodynamics*. Allyn & Bacon, Boston, MA, pp. 472–473 (Table B.10).

Abs. press. (psia) P	Sat. temp. ($^{\circ}\text{F}$) T	Sat. vapor	Temperature ($^{\circ}\text{F}$)					
			-100	0	100	200	300	400
Specific volume, v (ft^3/lbm)								
v_g								
0.2	-155.80	188.29	223.01	285.14	347.22	409.32	471.37	533.42
0.5	-137.64	79.698	89.095	114.00	138.85	163.70	188.55	213.37
1	-122.16	41.678	44.458	56.949	69.397	81.83	94.27	106.68
2	-104.87	21.831	22.139	28.426	34.668	40.893	47.12	53.34
5	-78.62	9.3011	–	11.311	13.831	16.333	18.83	21.34
10	-55.58	4.8778	–	5.6060	6.8855	8.1464	9.399	10.65
15	-40.57	3.3412	–	3.7037	4.5701	5.4174	6.256	7.10
20	-29.12	2.5527	–	2.7521	3.4122	4.0529	4.685	5.325
40	1.63	1.3285	–	–	1.6749	2.0060	2.3281	2.657
60	22.03	0.90222	–	–	1.0952	1.3235	1.5424	1.767
80	37.76	0.68318	–	–	0.80477	0.98209	1.1495	1.323
100	50.77	0.54908	–	–	0.63003	0.77712	0.91372	1.046
120	61.95	0.45822	–	–	0.51309	0.64036	0.75651	0.8678
140	71.83	0.39243	–	–	0.42911	0.54258	0.64419	0.7409
160	80.71	0.34249	–	–	0.36568	0.46914	0.55993	0.6447
180	88.81	0.30323	–	–	0.31587	0.41194	0.49437	0.5715
200	96.27	0.27150	–	–	0.27553	0.36609	0.44190	0.51218
250	112.76	0.21351	–	–	–	0.28325	0.34740	0.40549
300	126.98	0.17400	–	–	–	0.22759	0.28431	0.33436
350	139.54	0.14514	–	–	–	0.18738	0.23917	0.28356
400	150.82	0.12297	–	–	–	0.15674	0.20524	0.24546
500	170.50	0.09053	–	–	–	0.11220	0.15757	0.19212
Internal energy, u (Btu/lbm)								
u_g								
0.2	-155.80	79.88	85.37	96.49	109.20	123.42	139.07	156.01
0.5	-137.64	81.58	85.34	96.47	109.19	123.42	139.06	156.00
1	-122.16	83.05	85.30	96.45	109.18	123.40	139.04	155.98
2	-104.87	84.72	85.22	96.41	109.15	123.38	139.02	155.95
5	-78.62	87.27	–	96.30	109.07	123.33	138.96	155.87
10	-55.58	89.49	–	96.04	108.93	123.24	138.86	155.78
15	-40.57	90.92	–	95.81	108.80	123.15	138.80	155.69
20	-29.12	92.00	–	95.57	108.66	123.06	138.74	155.60
40	1.63	94.79	–	–	108.09	122.69	138.49	155.28
60	22.03	96.55	–	–	107.50	122.32	138.23	155.02
80	37.76	97.84	–	–	106.89	121.94	137.96	154.86
100	50.77	98.85	–	–	106.25	121.55	137.70	154.77
120	61.95	99.68	–	–	105.59	121.16	137.43	154.58
140	71.83	100.37	–	–	104.89	120.75	137.15	154.41
160	80.71	100.96	–	–	104.16	120.34	136.88	154.24
180	88.81	101.46	–	–	103.38	119.92	136.60	154.07
200	96.27	101.89	–	–	102.55	119.49	136.31	153.82
250	112.76	102.71	–	–	–	118.36	135.59	153.29
300	126.98	103.24	–	–	–	117.15	134.84	152.75
350	139.54	103.54	–	–	–	115.85	134.06	152.20
400	150.82	103.60	–	–	–	114.42	133.26	151.64
500	170.50	103.01	–	–	–	111.05	131.55	150.48

Table C.10a Superheated Refrigerant-22 Vapor (English Units) *continued*

Abs. press. (psia) <i>P</i>	Sat. temp. (°F) <i>T</i>	Sat. vapor	Temperature (°F)					
			-100	0	100	200	300	400
Enthalpy, <i>h</i> (Btu/lbm)								
		<i>h_g</i>						
0.2	-155.80	86.85	93.62	107.04	122.05	138.57	156.52	175.75
0.5	-137.64	88.96	93.59	107.02	122.04	138.56	156.51	175.74
1	-122.16	90.77	93.53	106.99	122.02	138.54	156.49	175.72
2	-104.87	92.80	93.42	106.93	121.98	138.51	156.46	175.69
5	-78.62	95.87	–	106.74	121.87	138.44	156.38	175.61
10	-55.58	98.52	–	106.41	121.67	138.31	156.26	175.49
15	-40.57	100.19	–	106.09	121.48	138.18	156.16	175.39
20	-29.12	101.44	–	105.76	121.28	138.06	156.08	175.31
40	1.63	104.63	–	–	120.49	137.54	155.72	174.95
60	22.03	106.57	–	–	119.66	137.01	155.35	174.64
80	37.76	107.95	–	–	118.80	136.48	154.98	174.45
100	50.77	109.01	–	–	117.91	135.93	154.61	174.13
120	61.95	109.85	–	–	116.98	135.38	154.23	173.85
140	71.83	110.54	–	–	116.01	134.81	153.84	173.60
160	80.71	111.10	–	–	114.99	134.23	153.46	173.33
180	88.81	111.56	–	–	113.90	133.64	153.06	173.10
200	96.27	111.93	–	–	112.75	133.03	152.67	172.78
250	112.76	112.59	–	–	–	131.46	151.66	172.05
300	126.98	112.90	–	–	–	129.78	150.62	171.31
350	139.54	112.94	–	–	–	127.98	149.55	170.51
400	150.82	112.70	–	–	–	126.02	148.45	169.81
500	170.50	111.38	–	–	–	121.43	146.13	168.26
Entropy, <i>s</i> (Btu/(lbm · R))								
		<i>s_g</i>						
0.2	-155.80	0.29985	0.32028	0.35311	0.38261	0.40982	0.43515	0.45889
0.5	-137.64	0.28557	0.29917	0.33204	0.36155	0.38878	0.41411	0.43785
1	-122.16	0.27521	0.28314	0.31607	0.34561	0.37274	0.39807	0.42193
2	-104.87	0.26527	0.26700	0.30005	0.32964	0.35679	0.38212	0.40590
5	-78.62	0.25283	–	0.27872	0.30845	0.33566	0.36099	0.38477
10	-55.58	0.24399	–	0.26230	0.29229	0.31961	0.34494	0.36872
15	-40.57	0.23906	–	0.25248	0.28273	0.31016	0.33553	0.35931
20	-29.12	0.23566	–	0.24535	0.27588	0.30342	0.32884	0.35262
40	1.63	0.22780	–	–	0.25893	0.28694	0.31259	0.33637
60	22.03	0.22337	–	–	0.24855	0.27706	0.30293	0.32679
80	37.76	0.22029	–	–	0.24083	0.26987	0.29598	0.31998
100	50.77	0.21790	–	–	0.23454	0.26415	0.29050	0.31464
120	61.95	0.21593	–	–	0.22912	0.25936	0.28595	0.31024
140	71.83	0.21425	–	–	0.22428	0.25520	0.28205	0.30648
160	80.71	0.21276	–	–	0.21984	0.25149	0.27862	0.30320
180	88.81	0.21142	–	–	0.21566	0.24813	0.27554	0.30026
200	96.27	0.21018	–	–	0.21165	0.24503	0.27274	0.29760
250	112.76	0.20740	–	–	–	0.23814	0.26665	0.29186
300	126.98	0.20487	–	–	–	0.23204	0.26146	0.28705
350	139.54	0.20244	–	–	–	0.22641	0.25688	0.28286
400	150.82	0.20001	–	–	–	0.22104	0.25273	0.27914
500	170.50	0.19474	–	–	–	0.21034	0.24532	0.27267

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Abs. press. (kPa)	Sat. temp. (°C)	Sat. vapor	Temperature (°C)					
			T_g	-50	0	50	100	150
Specific volume, h (m³/kg)								
		v_g						
1	-107.61	15.885	21.455	26.263	31.070	35.876	40.685	45.492
5	-89.79	3.519	4.283	5.248	6.211	7.176	8.137	9.098
10	-80.64	1.8411	2.137	2.621	3.104	3.588	4.069	4.549
20	-70.41	0.9646	1.064	1.308	1.550	1.794	2.034	2.275
40	-58.86	0.5059	0.527	0.651	0.773	0.897	1.017	1.138
60	-51.37	0.3468	0.349	0.432	0.514	0.596	0.673	0.759
80	-45.68	0.2652	–	0.323	0.385	0.446	0.510	0.570
100	-41.03	0.2152	–	0.257	0.307	0.356	0.407	0.455
200	-25.12	0.1123	–	0.1260	0.1519	0.1770	0.2020	0.2260
300	-14.61	0.0766	–	0.0822	0.1001	0.1172	0.1331	0.1497
400	-6.52	0.0582	–	0.0598	0.0739	0.0871	0.0994	0.118
500	0.15	0.0469	–	–	0.0586	0.0694	0.0796	0.0895
600	5.88	0.0393	–	–	0.0482	0.0573	0.0660	0.0744
700	10.93	0.0338	–	–	0.0408	0.0488	0.0564	0.0637
800	15.47	0.0296	–	–	0.0347	0.0418	0.0489	0.0555
900	19.61	0.0263	–	–	0.0307	0.0373	0.0434	0.0493
1000	23.42	0.0237	–	–	0.0272	0.0333	0.0388	0.0442
1500	39.10	0.0155	–	–	0.0168	0.0213	0.0253	0.0294
2000	51.28	0.0113	–	–	–	0.0153	0.0184	0.0214
2500	61.38	0.0087	–	–	–	0.0116	0.0144	0.0169
3000	70.07	0.0069	–	–	–	0.0091	0.0117	0.0138
Internal energy, v (kJ/kg)								
		u_g						
1	-107.61	184.53	208.93	233.47	260.97	290.87	323.67	358.81
5	-89.79	191.51	208.88	233.44	260.95	290.86	323.66	358.80
10	-80.64	195.18	208.78	233.39	260.92	290.84	323.64	358.79
20	-70.41	199.32	208.56	233.24	260.82	290.82	323.63	358.77
40	-58.86	204.01	208.09	232.94	260.59	290.79	323.62	358.75
60	-51.37	207.04	207.64	232.66	260.40	290.73	323.58	358.72
80	-45.68	209.33	–	232.38	260.21	290.66	323.52	358.65
100	-41.03	211.19	–	232.11	260.02	290.52	323.43	358.56
200	-25.12	217.40	–	230.84	259.29	290.07	323.13	358.41
300	-14.61	221.31	–	229.38	258.36	289.42	322.77	358.11
400	-6.52	224.22	–	227.99	257.48	288.76	322.30	357.91
500	0.15	226.55	–	–	256.66	288.25	321.90	357.60
600	5.88	228.45	–	–	255.67	287.67	321.45	357.23
700	10.93	230.07	–	–	254.80	287.02	320.94	356.75
800	15.47	231.48	–	–	253.97	286.75	320.60	356.43
900	19.61	232.72	–	–	252.84	285.86	320.05	355.93
1000	23.42	233.75	–	–	251.61	285.04	319.61	355.51
1500	39.10	237.74	–	–	245.91	281.80	317.28	353.30
2000	51.28	239.94	–	–	–	278.10	315.07	352.20
2500	61.38	240.85	–	–	–	274.17	312.35	350.21
3000	70.07	240.68	–	–	–	269.41	309.39	348.33

Table C.10b Superheated Refrigerant-22 Vapor (Metric Units) *continued*

Abs. press. (kPa)	Sat. temp. (°C)	Sat. vapor	Temperature (°C)					
			T_g	-50	0	50	100	150
Enthalpy, h (kJ/kg)								
		h_g						
1	-107.61	200.41	230.38	259.73	292.04	326.75	364.35	404.30
5	-89.79	209.10	230.29	259.68	292.00	326.74	364.34	404.29
10	-80.64	213.59	230.15	259.60	291.96	326.72	364.33	404.28
20	-70.41	218.61	229.84	259.40	291.82	326.70	364.32	404.27
40	-58.86	224.25	229.17	258.98	291.51	326.67	364.31	404.26
60	-51.37	227.85	228.56	258.59	291.25	326.51	364.30	404.25
80	-45.68	230.55	–	258.22	291.01	326.34	364.28	404.23
100	-41.03	232.71	–	257.81	290.81	326.12	364.08	404.05
200	-25.12	239.86	–	256.04	289.67	325.47	363.53	403.60
300	-14.61	244.29	–	254.04	288.39	324.58	362.72	403.02
400	-6.52	247.50	–	251.91	287.04	323.60	362.08	402.62
500	0.15	250.00	–	–	285.96	322.95	361.70	402.37
600	5.88	252.03	–	–	284.59	322.05	361.05	401.87
700	10.93	253.73	–	–	283.36	321.18	360.42	401.32
800	15.47	255.16	–	–	281.73	320.19	359.72	400.82
900	19.61	256.39	–	–	280.47	319.43	359.11	400.31
1000	23.42	257.45	–	–	278.81	318.34	358.41	399.66
1500	39.10	260.99	–	–	271.11	313.75	355.23	397.40
2000	51.28	262.54	–	–	–	308.70	351.87	395.00
2500	61.38	262.60	–	–	–	303.17	348.35	392.46
3000	70.07	261.38	–	–	–	296.71	344.49	389.73
Entropy, s (kJ/(kg · K))								
		s_g						
1	-107.61	1.27520	1.43157	1.55006	1.65851	1.75784	1.85237	1.94160
5	-89.79	1.17223	1.27655	1.39517	1.50370	1.60310	1.69763	1.78686
10	-80.64	1.12969	1.20937	1.32828	1.43689	1.53645	1.63098	1.72049
20	-70.41	1.08905	1.14178	1.26115	1.36998	1.46981	1.56434	1.65417
40	-58.86	1.05047	1.07252	1.19285	1.30205	1.40317	1.49770	1.58763
60	-51.37	1.02880	1.03197	1.15310	1.26268	1.36402	1.45855	1.54858
80	-45.68	1.01390	–	1.12447	1.23451	1.33601	1.43054	1.52067
100	-41.03	1.00240	–	1.10201	1.21251	1.31426	1.40924	1.49902
200	-25.12	0.96876	–	1.03090	1.14387	1.25603	1.35131	1.44089
300	-14.61	0.94985	–	0.98699	1.10230	1.20627	1.30160	1.39123
400	-6.52	0.93671	–	0.95345	1.07131	1.17637	1.27173	1.36163
500	0.15	0.92667	–	–	1.04749	1.15389	1.25125	1.34573
600	5.88	0.91851	–	–	1.02686	1.13460	1.23263	1.32711
700	10.93	0.91160	–	–	1.00967	1.11845	1.21698	1.31146
800	15.47	0.90558	–	–	0.99155	1.10218	1.20155	1.29603
900	19.61	0.90022	–	–	0.97826	1.09031	1.19035	1.28483
1000	23.42	0.89537	–	–	0.96455	1.07831	1.17906	1.27354
1500	39.10	0.87571	–	–	0.90752	1.03033	1.13463	1.22911
2000	51.28	0.85985	–	–	–	0.99257	1.10115	1.19750
2500	61.38	0.84625	–	–	–	0.96324	1.07357	1.17206
3000	70.07	0.83002	–	–	–	0.92890	1.04919	1.15023

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Sat. press., psia	Sat. temp., °F	Specific volume, ft ³ /lbm		Enthalpy, Btu/lbm			Entropy, Btu/(lbm · R)		
		v_f	v_g	h_f	h_{fg}	h_g	s_f	s_{fg}	s_g
0.01	233.57	1.21×10^{-3}	3637	6.668	127.732	134.400	0.01137	0.18428	0.19565
0.02	259.88	1.21	1893	7.532	127.614	135.146	0.01259	0.17735	0.18994
0.03	276.22	1.21	1292	8.068	127.540	135.608	0.01332	0.17332	0.18664
0.05	297.97	1.21	799	8.778	127.442	136.220	0.01427	0.16821	0.18248
0.1	329.73	1.22	416	9.814	127.300	137.114	0.01561	0.16126	0.17687
0.2	364.25	1.22×10^{-3}	217.3	10.936	127.144	138.080	0.01699	0.15432	0.17131
0.3	385.92	1.22	148.6	11.639	127.047	138.686	0.01783	0.15024	0.16807
0.4	401.98	1.22	113.7	12.159	126.975	139.134	0.01844	0.14736	0.16580
0.5	415.00	1.22	92.18	12.568	126.916	139.484	0.01892	0.14511	0.16403
0.6	425.82	1.23	77.84	12.929	126.868	139.797	0.01932	0.14328	0.16260
0.8	443.50	1.23×10^{-3}	59.58	13.500	126.788	140.288	0.01994	0.14038	0.16032
1	457.72	1.24	48.42	13.959	126.724	140.683	0.02045	0.13814	0.15859
2	504.93	1.24	25.39	15.476	126.512	141.988	0.02205	0.13116	0.15321
3	535.25	1.24	17.50	16.439	126.377	142.816	0.02302	0.12706	0.15008
5	575.7	1.24	10.90	17.741	126.193	143.934	0.02430	0.12188	0.14618
7	604.7	1.25×10^{-3}	8.04	18.657	126.065	144.722	0.02516	0.11846	0.14362
10	637.0	1.25	5.81	19.685	125.919	145.604	0.02610	0.11483	0.14093
20	706.0	1.26	3.09	21.864	125.609	147.473	0.02800	0.10779	0.13579
40	784.4	1.27	1.648	24.345	125.255	149.600	0.03004	0.10068	0.13072
60	835.7	1.28	1.144	25.940	125.024	150.964	0.03127	0.09652	0.12779
80	874.8	1.29×10^{-3}	0.885	27.149	124.849	152.008	0.03218	0.09356	0.12574
100	906.8	1.29	0.725	28.152	124.706	152.858	0.03290	0.09127	0.12417
150	969.4	1.30	0.507	30.090	124.424	154.514	0.03425	0.08707	0.12132
200	1017.2	1.31	0.392	31.560	124.209	155.769	0.03523	0.08411	0.11934
250	1057.2	1.31	0.322	32.784	124.029	156.813	0.03603	0.08178	0.11781
300	1091.2	1.32×10^{-3}	0.276	33.824	123.876	157.700	0.03669	0.07989	0.11658
400	1148.4	1.32	0.215	35.565	123.620	159.185	0.03775	0.07688	0.11463
450	1173.2	1.32	0.194	36.315	123.509	159.824	0.03820	0.07566	0.11386
500	1196.0	1.33	0.177	37.006	123.406	160.412	0.03861	0.07455	0.11316
600	1236.8	1.34	0.151	38.245	123.221	161.466	0.03932	0.07264	0.11196
700	1273.3	1.34×10^{-3}	0.132	39.339	123.058	162.397	0.03993	0.07102	0.11095
800	1306.1	1.34	0.118	40.324	122.910	163.234	0.04047	0.06961	0.11008
900	1336.2	1.35	0.106	41.226	122.775	164.001	0.04095	0.06837	0.10932
1000	1364.0	1.35	0.098	42.056	122.649	164.705	0.04139	0.06726	0.10865
1100	1390.0	1.36	0.090	42.828	122.533	165.361	0.04179	0.06625	0.10804

Sources: Reprinted by permission from Sheldon, L. A. *Thermodynamic Properties of Mercury Vapor*. General Electric Company, 1948. Liquid densities from WADC TR-59-598. Also from Reynolds, W. C., Perkins, H. C., 1977. *Engineering Thermodynamics*, second ed. McGraw-Hill, New York, p. 638 (Table B-3).

Table C.11b Saturated Mercury, Pressure Table (Metric Units)

Sat. press., MPa	Sat. temp., °C	Specific volume, m ³ /lbm v_g	Enthalpy, kJ/kg			Entropy, kJ/(kg · K)		
			h_f	h_{fg}	h_g	s_f	s_{fg}	s_g
0.000 06	109.2	259.6	15.13	297.20	312.33	0.0466	0.7774	0.8240
0.000 07	112.3	224.3	15.55	297.14	312.69	0.0477	0.7709	0.8186
0.000 08	115.0	197.7	15.93	297.09	313.02	0.0487	0.7654	0.8141
0.000 09	117.5	176.8	16.27	297.04	313.31	0.0496	0.7604	0.8100
0.000 10	119.7	160.1	16.58	297.00	313.58	0.0503	0.7560	0.8063
0.0002	134.9	83.18	18.67	296.71	315.38	0.0556	0.7271	0.7827
0.0004	151.5	43.29	20.93	296.40	317.33	0.0610	0.6981	0.7591
0.0006	161.8	29.57	22.33	296.21	318.54	0.0643	0.6811	0.7454
0.0008	169.4	22.57	23.37	296.06	319.43	0.0666	0.6690	0.7356
0.0010	175.5	18.31	24.21	295.95	320.16	0.0685	0.6596	0.7281
0.002	195.6	9.570	26.94	295.57	322.51	0.0744	0.6305	0.7049
0.004	217.7	5.013	29.92	295.15	325.07	0.0806	0.6013	0.6819
0.006	231.6	3.438	31.81	294.89	326.70	0.0843	0.5842	0.6685
0.008	242.0	2.632	33.21	294.70	327.91	0.0870	0.5721	0.6591
0.010	250.3	2.140	34.33	294.54	328.87	0.0892	0.5627	0.6519
0.02	278.1	1.128	38.05	294.02	332.07	0.0961	0.5334	0.6295
0.04	309.1	0.5942	42.21	293.43	335.64	0.1034	0.5039	0.6073
0.06	329.0	0.4113	44.85	293.06	337.91	0.1078	0.4869	0.5947
0.08	343.9	0.3163	46.84	292.78	339.62	0.1110	0.4745	0.5855
0.1	356.1	0.2581	48.45	292.55	341.00	0.1136	0.4649	0.5785
0.2	397.1	0.1377	53.87	291.77	345.64	0.1218	0.4353	0.5571
0.3	423.8	0.095 51	57.38	291.27	348.65	0.1268	0.4179	0.5447
0.4	444.1	0.073 78	60.03	290.89	350.92	0.1305	0.4056	0.5361
0.5	460.7	0.060 44	62.20	290.58	352.78	0.1334	0.3960	0.5294
0.6	474.9	0.051 37	64.06	290.31	354.37	0.1359	0.3881	0.5240
0.7	487.3	0.044 79	65.66	290.08	355.74	0.1380	0.3815	0.5195
0.8	498.4	0.039 78	67.11	289.87	356.98	0.1398	0.3757	0.5155
0.9	508.5	0.035 84	68.42	289.68	358.10	0.1415	0.3706	0.5121
1.0	517.8	0.032 66	69.61	289.50	359.11	0.1429	0.3660	0.5089
1.2	534.4	0.027 81	71.75	289.19	360.94	0.1455	0.3581	0.5036
1.4	549.0	0.024 29	73.63	288.92	362.55	0.1478	0.3514	0.4992
1.6	562.0	0.021 61	75.37	288.67	364.04	0.1498	0.3456	0.4954
1.8	574.0	0.019 49	76.83	288.45	365.28	0.1515	0.3405	0.4920
2.0	584.9	0.017 78	78.23	288.24	366.47	0.1531	0.3359	0.4890
2.2	595.1	0.016 37	79.54	288.05	367.59	0.1546	0.3318	0.4864
2.4	604.6	0.015 18	80.75	287.87	368.62	0.1559	0.3280	0.4839
2.6	613.5	0.014 16	81.89	287.70	369.59	0.1571	0.3245	0.4816
2.8	622.0	0.013 29	82.96	287.54	370.50	0.1583	0.3212	0.4795
3.0	630.0	0.012 52	83.97	287.39	371.36	0.1594	0.3182	0.4776
3.5	648.5	0.010 96	86.33	287.04	373.37	0.1619	0.3115	0.4734
4.0	665.1	0.009 78	88.43	286.73	375.16	0.1641	0.3056	0.4697
4.5	680.3	0.008 85	90.35	286.44	376.79	0.1660	0.3004	0.4664
5.0	694.4	0.008 09	92.11	286.18	378.29	0.1678	0.2958	0.4636
5.5	707.4	0.007 46	93.76	285.93	379.69	0.1694	0.2916	0.4610
6.0	719.7	0.006 93	95.30	285.70	381.00	0.1709	0.2878	0.4587
6.5	731.3	0.006 48	96.75	285.48	382.23	0.1723	0.2842	0.4565
7.0	742.3	0.006 09	98.12	285.28	383.40	0.1736	0.2809	0.4545
7.5	752.7	0.005 75	99.42	285.08	384.50	0.1748	0.2779	0.4527

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Table C.12a Critical Point Data (English Units)

Substance	Formula	Molecular mass	Temp. R	Pressure psia	Volume, ft ³ /lb mole
Air	–	28.97	238.3	547.6	1.481
Ammonia	NH ₃	17.03	729.8	1636	1.16
Argon	Ar	39.948	272	705	1.20
Bromine	Br ₂	159.808	1052	1500	2.17
Carbon dioxide	CO ₂	44.01	547.5	1071	1.51
Carbon monoxide	CO	28.011	240	507	1.49
Chlorine	Cl ₂	70.906	751	1120	1.99
Deuterium (normal)	D ₂	4.00	69.1	241	–
Helium	He	4.003	9.5	33.2	0.926
Helium ³	He	3.00	6.01	16.9	–
Hydrogen (normal)	H ₂	2.016	59.9	188.1	1.04
Krypton	Kr	83.80	376.9	798	1.48
Neon	Ne	20.183	80.1	395	0.668
Nitrogen	N ₂	28.013	227.1	492	1.44
Nitrous oxide	N ₂ O	44.013	557.4	1054	1.54
Oxygen	O ₂	31.999	278.6	736	1.25
Sulfur dioxide	SO ₂	64.063	775.2	1143	1.95
Water	H ₂ O	18.015	1165.3	3204	0.90
Xenon	Xe	131.30	521.55	852	1.90
Benzene	C ₆ H ₆	78.115	1012	714	4.17
<i>n</i> -Butane	C ₄ H ₁₀	58.124	765.2	551	4.08
Carbon tetrachloride	CCl ₄	153.82	1001.5	661	4.42
Chloroform	CHCl ₃	119.38	965.8	794	3.85
Dichlorodifluoromethane	CCl ₂ F ₂	120.91	692.4	582	3.49
Dichlorofluoromethane	CHCl ₂ F	102.92	813.0	749	3.16
Ethane	C ₂ H ₆	30.020	549.8	708	2.37
Ethyl alcohol	C ₂ H ₅ OH	46.07	929.0	926	2.68
Ethylene	C ₂ H ₄	28.054	508.3	742	1.99
<i>n</i> -Hexane	C ₆ H ₁₄	86.178	914.2	439	5.89
Methane	CH ₄	16.043	343.9	673	1.59
Methyl alcohol	CH ₃ OH	32.042	923.7	1154	1.89
Methyl chloride	CH ₃ Cl	50.488	749.3	968	2.29
Propane	C ₃ H ₈	44.097	665.9	617	3.20
Propene	C ₃ H ₆	42.081	656.9	670	2.90
Propyne	C ₃ H ₄	40.065	722	776	–
Trichlorofluoromethane	CCl ₃ F	137.37	848.1	635	3.97

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