

CHAPTER 20

THERMOPHYSICAL PROPERTIES OF REFRIGERANTS

THIS CHAPTER presents tabular data for the thermodynamic and transport properties of refrigerants arranged for the occasional user. Most of the refrigerants have a thermodynamic property chart on pressure-enthalpy coordinates with an abbreviated set of tabular data for the saturated liquid and vapor on the facing page. In addition, tabular data in the superheated vapor region are given for R134a to assist students working on compression cycle examples.

For each of the cryogenic fluids, a second table of properties is provided for the vapor at a pressure of one standard atmosphere; these tables provide data needed when these gases are used in heat transfer or purge gas applications. For the zeotropic blends, including R-729 (air), tables are incremented in pressure with properties given for the liquid on the bubble line and vapor on the dew line. This arrangement is chosen because pressure is more commonly measured in the field while servicing equipment; it also highlights the difference between the bubble and dew point temperatures—the so-called temperature glide experienced with blends.

For a few fluids there are gaps in some properties at low temperatures due to limitations in the data and/or the models used.

New for the 2001 *ASHRAE Handbook* are R-143a and R-245fa. Most of the CFC refrigerants have been deleted. Tables for R-11, R-13, R-113, R-114, R-141b, R-142b, R-500, R-502, R-503, and R-720 (neon) may be found in the 1997 *ASHRAE Handbook*. R-12 has been retained to assist in making comparisons. Revised formulations have been used for many of the HFC refrigerants; these conform to international standards, where applicable. The formulations used are detailed in the References section.

The reference states used for most of the refrigerants correspond to the international convention of 200 kJ/kg for enthalpy and 1 kJ/(kg·K) for entropy, both for the saturated liquid at 0°C. The exceptions are water and fluids that have very low critical temperatures, such as ethylene and the cryogenics.

These data are intended to help engineers make preliminary comparisons among unfamiliar fluids. For greater detail and a wider range of data, consult the sources listed in the References section.

Refrigerant	Page	Refrigerant	Page
Halocarbon Refrigerants		R-718 (water/steam)	20.32
<i>Methane Series</i>		R-744 (carbon dioxide)	20.34
R-12 (dichlorodifluoromethane)	20.2	Hydrocarbon Refrigerants	
R-22 (chlorodifluoromethane)	20.4	R-50 (methane)	20.36
R-23 (trifluoromethane)	20.6	R-170 (ethane)	20.38
R-32 (difluoromethane)	20.8	R-290 (propane)	20.40
<i>Ethane Series</i>		R-600 (<i>n</i> -butane)	20.42
R-123 (2,2-dichloro-1,1,1-trifluoroethane)	20.10	R-600a (isobutane)	20.44
R-124 (2-chloro-1,1,1,2-tetrafluoroethane)	20.12	R-1150 (ethylene)	20.46
R-125 (pentafluoroethane)	20.14	R-1270 (propylene)	20.48
R-134a (1,1,1,2-tetrafluoroethane)	20.16	Cryogenic Fluids	
R-152a (1,1-difluoroethane)	20.20	R-702 (normal hydrogen)	20.50
R-143a (1,1,1-trifluoroethane)	20.22	R-702p (parahydrogen)	20.52
<i>Propane Series</i>		R-704 (helium)	20.54
R-245fa (1,1,1,3,3-pentafluoropropane)	20.23	R-728 (nitrogen)	20.56
<i>Zeotropic Blends (% by mass)</i>		R-729 (air)	20.58
R-404A [R-125/143a/134a (44/52/4)]	20.24	R-732 (oxygen)	20.60
R-407C [R-32/125/134a (23/25/52)]	20.26	R-740 (argon)	20.62
R-410A [R-32/125 (50/50)]	20.28	Absorption Solutions	
<i>Azeotropic Blends</i>		Ammonia-Water	20.65
R-507A [R-125/143a (50/50)]	20.29	Water-Lithium Bromide	20.65
Inorganic Refrigerants			
R-717 (ammonia)	20.30		

The preparation of this chapter is assigned to TC 3.1, Refrigerants and Secondary Coolants.

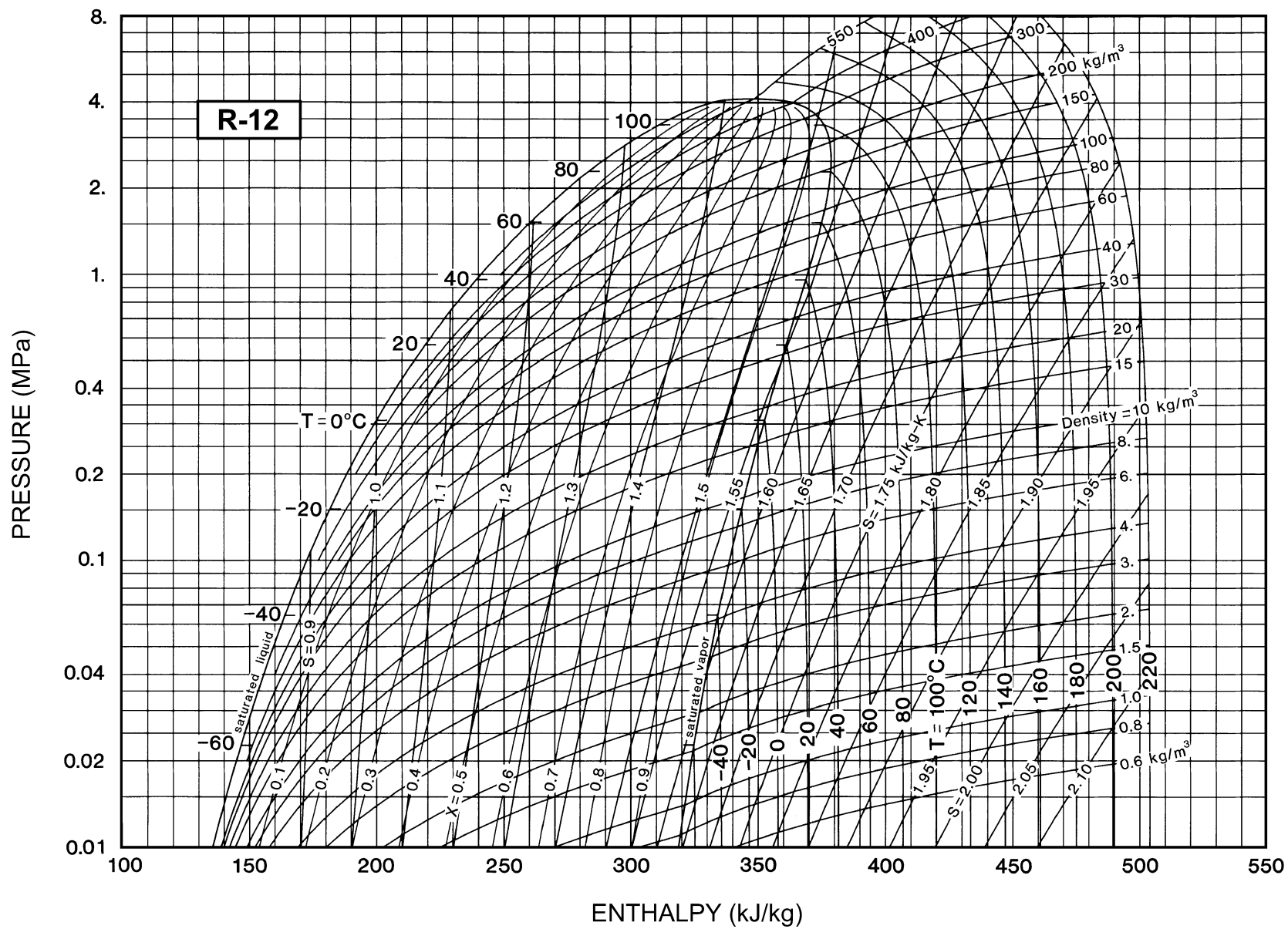


Fig. 1 Pressure-Enthalpy Diagram for Refrigerant 12

Refrigerant 12 (Dichlorodifluoromethane) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, Volume, kg/m³ m³/kg		Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c _p , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-100.00	0.00119	1679.1	10.004	113.32	306.09	0.6077	1.7210	0.819	0.449	1.182	1035.	118.5	1005.	6.78	116.7	4.27	26.48	-100.00
-90.00	0.00286	1652.8	4.3948	121.53	310.59	0.6538	1.6861	0.824	0.465	1.176	990.	121.4	819.0	7.18	112.0	4.67	24.90	-90.00
-80.00	0.00619	1626.3	2.1355	129.81	315.19	0.6978	1.6576	0.831	0.481	1.172	945.	124.1	684.9	7.58	107.4	5.08	23.35	-80.00
-70.00	0.01228	1599.5	1.1286	138.17	319.87	0.7400	1.6344	0.840	0.497	1.168	902.	126.7	584.0	7.97	103.0	5.50	21.81	-70.00
-60.00	0.02261	1572.3	0.63992	146.62	324.61	0.7806	1.6156	0.850	0.513	1.166	859.	129.1	505.1	8.37	98.8	5.93	20.30	-60.00
-50.00	0.03911	1544.7	0.38494	155.18	329.39	0.8197	1.6004	0.861	0.530	1.165	816.	131.2	441.8	8.76	94.7	6.38	18.81	-50.00
-40.00	0.06409	1516.5	0.24342	163.86	334.18	0.8577	1.5882	0.873	0.548	1.166	775.	133.0	389.8	9.16	90.7	6.84	17.35	-40.00
-30.00	0.10026	1487.7	0.16057	172.67	338.94	0.8946	1.5784	0.886	0.566	1.169	733.	134.5	346.2	9.55	86.9	7.32	15.91	-30.00
-29.75b	0.10133	1487.0	0.15900	172.89	339.06	0.8955	1.5782	0.887	0.567	1.169	732.	134.5	345.2	9.56	86.8	7.33	15.88	-29.75
-28.00	0.10910	1481.9	0.14841	174.44	339.89	0.9019	1.5767	0.889	0.570	1.170	725.	134.7	338.3	9.63	86.1	7.41	15.63	-28.00
-26.00	0.11854	1476.0	0.13736	176.23	340.83	0.9091	1.5751	0.892	0.574	1.171	717.	135.0	330.6	9.71	85.3	7.51	15.35	-26.00
-24.00	0.12860	1470.1	0.12731	178.02	341.78	0.9163	1.5735	0.895	0.578	1.171	709.	135.2	323.2	9.79	84.6	7.61	15.06	-24.00
-22.00	0.13931	1464.1	0.11815	179.81	342.72	0.9234	1.5720	0.898	0.582	1.172	701.	135.4	316.0	9.87	83.8	7.71	14.78	-22.00
-20.00	0.15070	1458.1	0.10978	181.62	343.65	0.9305	1.5706	0.901	0.586	1.174	693.	135.6	309.0	9.95	83.1	7.80	14.50	-20.00
-18.00	0.16279	1452.1	0.10213	183.42	344.59	0.9376	1.5693	0.904	0.590	1.175	684.	135.8	302.2	10.03	82.4	7.90	14.23	-18.00
-16.00	0.17562	1446.1	0.09512	185.24	345.52	0.9447	1.5680	0.907	0.594	1.176	676.	136.0	295.6	10.10	81.6	8.01	13.95	-16.00
-14.00	0.18920	1440.0	0.08870	187.06	346.44	0.9517	1.5667	0.910	0.598	1.178	668.	136.1	289.2	10.18	80.9	8.11	13.67	-14.00
-12.00	0.20358	1433.8	0.08280	188.89	347.37	0.9587	1.5655	0.913	0.602	1.179	660.	136.3	283.0	10.26	80.2	8.21	13.40	-12.00
-10.00	0.21878	1427.6	0.07737	190.72	348.29	0.9656	1.5644	0.917	0.607	1.181	652.	136.4	276.9	10.34	79.4	8.31	13.12	-10.00
-8.00	0.23483	1421.4	0.07237	192.56	349.20	0.9726	1.5633	0.920	0.611	1.183	644.	136.5	271.0	10.42	78.7	8.41	12.85	-8.00
-6.00	0.25176	1415.1	0.06777	194.41	350.11	0.9795	1.5623	0.923	0.616	1.184	636.	136.6	265.2	10.50	78.0	8.52	12.58	-6.00
-4.00	0.26960	1408.8	0.06352	196.27	351.01	0.9863	1.5613	0.927	0.620	1.186	628.	136.6	259.6	10.58	77.3	8.62	12.31	-4.00
-2.00	0.28839	1402.5	0.05959	198.13	351.91	0.9932	1.5603	0.930	0.625	1.189	620.	136.7	254.1	10.66	76.6	8.73	12.04	-2.00
0.00	0.30815	1396.1	0.05595	200.00	352.81	1.0000	1.5594	0.934	0.630	1.191	612.	136.7	248.7	10.74	75.9	8.84	11.77	0.00
2.00	0.32891	1389.6	0.05258	201.88	353.69	1.0068	1.5586	0.938	0.635	1.193	604.	136.7	243.5	10.82	75.1	8.95	11.51	2.00
4.00	0.35071	1383.1	0.04946	203.76	354.57	1.0136	1.5577	0.942	0.640	1.196	596.	136.7	238.4	10.90	74.4	9.06	11.24	4.00
6.00	0.37358	1376.5	0.04656	205.65	355.45	1.0203	1.5569	0.946	0.645	1.199	588.	136.7	233.4	10.98	73.7	9.17	10.98	6.00
8.00	0.39756	1369.9	0.04386	207.56	356.32	1.0270	1.5561	0.950	0.650	1.202	580.	136.6	228.6	11.07	73.0	9.28	10.71	8.00
10.00	0.42267	1363.2	0.04135	209.46	357.18	1.0337	1.5554	0.954	0.656	1.205	572.	136.5	223.8	11.15	72.3	9.39	10.45	10.00
12.00	0.44895	1356.5	0.03901	211.38	358.03	1.0404	1.5547	0.958	0.661	1.208	564.	136.5	219.1	11.23	71.6	9.51	10.19	12.00
14.00	0.47643	1349.7	0.03683	213.31	358.88	1.0471	1.5540	0.962	0.667	1.211	556.	136.3	214.6	11.31	70.9	9.62	9.94	14.00
16.00	0.50514	1342.8	0.03480	215.24	359.71	1.0537	1.5533	0.967	0.672	1.215	548.	136.2	210.1	11.40	70.2	9.74	9.68	16.00
18.00	0.53513	1335.9	0.03290	217.18	360.54	1.0603	1.5527	0.971	0.678	1.219	540.	136.1	205.7	11.48	69.6	9.86	9.42	18.00
20.00	0.56642	1328.9	0.03112	219.14	361.36	1.0669	1.5521	0.976	0.685	1.223	532.	135.9	201.4	11.57	68.9	9.98	9.17	20.00
22.00	0.59905	1321.8	0.02946	221.10	362.17	1.0735	1.5515	0.981	0.691	1.228	524.	135.7	197.2	11.65	68.2	10.10	8.92	22.00
24.00	0.63305	1314.6	0.02790	223.07	362.97	1.0801	1.5509	0.986	0.697	1.232	516.	135.5	193.1	11.74	67.5	10.23	8.67	24.00
26.00	0.66846	1307.4	0.02643	225.05	363.76	1.0866	1.5503	0.991	0.704	1.237	508.	135.2	189.0	11.83	66.8	10.36	8.42	26.00
28.00	0.70531	1300.1	0.02506	227.04	364.54	1.0932	1.5498	0.997	0.711	1.242	499.	134.9	185.0	11.92	66.1	10.49	8.17	28.00
30.00	0.74365	1292.7	0.02377	229.04	365.31	1.0997	1.5492	1.002	0.718	1.248	491.	134.7	181.1	12.01	65.4	10.62	7.92	30.00
32.00	0.78350	1285.2	0.02256	231.06	366.07	1.1062	1.5487	1.008	0.726	1.254	483.	134.3	177.3	12.10	64.8	10.75	7.68	32.00
34.00	0.82491	1277.6	0.02142	233.08	366.81	1.1127	1.5481	1.014	0.734	1.260	475.	134.0	173.5	12.19	64.1	10.89	7.43	34.00
36.00	0.86791	1269.9	0.02034	235.12	367.54	1.1192	1.5476	1.020	0.742	1.267	467.	133.6	169.8	12.28	63.4	11.03	7.19	36.00
38.00	0.91253	1262.2	0.01933	237.16	368.26	1.1257	1.5470	1.026	0.750	1.274	459.	133.2	166.1	12.38	62.7	11.18	6.95	38.00
40.00	0.95882	1254.3	0.01838	239.22	368.96	1.1322	1.5465	1.033	0.759	1.282	450.	132.8	162.5	12.48	62.1	11.33	6.72	40.00
42.00	1.0068	1246.3	0.01748	241.29	369.65	1.1387	1.5459	1.040	0.768	1.290	442.	132.4	159.0	12.57	61.4	11.48	6.48	42.00
44.00	1.0566	1238.1	0.01662	243.38	370.33	1.1451	1.5454	1.048	0.778	1.299	434.	131.9	155.5	12.67	60.7	11.63	6.25	44.00
46.00	1.1081	1229.9	0.01582	245.47	370.98	1.1516	1.5448	1.055	0.788	1.308	426.	131.4	152.0	12.78	60.0	11.79	6.01	46.00
48.00	1.1614	1221.5	0.01505	247.59	371.62	1.1580	1.5443	1.063	0.798	1.318	417.	130.9	148.6	12.88	59.4	11.96	5.78	48.00
50.00	1.2166	1213.0	0.01433	249.71	372.24	1.1645	1.5437	1.072	0.810	1.329	409.	130.3	145.3	12.99	58.7	12.13	5.55	50.00
52.00	1.2737	1204.4	0.01365	251.85	372.85	1.1710	1.5431	1.081	0.821	1.340	400.	12						

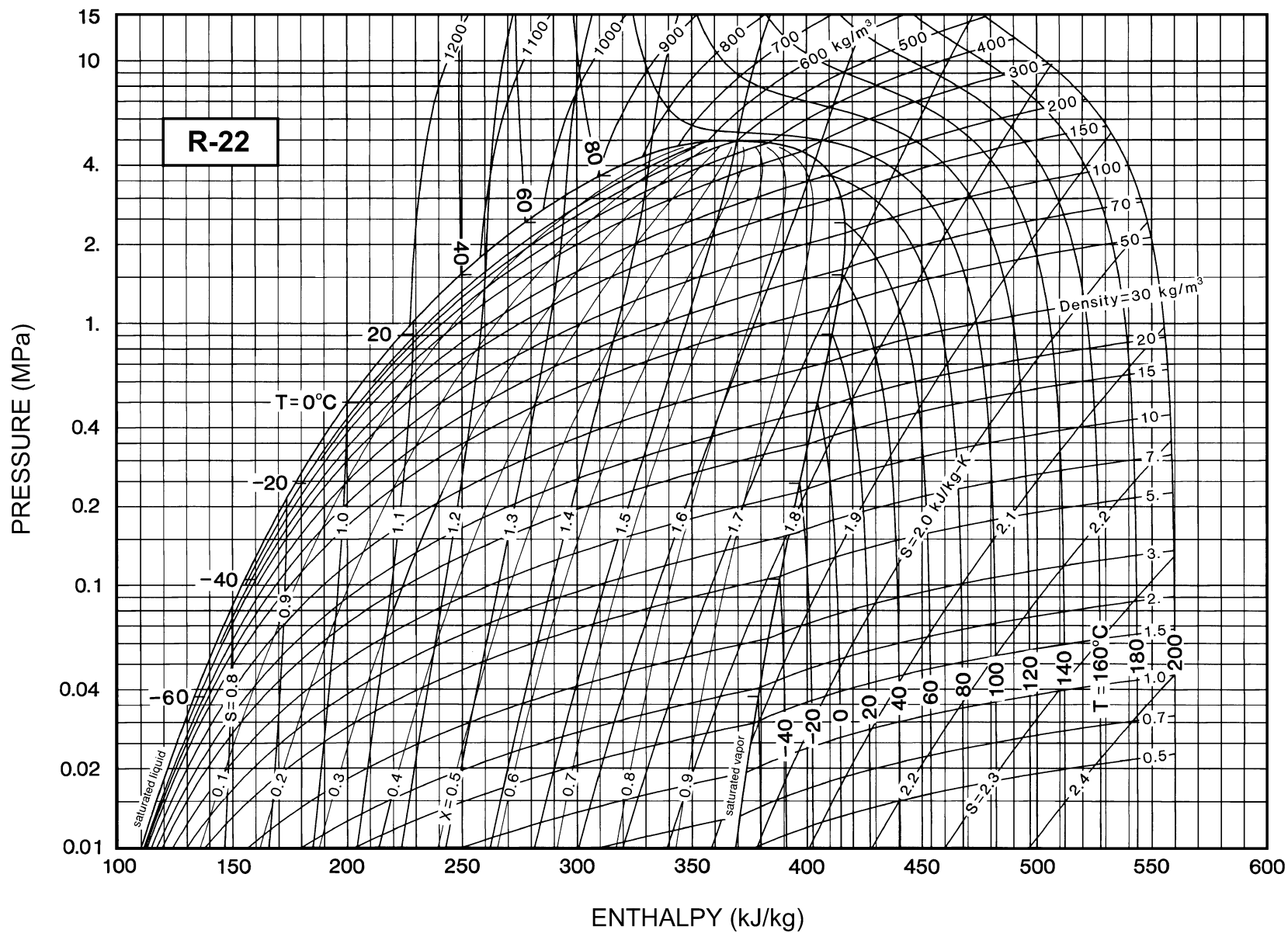


Fig. 2 Pressure-Enthalpy Diagram for Refrigerant 22

Refrigerant 22 (Chlorodifluoromethane) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c _p , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-100.00	0.00201	1571.3	8.2660	90.71	358.97	0.5050	2.0543	1.061	0.497	1.243	1127.	143.6	845.8	7.25	143.1	4.46	28.12	-100.00
-90.00	0.00481	1544.9	3.6448	101.32	363.85	0.5646	1.9980	1.061	0.512	1.237	1080.	147.0	699.4	7.67	137.8	4.84	26.36	-90.00
-80.00	0.01037	1518.2	1.7782	111.94	368.77	0.6210	1.9508	1.062	0.528	1.233	1033.	150.3	591.0	8.09	132.6	5.25	24.63	-80.00
-70.00	0.02047	1491.2	0.94342	122.58	373.70	0.6747	1.9108	1.065	0.545	1.231	986.	153.3	507.6	8.52	127.6	5.68	22.92	-70.00
-60.00	0.03750	1463.7	0.53680	133.27	378.59	0.7260	1.8770	1.071	0.564	1.230	940.	156.0	441.4	8.94	122.6	6.12	21.24	-60.00
-50.00	0.06453	1435.6	0.32385	144.03	383.42	0.7752	1.8480	1.079	0.585	1.232	893.	158.3	387.5	9.36	117.8	6.59	19.58	-50.00
-48.00	0.07145	1429.9	0.29453	146.19	384.37	0.7849	1.8428	1.081	0.589	1.233	884.	158.7	377.8	9.45	116.9	6.69	19.25	-48.00
-46.00	0.07894	1424.2	0.26837	148.36	385.32	0.7944	1.8376	1.083	0.594	1.234	875.	159.1	368.6	9.53	115.9	6.79	18.92	-46.00
-44.00	0.08705	1418.4	0.24498	150.53	386.26	0.8039	1.8327	1.086	0.599	1.235	865.	159.5	359.6	9.62	115.0	6.89	18.59	-44.00
-42.00	0.09580	1412.6	0.22402	152.70	387.20	0.8134	1.8278	1.088	0.603	1.236	856.	159.9	351.0	9.70	114.0	6.99	18.27	-42.00
-40.81b	0.10132	1409.2	0.21260	154.00	387.75	0.8189	1.8250	1.090	0.606	1.236	851.	160.1	346.0	9.75	113.5	7.05	18.08	-40.81
-40.00	0.10523	1406.8	0.20521	154.89	388.13	0.8227	1.8231	1.091	0.608	1.237	847.	160.3	342.6	9.79	113.1	7.09	17.94	-40.00
-38.00	0.11538	1401.0	0.18829	157.07	389.06	0.8320	1.8186	1.093	0.613	1.238	838.	160.6	334.5	9.87	112.2	7.19	17.62	-38.00
-36.00	0.12628	1395.1	0.17304	159.27	389.97	0.8413	1.8141	1.096	0.619	1.239	828.	160.9	326.7	9.96	111.2	7.29	17.30	-36.00
-34.00	0.13797	1389.1	0.15927	161.47	390.89	0.8505	1.8098	1.099	0.624	1.241	819.	161.2	319.1	10.04	110.3	7.40	16.98	-34.00
-32.00	0.15050	1383.2	0.14682	163.67	391.79	0.8596	1.8056	1.102	0.629	1.242	810.	161.5	311.7	10.12	109.4	7.51	16.66	-32.00
-30.00	0.16389	1377.2	0.13553	165.88	392.69	0.8687	1.8015	1.105	0.635	1.244	800.	161.8	304.6	10.21	108.5	7.61	16.34	-30.00
-28.00	0.17819	1371.1	0.12528	168.10	393.58	0.8778	1.7975	1.108	0.641	1.246	791.	162.0	297.7	10.29	107.5	7.72	16.02	-28.00
-26.00	0.19344	1365.0	0.11597	170.33	394.47	0.8868	1.7937	1.112	0.646	1.248	782.	162.3	291.0	10.38	106.6	7.83	15.70	-26.00
-24.00	0.20968	1358.9	0.10749	172.56	395.34	0.8957	1.7899	1.115	0.653	1.250	772.	162.5	284.4	10.46	105.7	7.94	15.39	-24.00
-22.00	0.22696	1352.7	0.09975	174.80	396.21	0.9046	1.7862	1.119	0.659	1.253	763.	162.7	278.1	10.55	104.8	8.06	15.07	-22.00
-20.00	0.24531	1346.5	0.09268	177.04	397.06	0.9135	1.7826	1.123	0.665	1.255	754.	162.8	271.9	10.63	103.9	8.17	14.76	-20.00
-18.00	0.26479	1340.3	0.08621	179.30	397.91	0.9223	1.7791	1.127	0.672	1.258	744.	163.0	265.9	10.72	103.0	8.29	14.45	-18.00
-16.00	0.28543	1334.0	0.08029	181.56	398.75	0.9311	1.7757	1.131	0.678	1.261	735.	163.1	260.1	10.80	102.1	8.40	14.14	-16.00
-14.00	0.30728	1327.6	0.07485	183.83	399.57	0.9398	1.7723	1.135	0.685	1.264	726.	163.2	254.4	10.89	101.1	8.52	13.83	-14.00
-12.00	0.33038	1321.2	0.06986	186.11	400.39	0.9485	1.7690	1.139	0.692	1.267	716.	163.3	248.8	10.98	100.2	8.65	13.52	-12.00
-10.00	0.35479	1314.7	0.06527	188.40	401.20	0.9572	1.7658	1.144	0.699	1.270	707.	163.3	243.4	11.06	99.3	8.77	13.21	-10.00
-8.00	0.38054	1308.2	0.06103	190.70	401.99	0.9658	1.7627	1.149	0.707	1.274	697.	163.4	238.1	11.15	98.4	8.89	12.91	-8.00
-6.00	0.40769	1301.6	0.05713	193.01	402.77	0.9744	1.7596	1.154	0.715	1.278	688.	163.4	233.0	11.24	97.5	9.02	12.60	-6.00
-4.00	0.43628	1295.0	0.05352	195.33	403.55	0.9830	1.7566	1.159	0.722	1.282	679.	163.4	227.9	11.32	96.6	9.15	12.30	-4.00
-2.00	0.46636	1288.3	0.05019	197.66	404.30	0.9915	1.7536	1.164	0.731	1.287	669.	163.4	223.0	11.41	95.7	9.28	12.00	-2.00
0.00	0.49799	1281.5	0.04710	200.00	405.05	1.0000	1.7507	1.169	0.739	1.291	660.	163.3	218.2	11.50	94.8	9.42	11.70	0.00
2.00	0.53120	1274.7	0.04424	202.35	405.78	1.0085	1.7478	1.175	0.748	1.296	650.	163.2	213.5	11.59	93.9	9.56	11.40	2.00
4.00	0.56605	1267.8	0.04159	204.71	406.50	1.0169	1.7450	1.181	0.757	1.301	641.	163.1	208.9	11.68	93.1	9.70	11.10	4.00
6.00	0.60259	1260.8	0.03913	207.09	407.20	1.0254	1.7422	1.187	0.766	1.307	632.	163.0	204.4	11.77	92.2	9.84	10.81	6.00
8.00	0.64088	1253.8	0.03683	209.47	407.89	1.0338	1.7395	1.193	0.775	1.313	622.	162.8	200.0	11.86	91.3	9.99	10.51	8.00
10.00	0.68095	1246.7	0.03470	211.87	408.56	1.0422	1.7368	1.199	0.785	1.319	613.	162.6	195.7	11.96	90.4	10.14	10.22	10.00
12.00	0.72286	1239.5	0.03271	214.28	409.21	1.0505	1.7341	1.206	0.795	1.326	603.	162.4	191.5	12.05	89.5	10.29	9.93	12.00
14.00	0.76668	1232.2	0.03086	216.70	409.85	1.0589	1.7315	1.213	0.806	1.333	594.	162.2	187.3	12.14	88.6	10.45	9.64	14.00
16.00	0.81244	1224.9	0.02912	219.14	410.47	1.0672	1.7289	1.220	0.817	1.340	584.	161.9	183.2	12.24	87.7	10.61	9.35	16.00
18.00	0.86020	1217.4	0.02750	221.59	411.07	1.0755	1.7263	1.228	0.828	1.348	575.	161.6	179.2	12.33	86.8	10.77	9.06	18.00
20.00	0.91002	1209.9	0.02599	224.06	411.66	1.0838	1.7238	1.236	0.840	1.357	565.	161.3	175.3	12.43	85.9	10.95	8.78	20.00
22.00	0.96195	1202.3	0.02457	226.54	412.22	1.0921	1.7212	1.244	0.853	1.366	555.	161.0	171.5	12.53	85.0	11.12	8.50	22.00
24.00	1.0160	1194.6	0.02324	229.04	412.77	1.1004	1.7187	1.252	0.866	1.375	546.	160.6	167.7	12.63	84.1	11.30	8.22	24.00
26.00	1.0724	1186.7	0.02199	231.55	413.29	1.1086	1.7162	1.261	0.879	1.385	536.	160.2	163.9	12.74	83.2	11.49	7.94	26.00
28.00	1.1309	1178.8	0.02082	234.08	413.79	1.1169	1.7136	1.271	0.893	1.396	527.	159.7	160.3	12.84	82.3	11.69	7.66	28.00
30.00	1.1919	1170.7	0.01972	236.62	414.26	1.1252	1.7111	1.281	0.908	1.408	517.	159.2	156.7	12.95	81.4	11.89	7.38	30.00
32.00	1.2552	1162.6	0.01869	239.19	414.71	1.1334	1.7086	1.291	0.924	1.420	507.	158.7	153.1	13.06	80.5	12.10	7.11	32.00
34.00	1.3210	1154.3	0.01771	241.77	415.14	1.1417	1.7061	1.302	0.940	1.434	497.	158.2	149.6	13.17	79.6	12.31	6.84	34.00
36.00																		

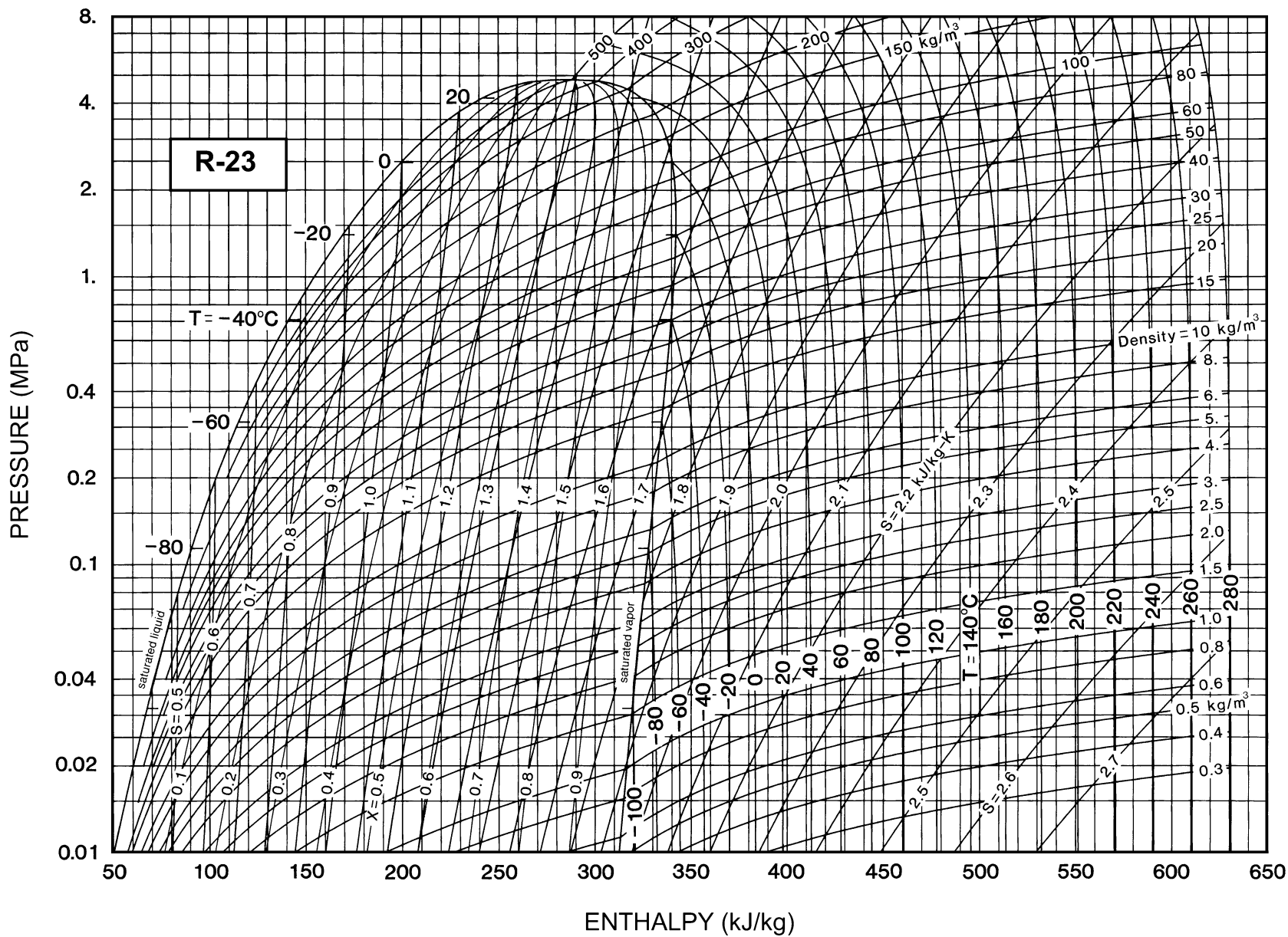


Fig. 3 Pressure-Enthalpy Diagram for Refrigerant 23

Refrigerant 23 (Trifluoromethane) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, kg/m ³		Volume, m ³ /kg		Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c _p , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-155.13a	0.00006	1682.3	238.15	—	—	-3.08	289.40	-0.0682	2.4101	1.245	0.497	1.315	1002.7	135.74	1749.9	5.35	257.6	3.78	32.34	-155.13
-150.00	0.00014	1666.7	104.65	—	—	3.24	291.93	-0.0157	2.3285	1.224	0.502	1.312	1012.7	138.45	1442.8	5.64	240.8	4.07	31.28	-150.00
-140.00	0.00061	1635.6	26.092	—	—	15.35	296.89	0.0788	2.1932	1.199	0.514	1.306	1017.8	143.48	1034.0	6.22	214.0	4.61	29.20	-140.00
-130.00	0.00207	1603.5	8.1690	—	—	27.28	301.84	0.1652	2.0832	1.190	0.530	1.300	1006.8	148.15	776.6	6.80	192.9	5.15	27.13	-130.00
-120.00	0.00591	1570.4	3.0565	—	—	39.18	306.74	0.2455	1.9926	1.190	0.553	1.296	983.3	152.42	605.4	7.37	176.0	5.70	25.07	-120.00
-110.00	0.01452	1536.4	1.3172	—	—	51.11	311.52	0.3209	1.9171	1.196	0.582	1.295	950.3	156.26	486.3	7.93	162.0	6.25	23.02	-110.00
-100.00	0.03165	1501.5	0.63560	—	—	63.13	316.12	0.3924	1.8534	1.207	0.619	1.296	910.2	159.60	399.9	8.48	150.2	6.82	20.98	-100.00
-90.00	0.06255	1465.5	0.33598	—	—	75.28	320.47	0.4604	1.7992	1.221	0.665	1.303	864.9	162.39	335.1	9.03	140.1	7.42	18.96	-90.00
-82.06b	0.10132	1436.2	0.21367	—	—	85.03	323.71	0.5124	1.7615	1.235	0.707	1.311	826.2	164.18	294.5	9.47	133.0	7.92	17.38	-82.06
-80.00	0.11402	1428.4	0.19121	—	—	87.59	324.52	0.5257	1.7524	1.238	0.718	1.314	815.8	164.58	285.1	9.58	131.3	8.05	16.97	-80.00
-70.00	0.19431	1389.9	0.11556	—	—	100.10	328.22	0.5886	1.7115	1.260	0.779	1.332	763.7	166.08	245.3	10.12	123.4	8.73	15.00	-70.00
-68.00	0.21464	1382.1	0.10513	—	—	102.63	328.91	0.6009	1.7039	1.265	0.792	1.336	753.0	166.30	238.3	10.23	121.9	8.87	14.61	-68.00
-66.00	0.23659	1374.1	0.09583	—	—	105.17	329.59	0.6131	1.6965	1.270	0.806	1.341	742.2	166.48	231.6	10.34	120.5	9.02	14.22	-66.00
-64.00	0.26024	1366.1	0.08750	—	—	107.72	330.25	0.6253	1.6893	1.275	0.820	1.346	731.3	166.63	225.1	10.45	119.0	9.17	13.87	-64.00
-62.00	0.28567	1358.0	0.08003	—	—	110.28	330.89	0.6374	1.6822	1.280	0.834	1.351	720.4	166.75	218.9	10.56	117.6	9.32	13.45	-62.00
-60.00	0.31297	1349.8	0.07333	—	—	112.86	331.51	0.6495	1.6753	1.286	0.848	1.357	709.3	166.84	212.9	10.67	116.2	9.48	13.07	-60.00
-58.00	0.34223	1341.5	0.06729	—	—	115.44	332.11	0.6614	1.6685	1.292	0.863	1.363	698.2	166.90	207.1	10.78	114.9	9.64	12.69	-58.00
-56.00	0.37354	1333.1	0.06184	—	—	118.04	332.70	0.6733	1.6619	1.299	0.878	1.370	687.1	166.92	201.5	10.89	113.5	9.80	12.31	-56.00
-54.00	0.40699	1324.7	0.05691	—	—	120.65	333.26	0.6852	1.6553	1.305	0.894	1.377	675.8	166.90	196.1	11.00	112.2	9.96	11.93	-54.00
-52.00	0.44268	1316.2	0.05245	—	—	123.28	333.81	0.6970	1.6490	1.312	0.910	1.384	664.5	166.85	190.9	11.11	110.9	10.13	11.55	-52.00
-50.00	0.48069	1307.5	0.04840	—	—	125.92	334.33	0.7087	1.6427	1.320	0.926	1.392	653.2	166.77	185.8	11.23	109.6	10.31	11.18	-50.00
-49.00	0.50060	1303.2	0.04652	—	—	127.24	334.58	0.7146	1.6396	1.324	0.934	1.396	647.5	166.71	183.4	11.28	108.9	10.40	10.99	-49.00
-48.00	0.52113	1298.8	0.04472	—	—	128.57	334.83	0.7204	1.6365	1.327	0.943	1.401	641.8	166.65	180.9	11.34	108.3	10.49	10.81	-48.00
-47.00	0.54230	1294.4	0.04301	—	—	129.90	335.07	0.7263	1.6335	1.332	0.951	1.405	636.0	166.57	178.5	11.40	107.7	10.58	10.62	-47.00
-46.00	0.56410	1289.9	0.04137	—	—	131.24	335.30	0.7321	1.6305	1.336	0.960	1.410	630.3	166.49	176.2	11.45	107.0	10.67	10.44	-46.00
-45.00	0.58656	1285.4	0.03981	—	—	132.58	335.53	0.7379	1.6275	1.340	0.969	1.414	624.5	166.39	173.9	11.51	106.4	10.77	10.25	-45.00
-44.00	0.60969	1280.9	0.03831	—	—	133.93	335.76	0.7437	1.6245	1.344	0.978	1.419	618.7	166.29	171.6	11.57	105.8	10.86	10.07	-44.00
-43.00	0.63350	1276.4	0.03688	—	—	135.28	335.97	0.7495	1.6215	1.349	0.987	1.424	612.9	166.17	169.3	11.63	105.2	10.96	9.89	-43.00
-42.00	0.65801	1271.8	0.03552	—	—	136.63	336.18	0.7553	1.6186	1.354	0.996	1.430	607.1	166.05	167.1	11.69	104.5	11.06	9.70	-42.00
-41.00	0.68322	1267.2	0.03421	—	—	137.99	336.39	0.7611	1.6157	1.358	1.006	1.435	601.3	165.91	164.9	11.74	103.9	11.16	9.52	-41.00
-40.00	0.70915	1262.6	0.03296	—	—	139.35	336.58	0.7669	1.6128	1.363	1.016	1.441	595.5	165.77	162.7	11.80	103.3	11.26	9.34	-40.00
-39.00	0.73581	1257.9	0.03177	—	—	140.72	336.77	0.7726	1.6099	1.369	1.025	1.447	589.6	165.61	160.6	11.86	102.7	11.36	9.16	-39.00
-38.00	0.76322	1253.2	0.03062	—	—	142.09	336.95	0.7784	1.6070	1.374	1.035	1.453	583.7	165.45	158.5	11.92	102.1	11.46	8.98	-38.00
-37.00	0.79138	1248.5	0.02952	—	—	143.47	337.13	0.7841	1.6042	1.379	1.046	1.459	577.9	165.27	156.4	11.98	101.5	11.57	8.80	-37.00
-36.00	0.82032	1243.7	0.02847	—	—	144.86	337.30	0.7899	1.6014	1.385	1.056	1.465	572.0	165.08	154.3	12.04	100.8	11.68	8.62	-36.00
-35.00	0.85005	1238.9	0.02746	—	—	146.24	337.46	0.7956	1.5985	1.391	1.067	1.472	566.0	164.89	152.3	12.11	100.2	11.78	8.44	-35.00
-34.00	0.88057	1234.0	0.02650	—	—	147.64	337.61	0.8014	1.5957	1.397	1.077	1.479	560.1	164.68	150.3	12.17	99.6	11.89	8.27	-34.00
-33.00	0.91191	1229.1	0.02557	—	—	149.04	337.76	0.8071	1.5929	1.403	1.088	1.486	554.2	164.46	148.3	12.23	99.0	12.01	8.09	-33.00
-32.00	0.94407	1224.2	0.02468	—	—	150.44	337.89	0.8128	1.5901	1.409	1.100	1.494	548.2	164.23	146.3	12.29	98.4	12.12	7.91	-32.00
-31.00	0.97707	1219.2	0.02382	—	—	151.86	338.02	0.8186	1.5874	1.416	1.111	1.501	542.2	163.98	144.4	12.36	97.8	12.24	7.74	-31.00
-30.00	1.0109	1214.2	0.02300	—	—	153.27	338.14	0.8243	1.5846	1.423	1.123	1.509	536.3	163.73	142.5	12.42	97.2	12.36	7.56	-30.00
-29.00	1.0456	1209.1	0.02221	—	—	154.70	338.25	0.8300	1.5818	1.430	1.135	1.518	530.3	163.46	140.6	12.49	96.6	12.48	7.39	-29.00
-28.00	1.0813	1204.0	0.02145	—	—	156.13	338.35	0.8357	1.5791	1.437	1.148	1.527	524.2	163.18	138.7	12.55	96.0	12.60	7.22	-28.00
-27.00	1.1178	1198.8	0.02072	—	—	157.57	338.45	0.8415	1.5763	1.445	1.161	1.536	518.2	162.89	136.8	12.62	95.4	12.72	7.05	-27.00
-26.00	1.1552	1193.5	0.02002	—	—	159.01	338.53	0.8472	1.5736	1.452	1.174	1.545	512.2	162.59	135.0	12.68	94.8	12.85	6.87	-26.00
-25.00	1.1935	1188.3	0.01934	—	—	160.46	338.60	0.8529												

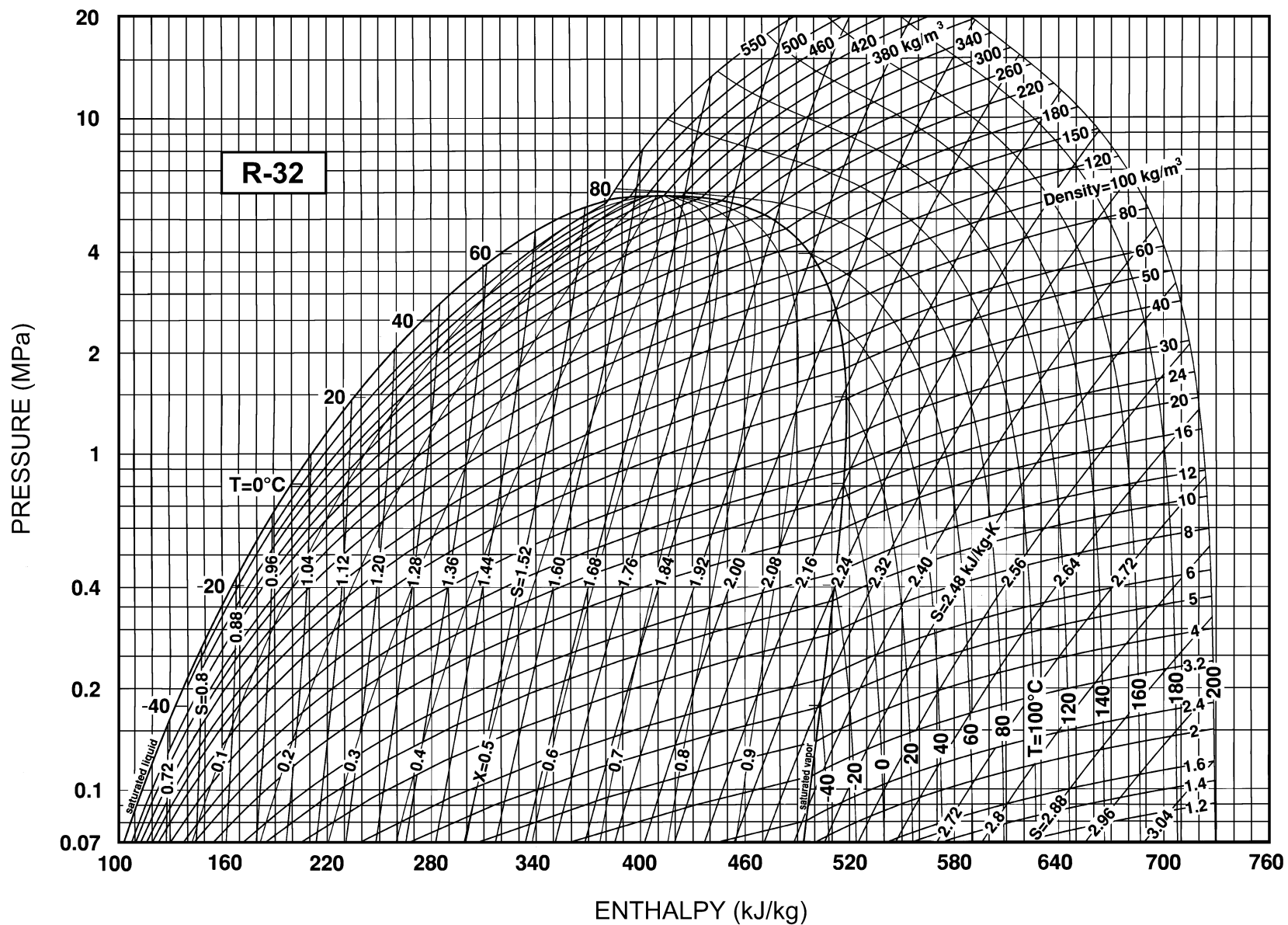
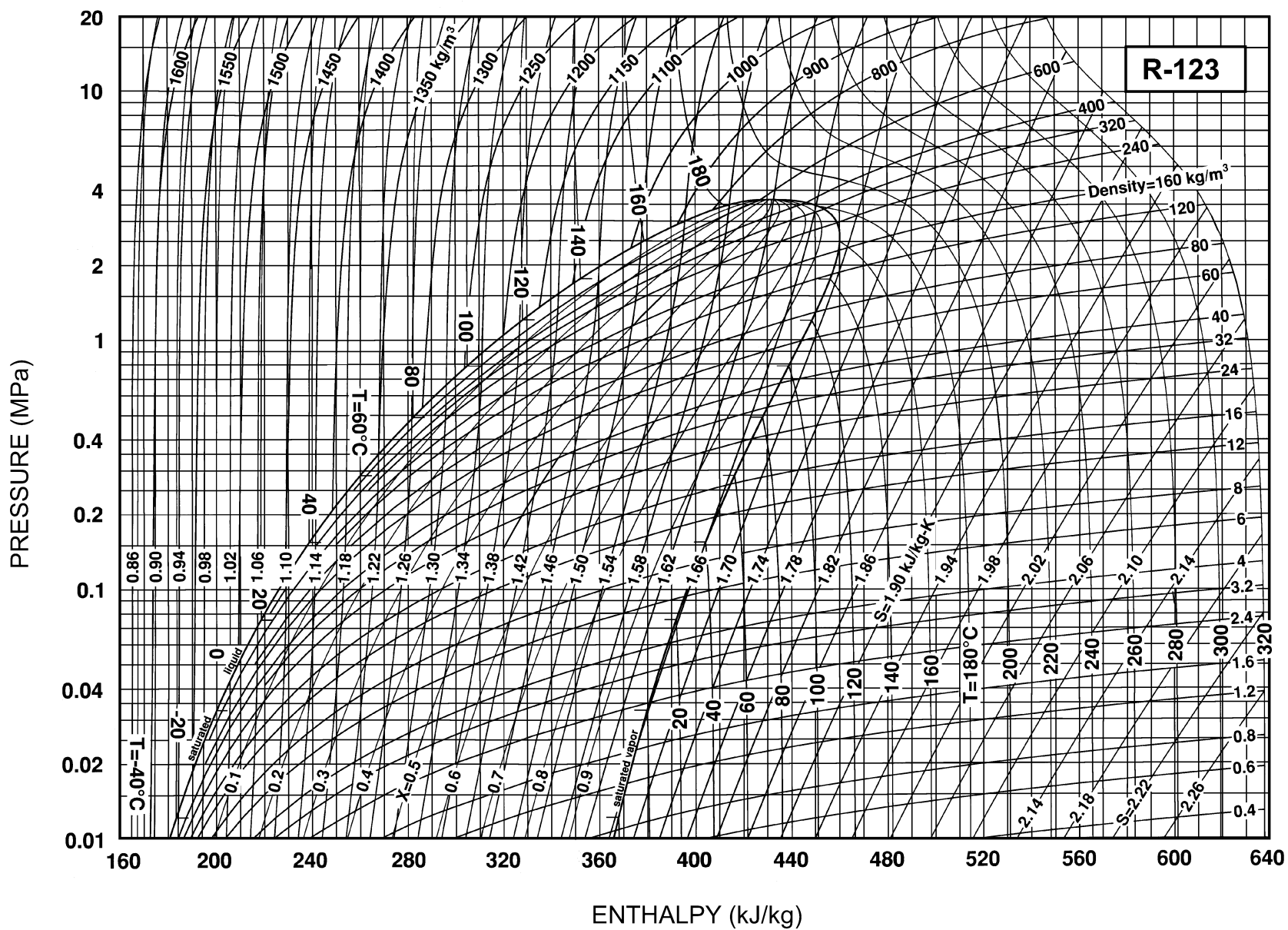


Fig. 4 Pressure-Enthalpy Diagram for Refrigerant 32

Refrigerant 32 (Difluoromethane) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-136.81a	0.00005	1429.3	453.85	-19.07	444.31	-0.1050	3.2937	1.592	0.660	1.321	1414.	169.6	—	—	—	—	39.01	-136.81
-130.00	0.00013	1412.7	174.36	-8.26	448.77	-0.0276	3.1651	1.583	0.665	1.318	1378.	173.6	—	—	—	—	37.47	-130.00
-120.00	0.00048	1388.4	51.184	7.52	455.33	0.0790	3.0030	1.573	0.674	1.315	1326.	179.2	—	—	—	—	35.23	-120.00
-110.00	0.00145	1363.8	17.907	23.20	461.86	0.1782	2.8668	1.565	0.686	1.312	1273.	184.5	678.6	6.80	229.8	5.69	33.02	-110.00
-100.00	0.00381	1339.0	7.2220	38.83	468.31	0.2711	2.7515	1.560	0.703	1.310	1221.	189.5	562.0	7.22	222.9	6.09	30.83	-100.00
-90.00	0.00887	1313.9	3.2721	54.42	474.61	0.3586	2.6529	1.559	0.725	1.310	1169.	194.1	475.3	7.64	216.1	6.51	28.68	-90.00
-80.00	0.01865	1288.4	1.6316	70.02	480.72	0.4415	2.5679	1.561	0.754	1.311	1118.	198.3	408.4	8.06	209.3	6.95	26.56	-80.00
-70.00	0.03607	1262.4	0.88072	85.66	486.57	0.5204	2.4939	1.566	0.790	1.314	1066.	202.0	355.0	8.48	202.5	7.40	24.48	-70.00
-60.00	0.06496	1235.7	0.50786	101.38	492.11	0.5958	2.4289	1.576	0.833	1.320	1014.	205.1	311.5	8.90	195.8	7.88	22.42	-60.00
-51.65b	0.10133	1212.9	0.33468	114.59	496.45	0.6565	2.3805	1.587	0.875	1.328	971.	207.4	280.9	9.25	190.1	8.30	20.74	-51.65
-50.00	0.11014	1208.4	0.30944	117.22	497.27	0.6683	2.3714	1.589	0.883	1.329	962.	207.7	275.3	9.32	189.0	8.39	20.41	-50.00
-40.00	0.17741	1180.2	0.19743	133.23	502.02	0.7382	2.3200	1.608	0.940	1.343	910.	209.7	244.6	9.75	182.2	8.93	18.44	-40.00
-38.00	0.19409	1174.4	0.18134	136.45	502.91	0.7519	2.3103	1.612	0.952	1.347	900.	210.1	239.0	9.84	180.8	9.05	18.05	-38.00
-36.00	0.21197	1168.6	0.16680	139.69	503.78	0.7655	2.3008	1.616	0.965	1.350	889.	210.4	233.6	9.92	179.4	9.16	17.66	-36.00
-34.00	0.23111	1162.8	0.15365	142.93	504.63	0.7791	2.2916	1.621	0.977	1.354	879.	210.6	228.3	10.01	178.0	9.28	17.27	-34.00
-32.00	0.25159	1156.9	0.14173	146.18	505.47	0.7926	2.2824	1.626	0.990	1.358	868.	210.9	223.2	10.10	176.7	9.40	16.89	-32.00
-30.00	0.27344	1151.0	0.13091	149.45	506.27	0.8060	2.2735	1.631	1.004	1.363	858.	211.1	218.2	10.19	175.3	9.52	16.50	-30.00
-28.00	0.29675	1145.0	0.12107	152.72	507.06	0.8193	2.2647	1.637	1.017	1.367	847.	211.3	213.4	10.27	173.9	9.65	16.12	-28.00
-26.00	0.32157	1138.9	0.11211	156.01	507.83	0.8326	2.2561	1.642	1.031	1.372	837.	211.4	208.7	10.36	172.5	9.78	15.74	-26.00
-24.00	0.34796	1132.9	0.10393	159.31	508.57	0.8458	2.2476	1.648	1.045	1.377	826.	211.5	204.1	10.45	171.1	9.91	15.36	-24.00
-22.00	0.37600	1126.7	0.09646	162.62	509.28	0.8589	2.2392	1.654	1.060	1.383	816.	211.6	199.6	10.54	169.7	10.04	14.99	-22.00
-20.00	0.40575	1120.6	0.08963	165.94	509.97	0.8720	2.2310	1.661	1.075	1.389	805.	211.7	195.2	10.63	168.3	10.18	14.61	-20.00
-18.00	0.43728	1114.3	0.08337	169.28	510.64	0.8850	2.2229	1.668	1.090	1.395	794.	211.7	191.0	10.73	166.9	10.32	14.24	-18.00
-16.00	0.47067	1108.0	0.07762	172.63	511.28	0.8979	2.2149	1.675	1.106	1.401	784.	211.7	186.8	10.82	165.5	10.46	13.87	-16.00
-14.00	0.50597	1101.7	0.07234	175.99	511.89	0.9109	2.2070	1.682	1.122	1.408	773.	211.7	182.7	10.91	164.1	10.61	13.50	-14.00
-12.00	0.54327	1095.2	0.06749	179.37	512.47	0.9237	2.1992	1.690	1.139	1.416	762.	211.6	178.8	11.01	162.7	10.76	13.14	-12.00
-10.00	0.58263	1088.8	0.06301	182.76	513.02	0.9365	2.1915	1.698	1.156	1.423	751.	211.5	174.9	11.10	161.3	10.92	12.77	-10.00
-8.00	0.62414	1082.2	0.05889	186.18	513.54	0.9493	2.1839	1.706	1.174	1.432	741.	211.4	171.1	11.20	159.8	11.08	12.41	-8.00
-6.00	0.66786	1075.6	0.05508	189.60	514.03	0.9620	2.1764	1.715	1.192	1.440	730.	211.2	167.4	11.30	158.4	11.25	12.05	-6.00
-4.00	0.71388	1068.9	0.05155	193.05	514.49	0.9747	2.1690	1.725	1.211	1.450	719.	211.0	163.8	11.40	157.0	11.42	11.69	-4.00
-2.00	0.76226	1062.1	0.04829	196.52	514.91	0.9874	2.1616	1.735	1.231	1.460	708.	210.8	160.2	11.50	155.5	11.60	11.34	-2.00
0.00	0.81310	1055.3	0.04527	200.00	515.30	1.0000	2.1543	1.745	1.251	1.470	697.	210.5	156.7	11.60	154.1	11.79	10.99	0.00
2.00	0.86647	1048.3	0.04246	203.50	515.65	1.0126	2.1471	1.756	1.272	1.481	686.	210.2	153.3	11.71	152.6	11.98	10.63	2.00
4.00	0.92245	1041.3	0.03986	207.03	515.96	1.0252	2.1399	1.767	1.294	1.493	675.	209.8	149.9	11.81	151.1	12.19	10.29	4.00
6.00	0.98113	1034.2	0.03743	210.58	516.24	1.0377	2.1327	1.779	1.317	1.506	664.	209.4	146.7	11.92	149.6	12.40	9.94	6.00
8.00	1.0426	1027.0	0.03518	214.15	516.47	1.0503	2.1256	1.792	1.341	1.519	652.	209.0	143.4	12.03	148.2	12.62	9.60	8.00
10.00	1.1069	1019.7	0.03308	217.74	516.66	1.0628	2.1185	1.806	1.367	1.534	641.	208.5	140.3	12.14	146.7	12.86	9.25	10.00
12.00	1.1742	1012.2	0.03112	221.36	516.80	1.0753	2.1114	1.820	1.393	1.549	630.	208.0	137.1	12.25	145.1	13.11	8.91	12.00
14.00	1.2445	1004.7	0.02929	225.01	516.90	1.0878	2.1043	1.835	1.421	1.565	618.	207.5	134.1	12.37	143.6	13.38	8.58	14.00
16.00	1.3179	997.1	0.02758	228.68	516.95	1.1003	2.0972	1.851	1.450	1.583	607.	206.9	131.1	12.48	142.1	13.67	8.24	16.00
18.00	1.3946	989.3	0.02598	232.39	516.95	1.1128	2.0902	1.868	1.481	1.602	595.	206.3	128.1	12.60	140.5	13.97	7.91	18.00
20.00	1.4746	981.4	0.02448	236.12	516.90	1.1253	2.0831	1.886	1.514	1.622	584.	205.6	125.2	12.73	139.0	14.30	7.59	20.00
22.00	1.5579	973.3	0.02307	239.89	516.79	1.1378	2.0760	1.905	1.548	1.644	572.	204.9	122.3	12.85	137.4	14.65	7.26	22.00
24.00	1.6448	965.2	0.02175	243.69	516.62	1.1503	2.0688	1.926	1.585	1.668	560.	204.1	119.5	12.98	135.8	15.03	6.94	24.00
26.00	1.7353	956.8	0.02051	247.53	516.39	1.1629	2.0616	1.948	1.624	1.693	548.	203.3	116.7	13.11	134.2	15.44	6.62	26.00
28.00	1.8295	948.3	0.01935	251.40	516.09	1.1755	2.0544	1.972	1.667	1.721	536.	202.4	113.9	13.25	132.6	15.88	6.30	28.00
30.00	1.9275	939.6	0.01826	255.32	515.72	1.1881	2.0471	1.997	1.712	1.750	524.	201.5	111.2	13.39	131.0	16.36	5.99	30.00
32.00	2.0294	930.7	0.01722	259.28	515.29	1.2007	2.0397	2.025	1.760	1.783	512.	200.6	108.5	13.53	129.3	16.89	5.68	32.00
34.00	2.1353	921.7	0.01625	263.28	514.77	1.2134	2.0322	2.055	1.813	1.819	499.	199.6	105.8	13.68	127.6	17.47	5.37	34.00
36.00	2.2454	912.4	0.01533	267.34	514.17	1												



Refrigerant 123 (2,2-Dichloro-1,1,1-trifluoroethane) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c _p , kJ/(kg·K)		c _p /c _v	Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-80.00	0.00013	1709.6	83.667	123.92	335.98	0.6712	1.7691	0.924	0.520	1.117	1133.	108.3	2093.	6.68	107.4	3.22	28.42	-80.00
-70.00	0.00034	1687.4	32.842	133.17	341.25	0.7179	1.7422	0.927	0.537	1.113	1091.	110.8	1680.	7.09	104.8	3.79	27.09	-70.00
-60.00	0.00081	1665.1	14.333	142.46	346.66	0.7625	1.7206	0.932	0.553	1.110	1049.	113.3	1383.	7.50	102.0	4.35	25.78	-60.00
-50.00	0.00177	1642.6	6.8460	151.81	352.21	0.8054	1.7034	0.939	0.569	1.107	1006.	115.6	1160.	7.91	99.1	4.92	24.48	-50.00
-40.00	0.00358	1620.0	3.5319	161.25	357.88	0.8468	1.6901	0.948	0.585	1.105	964.	117.9	986.4	8.31	96.1	5.49	23.19	-40.00
-30.00	0.00675	1597.0	1.9470	170.78	363.65	0.8868	1.6800	0.958	0.601	1.103	923.	120.0	848.0	8.70	93.0	6.05	21.92	-30.00
-20.00	0.01200	1573.8	1.1364	180.41	369.52	0.9256	1.6726	0.968	0.617	1.102	881.	122.0	735.4	9.09	89.8	6.61	20.66	-20.00
-10.00	0.02025	1550.1	0.69690	190.15	375.45	0.9633	1.6675	0.979	0.634	1.102	841.	123.8	642.4	9.47	86.7	7.18	19.41	-10.00
0.00	0.03265	1526.1	0.44609	200.00	381.44	1.0000	1.6642	0.990	0.651	1.102	801.	125.4	564.6	9.84	83.7	7.74	18.18	0.00
2.00	0.03574	1521.3	0.40991	201.98	382.64	1.0072	1.6638	0.993	0.654	1.103	793.	125.7	550.6	9.91	83.1	7.86	17.94	2.00
4.00	0.03907	1516.4	0.37720	203.97	383.84	1.0144	1.6634	0.995	0.658	1.103	785.	126.0	537.0	9.99	82.5	7.97	17.70	4.00
6.00	0.04264	1511.5	0.34759	205.97	385.05	1.0216	1.6631	0.997	0.661	1.103	777.	126.3	523.8	10.06	81.9	8.08	17.45	6.00
8.00	0.04647	1506.6	0.32075	207.96	386.25	1.0287	1.6628	0.999	0.665	1.103	769.	126.6	511.1	10.13	81.3	8.20	17.21	8.00
10.00	0.05057	1501.6	0.29637	209.97	387.46	1.0358	1.6626	1.002	0.668	1.104	761.	126.8	498.8	10.20	80.7	8.31	16.97	10.00
12.00	0.05495	1496.7	0.27420	211.97	388.66	1.0428	1.6625	1.004	0.672	1.104	754.	127.1	486.8	10.28	80.1	8.43	16.73	12.00
14.00	0.05963	1491.7	0.25401	213.99	389.87	1.0499	1.6624	1.006	0.675	1.104	746.	127.3	475.3	10.35	79.5	8.54	16.49	14.00
16.00	0.06463	1486.7	0.23559	216.00	391.08	1.0569	1.6623	1.009	0.679	1.105	738.	127.6	464.0	10.42	79.0	8.66	16.25	16.00
18.00	0.06995	1481.7	0.21877	218.02	392.29	1.0638	1.6623	1.011	0.682	1.105	730.	127.8	453.2	10.49	78.4	8.77	16.01	18.00
20.00	0.07561	1476.6	0.20338	220.05	393.49	1.0707	1.6624	1.014	0.686	1.106	723.	128.0	442.6	10.56	77.8	8.89	15.77	20.00
22.00	0.08163	1471.5	0.18929	222.08	394.70	1.0776	1.6625	1.016	0.690	1.106	715.	128.2	432.4	10.63	77.3	9.01	15.53	22.00
24.00	0.08802	1466.4	0.17637	224.12	395.91	1.0845	1.6626	1.018	0.693	1.107	707.	128.4	422.4	10.70	76.7	9.12	15.30	24.00
26.00	0.09480	1461.3	0.16451	226.16	397.12	1.0913	1.6628	1.021	0.697	1.107	700.	128.6	412.8	10.77	76.1	9.24	15.06	26.00
27.82b	0.10133	1456.6	0.15453	228.03	398.22	1.0975	1.6630	1.023	0.701	1.108	693.	128.7	404.2	10.84	75.6	9.35	14.84	27.82
28.00	0.10198	1456.2	0.15360	228.21	398.32	1.0981	1.6630	1.023	0.701	1.108	692.	128.7	403.4	10.84	75.6	9.36	14.82	28.00
30.00	0.10958	1451.0	0.14356	230.26	399.53	1.1049	1.6633	1.026	0.705	1.109	684.	128.9	394.3	10.91	75.0	9.48	14.59	30.00
32.00	0.11762	1445.8	0.13431	232.31	400.73	1.1116	1.6635	1.028	0.709	1.109	677.	129.0	385.4	10.98	74.5	9.60	14.35	32.00
34.00	0.12611	1440.6	0.12577	234.38	401.93	1.1183	1.6639	1.031	0.712	1.110	669.	129.1	376.8	11.05	74.0	9.72	14.12	34.00
36.00	0.13507	1435.4	0.11789	236.44	403.14	1.1250	1.6642	1.033	0.716	1.111	662.	129.3	368.4	11.12	73.4	9.84	13.89	36.00
38.00	0.14452	1430.1	0.11060	238.51	404.34	1.1317	1.6646	1.036	0.720	1.112	654.	129.4	360.3	11.19	72.9	9.96	13.66	38.00
40.00	0.15447	1424.8	0.10385	240.59	405.54	1.1383	1.6651	1.038	0.724	1.113	647.	129.5	352.4	11.26	72.4	10.08	13.43	40.00
42.00	0.16495	1419.4	0.09759	242.67	406.73	1.1449	1.6655	1.041	0.728	1.114	639.	129.5	344.7	11.33	71.8	10.20	13.20	42.00
44.00	0.17597	1414.1	0.09179	244.76	407.93	1.1515	1.6660	1.044	0.732	1.115	632.	129.6	337.2	11.40	71.3	10.32	12.97	44.00
46.00	0.18755	1408.7	0.08641	246.86	409.12	1.1581	1.6665	1.046	0.736	1.116	624.	129.7	329.9	11.46	70.8	10.45	12.74	46.00
48.00	0.19971	1403.3	0.08140	248.95	410.31	1.1646	1.6670	1.049	0.741	1.117	617.	129.7	322.8	11.53	70.3	10.57	12.51	48.00
50.00	0.21246	1397.8	0.07674	251.06	411.50	1.1711	1.6676	1.052	0.745	1.119	610.	129.7	315.9	11.60	69.8	10.70	12.28	50.00
52.00	0.22584	1392.3	0.07240	253.17	412.69	1.1776	1.6682	1.055	0.749	1.120	602.	129.7	309.1	11.67	69.3	10.82	12.05	52.00
54.00	0.23985	1386.8	0.06836	255.28	413.87	1.1840	1.6688	1.058	0.753	1.121	595.	129.7	302.6	11.74	68.8	10.95	11.83	54.00
56.00	0.25451	1381.2	0.06458	257.41	415.05	1.1905	1.6694	1.060	0.758	1.123	588.	129.7	296.2	11.80	68.3	11.08	11.60	56.00
58.00	0.26985	1375.6	0.06106	259.53	416.23	1.1969	1.6701	1.063	0.762	1.124	580.	129.7	289.9	11.87	67.8	11.21	11.38	58.00
60.00	0.28589	1370.0	0.05777	261.67	417.40	1.2033	1.6707	1.066	0.767	1.126	573.	129.6	283.9	11.94	67.3	11.34	11.16	60.00
62.00	0.30264	1364.3	0.05469	263.81	418.57	1.2096	1.6714	1.069	0.771	1.127	566.	129.6	277.9	12.01	66.8	11.47	10.93	62.00
64.00	0.32013	1358.6	0.05180	265.95	419.73	1.2160	1.6721	1.072	0.776	1.129	558.	129.5	272.1	12.07	66.3	11.61	10.71	64.00
66.00	0.33838	1352.8	0.04910	268.10	420.89	1.2223	1.6728	1.076	0.781	1.131	551.	129.4	266.5	12.14	65.9	11.74	10.49	66.00
68.00	0.35740	1347.0	0.04656	270.26	422.05	1.2286	1.6735	1.079	0.785	1.133	544.	129.3	261.0	12.21	65.4	11.88	10.27	68.00
70.00	0.37722	1341.2	0.04418	272.42	423.20	1.2349	1.6743	1.082	0.790	1.135	536.	129.2	255.6	12.28	64.9	12.01	10.05	70.00
72.00	0.39787	1335.3	0.04195	274.60	424.35	1.2411	1.6750	1.085	0.795	1.137	529.	129.0	250.4	12.35	64.5	12.15	9.84	72.00
74.00	0.41936	1329.3	0.03985	276.77	425.50	1.2474	1.6758	1.089	0.800	1.139	522.	128.9	245.2	12.42	64.0	12.29	9.62	74.00
76.00	0.44171	1323.4	0.03787	278.96	426.63	1.2536	1.6766	1.092	0.806	1.142	515.	128.7	240.2	12.49	63.5	12.44	9.40	76.00
78.00	0.46494	1317.3	0.03601	281.15	427.77	1.2598	1.6774	1.096	0.811	1.144	507.	128.5	235.3	12.55	63.1	12.58	9.19	78.00
80.00	0.48909	1311.2	0.03426	283.35														

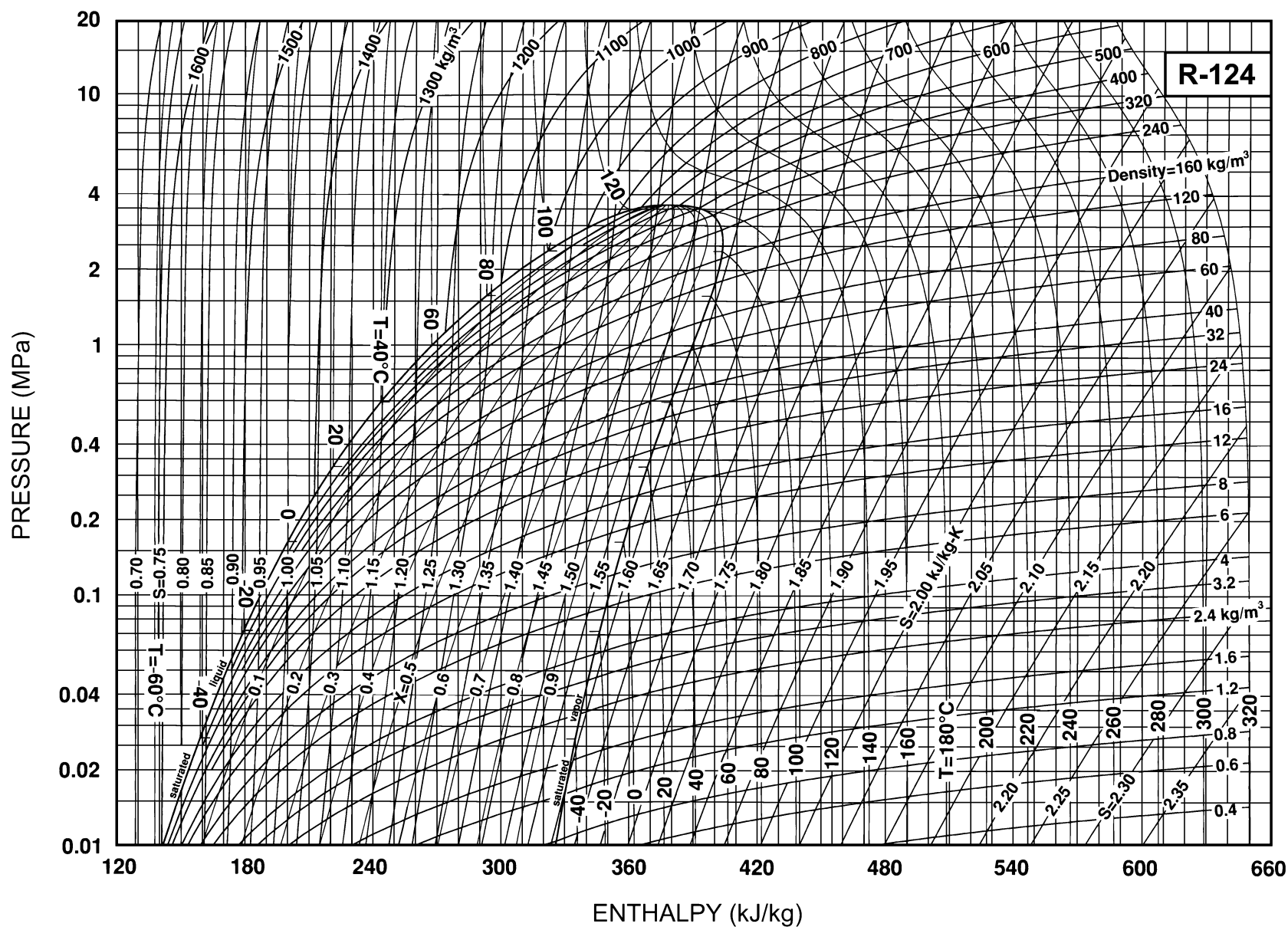


Fig. 6 Pressure-Enthalpy Diagram for Refrigerant 124

Refrigerant 124 (2-Chloro-1,1,1,2-tetrafluoroethane) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c _p , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-100.00	0.00024	1714.6	44.375	98.87	302.29	0.5417	1.7165	0.953	0.534	1.129	1052.	109.1	—	—	—	—	26.10	-100.00
-90.00	0.00067	1688.6	16.531	108.45	307.68	0.5954	1.6832	0.962	0.551	1.125	1007.	111.9	—	—	—	—	24.69	-90.00
-80.00	0.00169	1662.3	6.9645	118.13	313.21	0.6469	1.6569	0.972	0.569	1.122	963.	114.6	—	—	—	—	23.30	-80.00
-70.00	0.00379	1635.9	3.2523	127.91	318.86	0.6962	1.6362	0.983	0.586	1.119	919.	117.2	972.1	7.84	101.3	6.25	21.92	-70.00
-60.00	0.00779	1609.1	1.6560	137.80	324.62	0.7437	1.6202	0.995	0.605	1.117	875.	119.6	787.9	8.23	97.4	6.75	20.56	-60.00
-50.00	0.01482	1582.0	0.90713	147.81	330.46	0.7896	1.6081	1.007	0.624	1.116	832.	121.8	655.1	8.62	93.5	7.26	19.21	-50.00
-40.00	0.02642	1554.3	0.52863	157.95	336.36	0.8340	1.5993	1.020	0.644	1.116	790.	123.8	554.9	9.01	89.8	7.78	17.88	-40.00
-30.00	0.04452	1526.1	0.32470	168.23	342.29	0.8772	1.5930	1.034	0.665	1.118	748.	125.5	476.6	9.39	86.2	8.32	16.56	-30.00
-20.00	0.07145	1497.3	0.20856	178.66	348.23	0.9191	1.5890	1.049	0.688	1.120	706.	126.9	413.7	9.77	82.7	8.88	15.26	-20.00
-18.00	0.07813	1491.4	0.19180	180.76	349.42	0.9274	1.5884	1.052	0.693	1.121	698.	127.1	402.6	9.85	82.0	9.00	15.00	-18.00
-16.00	0.08529	1485.5	0.17665	182.87	350.61	0.9356	1.5879	1.056	0.698	1.122	690.	127.3	391.9	9.93	81.3	9.11	14.74	-16.00
-14.00	0.09296	1479.6	0.16293	184.99	351.79	0.9438	1.5874	1.059	0.703	1.123	682.	127.5	381.6	10.00	80.7	9.22	14.49	-14.00
-12.00	0.10117	1473.6	0.15048	187.11	352.97	0.9519	1.5870	1.062	0.708	1.124	673.	127.7	371.7	10.08	80.0	9.34	14.23	-12.00
-11.96b	0.10133	1473.5	0.15026	187.15	352.99	0.9521	1.5870	1.062	0.708	1.124	673.	127.7	371.5	10.08	80.0	9.34	14.23	-11.96
-10.00	0.10993	1467.6	0.13917	189.24	354.15	0.9600	1.5867	1.065	0.713	1.125	665.	127.9	362.1	10.15	79.3	9.46	13.98	-10.00
-8.00	0.11928	1461.6	0.12888	191.38	355.33	0.9681	1.5864	1.069	0.718	1.126	657.	128.1	352.8	10.23	78.7	9.57	13.72	-8.00
-6.00	0.12923	1455.5	0.11950	193.52	356.51	0.9761	1.5862	1.072	0.723	1.127	649.	128.2	343.9	10.31	78.0	9.69	13.47	-6.00
-4.00	0.13983	1449.4	0.11093	195.68	357.68	0.9841	1.5860	1.076	0.729	1.128	641.	128.3	335.3	10.38	77.3	9.81	13.22	-4.00
-2.00	0.15108	1443.2	0.10310	197.83	358.86	0.9921	1.5859	1.079	0.734	1.129	633.	128.5	326.9	10.46	76.7	9.93	12.97	-2.00
0.00	0.16303	1437.0	0.09593	200.00	360.02	1.0000	1.5858	1.083	0.740	1.131	625.	128.6	318.9	10.53	76.0	10.05	12.72	0.00
2.00	0.17570	1430.8	0.08936	202.17	361.19	1.0079	1.5858	1.087	0.746	1.132	617.	128.6	311.0	10.61	75.4	10.17	12.47	2.00
4.00	0.18911	1424.5	0.08333	204.35	362.35	1.0158	1.5858	1.090	0.751	1.134	609.	128.7	303.5	10.69	74.7	10.30	12.22	4.00
6.00	0.20331	1418.1	0.07779	206.54	363.51	1.0236	1.5859	1.094	0.757	1.135	601.	128.7	296.1	10.76	74.1	10.42	11.97	6.00
8.00	0.21830	1411.8	0.07268	208.74	364.67	1.0314	1.5860	1.098	0.763	1.137	593.	128.8	289.0	10.84	73.5	10.54	11.72	8.00
10.00	0.23414	1405.3	0.06798	210.94	365.82	1.0392	1.5861	1.102	0.769	1.139	585.	128.8	282.1	10.92	72.8	10.67	11.48	10.00
12.00	0.25084	1398.9	0.06364	213.15	366.97	1.0469	1.5863	1.106	0.776	1.141	577.	128.7	275.3	10.99	72.2	10.80	11.23	12.00
14.00	0.26844	1392.3	0.05964	215.37	368.11	1.0546	1.5865	1.110	0.782	1.143	569.	128.7	268.8	11.07	71.6	10.93	10.99	14.00
16.00	0.28696	1385.7	0.05593	217.60	369.25	1.0623	1.5868	1.114	0.788	1.145	561.	128.7	262.5	11.15	70.9	11.05	10.74	16.00
18.00	0.30644	1379.1	0.05250	219.84	370.38	1.0700	1.5870	1.119	0.795	1.148	553.	128.6	256.3	11.23	70.3	11.18	10.50	18.00
20.00	0.32692	1372.4	0.04932	222.09	371.51	1.0776	1.5873	1.123	0.802	1.150	545.	128.5	250.3	11.30	69.7	11.32	10.26	20.00
22.00	0.34842	1365.6	0.04636	224.34	372.63	1.0852	1.5876	1.128	0.809	1.153	537.	128.4	244.4	11.38	69.1	11.45	10.02	22.00
24.00	0.37097	1358.8	0.04362	226.60	373.75	1.0928	1.5880	1.132	0.816	1.156	529.	128.2	238.7	11.46	68.5	11.58	9.78	24.00
26.00	0.39462	1351.9	0.04107	228.88	374.85	1.1004	1.5883	1.137	0.823	1.159	521.	128.1	233.2	11.54	67.8	11.72	9.54	26.00
28.00	0.41938	1345.0	0.03870	231.16	375.96	1.1079	1.5887	1.142	0.830	1.162	513.	127.9	227.8	11.62	67.2	11.86	9.30	28.00
30.00	0.44530	1337.9	0.03648	233.45	377.05	1.1154	1.5891	1.147	0.838	1.165	505.	127.7	222.5	11.70	66.6	12.00	9.06	30.00
32.00	0.47241	1330.8	0.03442	235.75	378.14	1.1229	1.5895	1.152	0.845	1.169	497.	127.5	217.3	11.78	66.0	12.14	8.83	32.00
34.00	0.50075	1323.7	0.03249	238.07	379.22	1.1304	1.5900	1.157	0.853	1.172	489.	127.2	212.3	11.87	65.4	12.28	8.59	34.00
36.00	0.53034	1316.4	0.03069	240.39	380.29	1.1379	1.5904	1.163	0.861	1.176	481.	126.9	207.3	11.95	64.8	12.43	8.36	36.00
38.00	0.56123	1309.1	0.02901	242.72	381.36	1.1453	1.5909	1.168	0.870	1.180	473.	126.6	202.5	12.03	64.2	12.57	8.13	38.00
40.00	0.59345	1301.6	0.02743	245.07	382.41	1.1528	1.5913	1.174	0.878	1.185	465.	126.3	197.8	12.12	63.6	12.72	7.90	40.00
42.00	0.62704	1294.1	0.02596	247.43	383.45	1.1602	1.5918	1.180	0.887	1.189	457.	125.9	193.2	12.20	63.0	12.88	7.67	42.00
44.00	0.66202	1286.5	0.02457	249.79	384.49	1.1676	1.5923	1.187	0.897	1.194	449.	125.6	188.7	12.29	62.4	13.03	7.44	44.00
46.00	0.69845	1278.8	0.02327	252.17	385.51	1.1750	1.5928	1.193	0.906	1.199	441.	125.2	184.3	12.38	61.8	13.19	7.21	46.00
48.00	0.73635	1271.0	0.02205	254.56	386.52	1.1824	1.5933	1.200	0.916	1.205	433.	124.7	179.9	12.47	61.2	13.35	6.98	48.00
50.00	0.77577	1263.1	0.02090	256.97	387.53	1.1897	1.5937	1.207	0.926	1.211	425.	124.3	175.7	12.56	60.6	13.51	6.76	50.00
52.00	0.81675	1255.1	0.01982	259.39	388.51	1.1971	1.5942	1.214	0.937	1.217	417.	123.8	171.5	12.65	60.0	13.68	6.53	52.00
54.00	0.85931	1247.0	0.01880	261.82	389.49	1.2044	1.5947	1.221	0.948	1.224	409.	123.3	167.4	12.75	59.4	13.85	6.31	54.00
56.00	0.90350	1238.7	0.01784	264.26	390.45	1.2118	1.5951	1.229	0.959	1.231	401.	122.7	163.4	12.85	58.8	14.02	6.09	56.00
58.00	0.94937	1230.3	0.01693	266.73	391.39	1.2191	1.5956	1.238	0.971	1.239	393.	122.1	159.5	12.95	58.2	14.20	5.87	58.00
60.00	0.99695	1221.8	0.01607	269.20	392.33	1.2265	1.5960	1.246	0.984</									

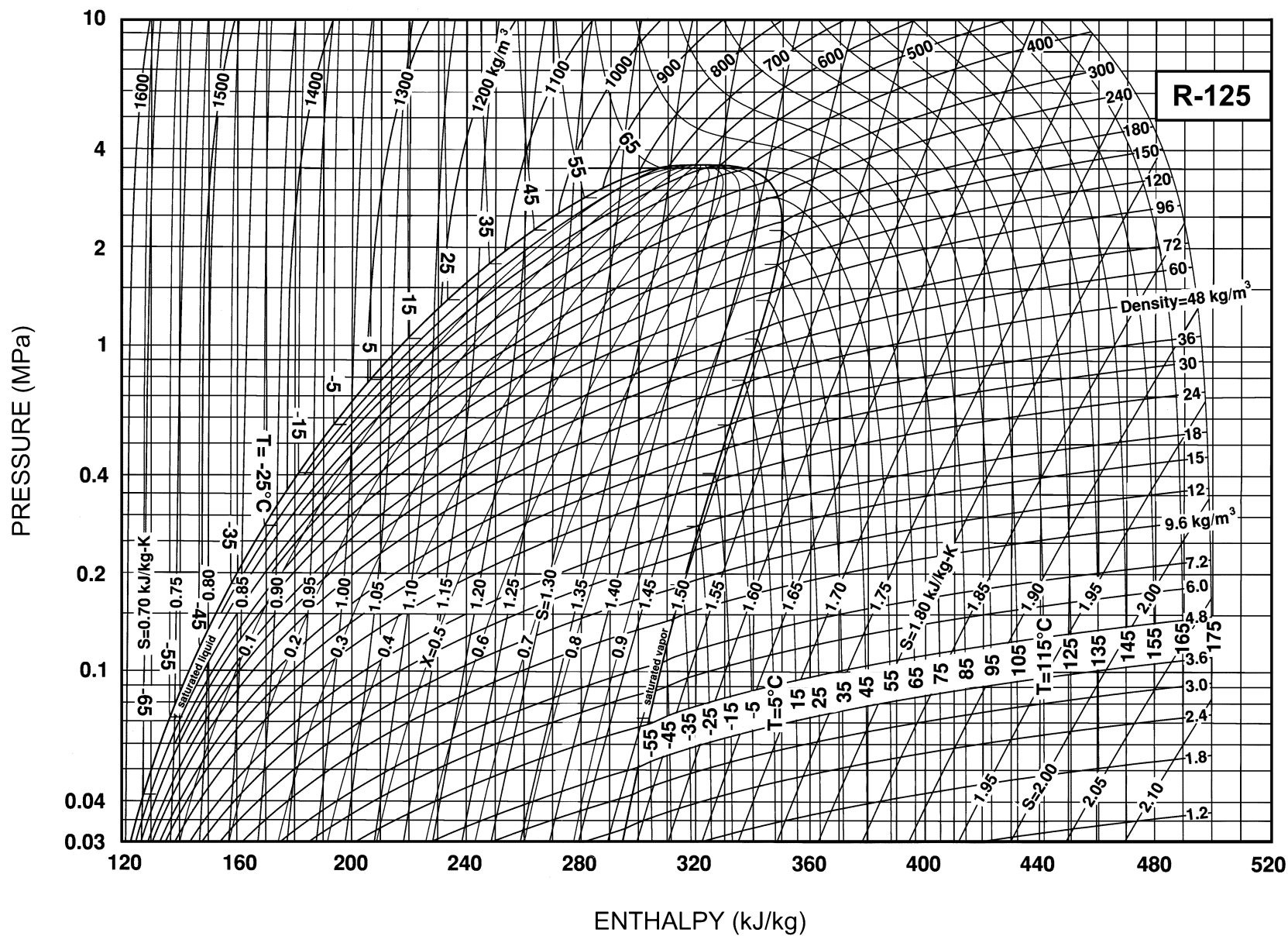


Fig. 7 Pressure-Enthalpy Diagram for Refrigerant 125

Refrigerant 125 (Pentafluoroethane) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c _p , kJ/(kg·K)		c _p /c _v	Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-100.63a	0.00294	1690.8	4.0484	87.33	277.25	0.4910	1.5919	1.043	0.569	1.142	955.	116.4	1218.	7.43	120.4	5.72	21.79	-100.63
-100.00	0.00312	1688.8	3.8337	87.99	277.60	0.4948	1.5899	1.043	0.570	1.141	951.	116.6	1194.	7.46	120.0	5.76	21.69	-100.00
-90.00	0.00734	1656.1	1.7168	98.44	283.22	0.5535	1.5624	1.048	0.593	1.138	892.	119.4	905.2	7.90	114.1	6.31	20.08	-90.00
-80.00	0.01556	1623.1	0.85019	108.97	288.92	0.6094	1.5411	1.057	0.618	1.137	837.	121.9	718.7	8.33	108.5	6.88	18.50	-80.00
-70.00	0.03021	1589.6	0.45734	119.61	294.68	0.6631	1.5249	1.070	0.645	1.137	785.	124.1	588.2	8.76	103.2	7.48	16.94	-70.00
-60.00	0.05450	1555.5	0.26343	130.40	300.44	0.7149	1.5126	1.087	0.675	1.140	735.	126.0	491.5	9.19	98.2	8.10	15.41	-60.00
-58.00	0.06085	1548.5	0.23760	132.57	301.58	0.7250	1.5106	1.090	0.681	1.140	725.	126.3	475.1	9.28	97.2	8.23	15.11	-58.00
-56.00	0.06777	1541.6	0.21477	134.76	302.73	0.7351	1.5086	1.094	0.688	1.141	715.	126.6	459.4	9.37	96.2	8.36	14.81	-56.00
-54.00	0.07531	1534.5	0.19454	136.95	303.88	0.7451	1.5068	1.098	0.695	1.142	706.	126.9	444.5	9.45	95.2	8.49	14.51	-54.00
-52.00	0.08350	1527.5	0.17657	139.16	305.02	0.7551	1.5051	1.102	0.701	1.143	696.	127.1	430.3	9.54	94.2	8.62	14.21	-52.00
-50.00	0.09237	1520.4	0.16058	141.37	306.16	0.7650	1.5035	1.106	0.708	1.145	686.	127.4	416.8	9.62	93.3	8.75	13.91	-50.00
-48.13b	0.10133	1513.7	0.14720	143.44	307.22	0.7743	1.5021	1.110	0.715	1.146	677.	127.6	404.6	9.70	92.4	8.87	13.63	-48.13
-48.00	0.10198	1513.2	0.14631	143.59	307.30	0.7749	1.5020	1.110	0.715	1.146	677.	127.6	403.8	9.71	92.3	8.88	13.61	-48.00
-46.00	0.11236	1506.0	0.13355	145.81	308.43	0.7847	1.5006	1.114	0.723	1.147	667.	127.8	391.4	9.80	91.4	9.02	13.32	-46.00
-44.00	0.12355	1498.7	0.12211	148.05	309.56	0.7945	1.4993	1.119	0.730	1.149	658.	128.0	379.5	9.88	90.4	9.15	13.02	-44.00
-42.00	0.13559	1491.4	0.11184	150.29	310.69	0.8042	1.4981	1.123	0.738	1.151	648.	128.1	368.1	9.97	89.5	9.29	12.73	-42.00
-40.00	0.14853	1484.0	0.10260	152.55	311.81	0.8139	1.4970	1.128	0.745	1.153	639.	128.3	357.1	10.06	88.5	9.43	12.44	-40.00
-38.00	0.16241	1476.6	0.09427	154.81	312.93	0.8235	1.4959	1.132	0.753	1.155	630.	128.4	346.6	10.14	87.6	9.57	12.15	-38.00
-36.00	0.17728	1469.1	0.08675	157.09	314.04	0.8331	1.4949	1.137	0.761	1.157	620.	128.5	336.4	10.23	86.7	9.71	11.86	-36.00
-34.00	0.19318	1461.6	0.07994	159.37	315.15	0.8426	1.4940	1.142	0.769	1.159	611.	128.6	326.7	10.32	85.7	9.85	11.57	-34.00
-32.00	0.21017	1453.9	0.07377	161.66	316.25	0.8521	1.4932	1.148	0.777	1.161	601.	128.6	317.2	10.41	84.8	10.00	11.28	-32.00
-30.00	0.22829	1446.2	0.06817	163.97	317.35	0.8616	1.4924	1.153	0.786	1.164	592.	128.6	308.2	10.50	83.9	10.14	11.00	-30.00
-28.00	0.24758	1438.5	0.06307	166.28	318.44	0.8710	1.4917	1.158	0.794	1.167	583.	128.6	299.4	10.59	83.0	10.29	10.72	-28.00
-26.00	0.26810	1430.6	0.05843	168.61	319.52	0.8804	1.4910	1.164	0.803	1.170	573.	128.6	290.9	10.68	82.1	10.44	10.43	-26.00
-24.00	0.28990	1422.7	0.05419	170.95	320.60	0.8898	1.4904	1.169	0.812	1.173	564.	128.5	282.7	10.77	81.2	10.59	10.15	-24.00
-22.00	0.31304	1414.7	0.05032	173.30	321.66	0.8991	1.4899	1.175	0.821	1.176	555.	128.5	274.8	10.86	80.3	10.75	9.87	-22.00
-20.00	0.33755	1406.6	0.04678	175.66	322.72	0.9084	1.4894	1.181	0.830	1.179	545.	128.4	267.1	10.95	79.4	10.90	9.60	-20.00
-18.00	0.36350	1398.4	0.04353	178.03	323.77	0.9177	1.4889	1.188	0.840	1.183	536.	128.2	259.6	11.05	78.5	11.06	9.32	-18.00
-16.00	0.39093	1390.1	0.04054	180.42	324.81	0.9269	1.4884	1.194	0.849	1.187	527.	128.1	252.4	11.14	77.6	11.22	9.05	-16.00
-14.00	0.41991	1381.8	0.03780	182.82	325.85	0.9361	1.4880	1.201	0.859	1.191	517.	127.9	245.4	11.24	76.7	11.38	8.77	-14.00
-12.00	0.45049	1373.3	0.03528	185.23	326.87	0.9453	1.4877	1.207	0.869	1.196	508.	127.6	238.6	11.33	75.8	11.55	8.50	-12.00
-10.00	0.48272	1364.7	0.03295	187.66	327.88	0.9545	1.4873	1.214	0.880	1.201	499.	127.4	232.0	11.43	75.0	11.72	8.23	-10.00
-8.00	0.51666	1356.0	0.03081	190.09	328.88	0.9636	1.4870	1.222	0.891	1.206	489.	127.1	225.5	11.53	74.1	11.89	7.97	-8.00
-6.00	0.55237	1347.2	0.02882	192.55	329.86	0.9727	1.4867	1.229	0.902	1.211	480.	126.8	219.2	11.63	73.2	12.07	7.70	-6.00
-4.00	0.58990	1338.3	0.02699	195.02	330.84	0.9818	1.4865	1.237	0.913	1.217	471.	126.4	213.1	11.73	72.3	12.25	7.44	-4.00
-2.00	0.62932	1329.2	0.02528	197.50	331.80	0.9909	1.4862	1.245	0.925	1.224	461.	126.0	207.2	10.61	71.4	12.41	7.17	-2.00
0.00	0.67068	1320.0	0.02371	200.00	332.74	1.0000	1.4860	1.254	0.938	1.230	452.	125.6	201.4	10.99	70.6	12.58	6.91	0.00
2.00	0.71405	1310.7	0.02224	202.52	333.67	1.0091	1.4857	1.262	0.950	1.238	442.	125.2	195.7	11.23	69.7	12.75	6.65	2.00
4.00	0.75948	1301.2	0.02088	205.05	334.59	1.0181	1.4855	1.272	0.964	1.245	433.	124.7	190.2	11.42	68.8	12.93	6.40	4.00
6.00	0.80703	1291.5	0.01961	207.60	335.49	1.0271	1.4853	1.281	0.978	1.254	423.	124.1	184.8	11.60	68.0	13.12	6.14	6.00
8.00	0.85678	1281.7	0.01843	210.17	336.36	1.0362	1.4850	1.291	0.992	1.263	413.	123.6	179.5	11.76	67.1	13.31	5.89	8.00
10.00	0.90879	1271.7	0.01733	212.75	337.22	1.0452	1.4848	1.302	1.008	1.273	404.	123.0	174.3	11.91	66.2	13.51	5.64	10.00
12.00	0.96312	1261.5	0.01630	215.36	338.06	1.0542	1.4845	1.313	1.024	1.283	394.	122.3	169.2	12.07	65.4	13.72	5.39	12.00
14.00	1.0198	1251.1	0.01533	217.99	338.87	1.0632	1.4842	1.325	1.041	1.295	384.	121.6	164.3	12.22	64.5	13.94	5.14	14.00
16.00	1.0790	1240.5	0.01443	220.63	339.66	1.0723	1.4839	1.338	1.059	1.307	375.	120.9	159.4	12.37	63.6	14.16	4.90	16.00
18.00	1.1407	1229.7	0.01359	223.31	340.43	1.0813	1.4836	1.351	1.079	1.321	365.	120.1	154.6	12.53	62.8	14.39	4.66	18.00
20.00	1.2050	1218.6	0.01279	226.00	341.17	1.0903	1.4832	1.365	1.100	1.336	355.	119.3	149.9	12.69	61.9	14.63	4.42	20.00
22.00	1.2720	1207.3	0.01205	228.72	341.87	1.0994	1.4828	1.381	1.122	1.353	345.	118.4	145.3	12.85	61.0	14.89	4.18	22.00
24.00	1.3417	1195.7	0.01135	231.46	342.55	1.1085	1.4823	1.397	1.146	1.371	335.	117.5	140.8	13.01	60.2	15.15	3.95	24.00
26.00	1.4142	1183.8																

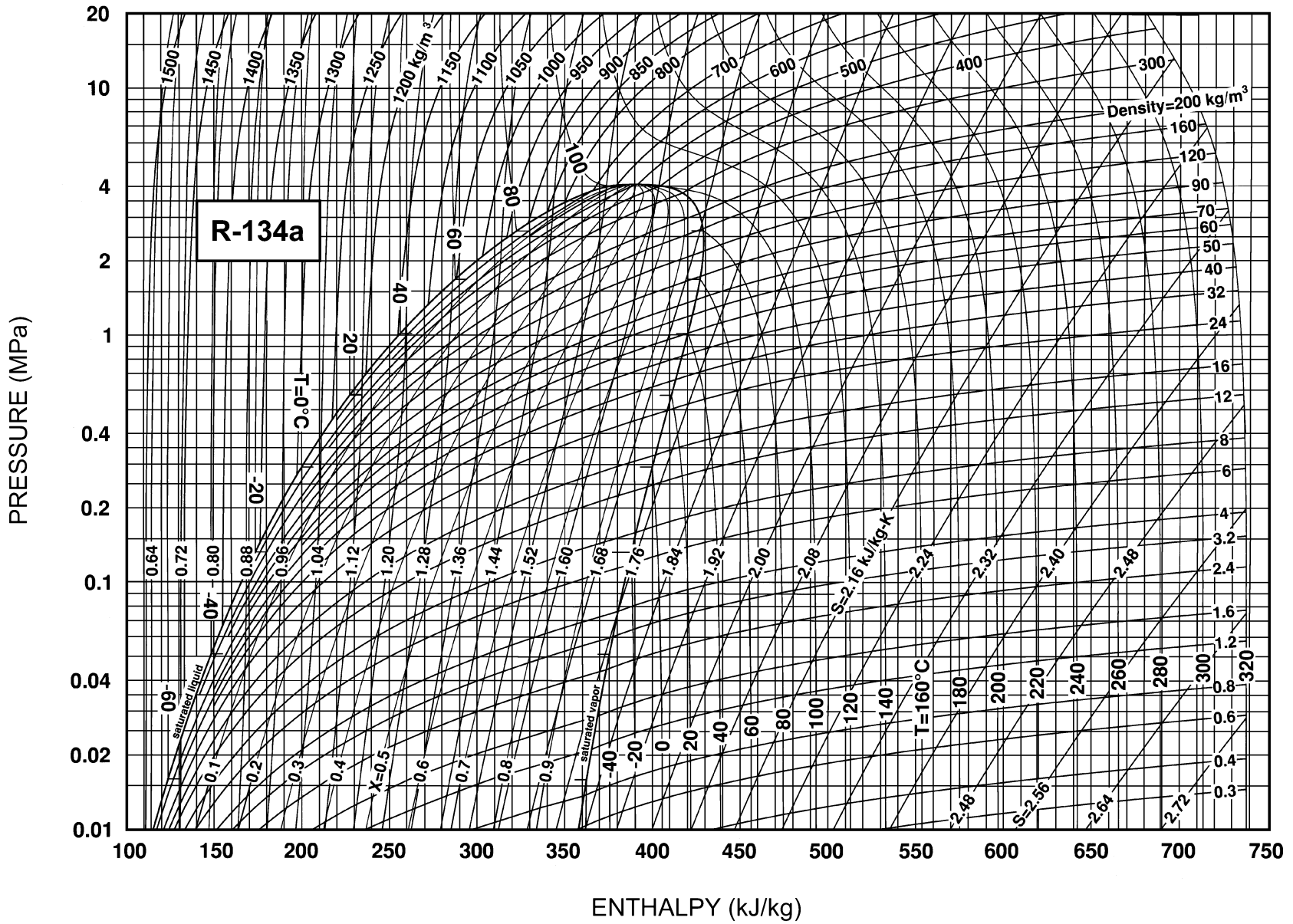


Fig. 8 Pressure-Enthalpy Diagram for Refrigerant 134a

Refrigerant 134a (1,1,1,2-Tetrafluoroethane) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, kg/m ³	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c _p , kJ/(kg·K)		c _p /c _v	Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-103.30a	0.00039	1591.1	35.496	71.46	334.94	0.4126	1.9639	1.184	0.585	1.164	1120.	126.8	2175.	6.46	145.2	3.08	28.07	-103.30
-100.00	0.00056	1582.4	25.193	75.36	336.85	0.4354	1.9456	1.184	0.593	1.162	1103.	127.9	1893.	6.60	143.2	3.34	27.50	-100.00
-90.00	0.00152	1555.8	9.7698	87.23	342.76	0.5020	1.8972	1.189	0.617	1.156	1052.	131.0	1339.	7.03	137.3	4.15	25.79	-90.00
-80.00	0.00367	1529.0	4.2682	99.16	348.83	0.5654	1.8580	1.198	0.642	1.151	1002.	134.0	1018.	7.46	131.5	4.95	24.10	-80.00
-70.00	0.00798	1501.9	2.0590	111.20	355.02	0.6262	1.8264	1.210	0.667	1.148	952.	136.8	809.2	7.89	126.0	5.75	22.44	-70.00
-60.00	0.01591	1474.3	1.0790	123.36	361.31	0.6846	1.8010	1.223	0.692	1.146	903.	139.4	663.1	8.30	120.7	6.56	20.80	-60.00
-50.00	0.02945	1446.3	0.60620	135.67	367.65	0.7410	1.7806	1.238	0.720	1.146	855.	141.7	555.1	8.72	115.6	7.36	19.18	-50.00
-40.00	0.05121	1417.7	0.36108	148.14	374.00	0.7956	1.7643	1.255	0.749	1.148	807.	143.6	472.2	9.12	110.6	8.17	17.60	-40.00
-30.00	0.08438	1388.4	0.22594	160.79	380.32	0.8486	1.7515	1.273	0.781	1.152	760.	145.2	406.4	9.52	105.8	8.99	16.04	-30.00
-28.00	0.09270	1382.4	0.20680	163.34	381.57	0.8591	1.7492	1.277	0.788	1.153	751.	145.4	394.9	9.60	104.8	9.15	15.73	-28.00
-26.07b	0.10133	1376.7	0.19018	165.81	382.78	0.8690	1.7472	1.281	0.794	1.154	742.	145.7	384.2	9.68	103.9	9.31	15.44	-26.07
-26.00	0.10167	1376.5	0.18958	165.90	382.82	0.8694	1.7471	1.281	0.794	1.154	742.	145.7	383.8	9.68	103.9	9.32	15.43	-26.00
-24.00	0.11130	1370.4	0.17407	168.47	384.07	0.8798	1.7451	1.285	0.801	1.155	732.	145.9	373.1	9.77	102.9	9.48	15.12	-24.00
-22.00	0.12165	1364.4	0.16006	171.05	385.32	0.8900	1.7432	1.289	0.809	1.156	723.	146.1	362.9	9.85	102.0	9.65	14.82	-22.00
-20.00	0.13273	1358.3	0.14739	173.64	386.55	0.9002	1.7413	1.293	0.816	1.158	714.	146.3	353.0	9.92	101.1	9.82	14.51	-20.00
-18.00	0.14460	1352.1	0.13592	176.23	387.79	0.9104	1.7396	1.297	0.823	1.159	705.	146.4	343.5	10.01	100.1	9.98	14.21	-18.00
-16.00	0.15728	1345.9	0.12551	178.83	389.02	0.9205	1.7379	1.302	0.831	1.161	695.	146.6	334.3	10.09	99.2	10.15	13.91	-16.00
-14.00	0.17082	1339.7	0.11605	181.44	390.24	0.9306	1.7363	1.306	0.838	1.163	686.	146.7	325.4	10.17	98.3	10.32	13.61	-14.00
-12.00	0.18524	1333.4	0.10744	184.07	391.46	0.9407	1.7348	1.311	0.846	1.165	677.	146.8	316.9	10.25	97.4	10.49	13.32	-12.00
-10.00	0.20060	1327.1	0.09959	186.70	392.66	0.9506	1.7334	1.316	0.854	1.167	668.	146.9	308.6	10.33	96.5	10.66	13.02	-10.00
-8.00	0.21693	1320.8	0.09242	189.34	393.87	0.9606	1.7320	1.320	0.863	1.169	658.	146.9	300.6	10.41	95.6	10.83	12.72	-8.00
-6.00	0.23428	1314.3	0.08587	191.99	395.06	0.9705	1.7307	1.325	0.871	1.171	649.	147.0	292.9	10.49	94.7	11.00	12.43	-6.00
-4.00	0.25268	1307.9	0.07987	194.65	396.25	0.9804	1.7294	1.330	0.880	1.174	640.	147.0	285.4	10.57	93.8	11.17	12.14	-4.00
-2.00	0.27217	1301.4	0.07436	197.32	397.43	0.9902	1.7282	1.336	0.888	1.176	631.	147.0	278.1	10.65	92.9	11.34	11.85	-2.00
0.00	0.29280	1294.8	0.06931	200.00	398.60	1.0000	1.7271	1.341	0.897	1.179	622.	146.9	271.1	10.73	92.0	11.51	11.56	0.00
2.00	0.31462	1288.1	0.06466	202.69	399.77	1.0098	1.7260	1.347	0.906	1.182	612.	146.9	264.3	10.81	91.1	11.69	11.27	2.00
4.00	0.33766	1281.4	0.06039	205.40	400.92	1.0195	1.7250	1.352	0.916	1.185	603.	146.8	257.6	10.90	90.2	11.86	10.99	4.00
6.00	0.36198	1274.7	0.05644	208.11	402.06	1.0292	1.7240	1.358	0.925	1.189	594.	146.7	251.2	10.98	89.4	12.04	10.70	6.00
8.00	0.38761	1267.9	0.05280	210.84	403.20	1.0388	1.7230	1.364	0.935	1.192	585.	146.5	244.9	11.06	88.5	12.22	10.42	8.00
10.00	0.41461	1261.0	0.04944	213.58	404.32	1.0485	1.7221	1.370	0.945	1.196	576.	146.4	238.8	11.15	87.6	12.40	10.14	10.00
12.00	0.44301	1254.0	0.04633	216.33	405.43	1.0581	1.7212	1.377	0.956	1.200	566.	146.2	232.9	11.23	86.7	12.58	9.86	12.00
14.00	0.47288	1246.9	0.04345	219.09	406.53	1.0677	1.7204	1.383	0.967	1.204	557.	146.0	227.1	11.32	85.9	12.77	9.58	14.00
16.00	0.50425	1239.8	0.04078	221.87	407.61	1.0772	1.7196	1.390	0.978	1.209	548.	145.7	221.5	11.40	85.0	12.95	9.30	16.00
18.00	0.53718	1232.6	0.03830	224.66	408.69	1.0867	1.7188	1.397	0.989	1.214	539.	145.5	216.0	11.49	84.1	13.14	9.03	18.00
20.00	0.57171	1225.3	0.03600	227.47	409.75	1.0962	1.7180	1.405	1.001	1.219	530.	145.1	210.7	11.58	83.3	13.33	8.76	20.00
22.00	0.60789	1218.0	0.03385	230.29	410.79	1.1057	1.7173	1.413	1.013	1.224	520.	144.8	205.5	11.67	82.4	13.53	8.48	22.00
24.00	0.64578	1210.5	0.03186	233.12	411.82	1.1152	1.7166	1.421	1.025	1.230	511.	144.5	200.4	11.76	81.6	13.72	8.21	24.00
26.00	0.68543	1202.9	0.03000	235.97	412.84	1.1246	1.7159	1.429	1.038	1.236	502.	144.1	195.4	11.85	80.7	13.92	7.95	26.00
28.00	0.72688	1195.2	0.02826	238.84	413.84	1.1341	1.7152	1.437	1.052	1.243	493.	143.6	190.5	11.95	79.8	14.13	7.68	28.00
30.00	0.77020	1187.5	0.02664	241.72	414.82	1.1435	1.7145	1.446	1.065	1.249	483.	143.2	185.8	12.04	79.0	14.33	7.42	30.00
32.00	0.81543	1179.6	0.02513	244.62	415.78	1.1529	1.7138	1.456	1.080	1.257	474.	142.7	181.1	12.14	78.1	14.54	7.15	32.00
34.00	0.86263	1171.6	0.02371	247.54	416.72	1.1623	1.7131	1.466	1.095	1.265	465.	142.1	176.6	12.24	77.3	14.76	6.89	34.00
36.00	0.91185	1163.4	0.02238	250.48	417.65	1.1717	1.7124	1.476	1.111	1.273	455.	141.6	172.1	12.34	76.4	14.98	6.64	36.00
38.00	0.96315	1155.1	0.02113	253.43	418.55	1.1811	1.7118	1.487	1.127	1.282	446.	141.0	167.7	12.44	75.6	15.21	6.38	38.00
40.00	1.0166	1146.7	0.01997	256.41	419.43	1.1905	1.7111	1.498	1.145	1.292	436.	140.3	163.4	12.55	74.7	15.44	6.13	40.00
42.00	1.0722	1138.2	0.01887	259.41	420.28	1.1999	1.7103	1.510	1.163	1.303	427.	139.7	159.2	12.65	73.9	15.68	5.88	42.00
44.00	1.1301	1129.5	0.01784	262.43	421.11	1.2092	1.7096	1.523	1.182	1.314	418.	138.9	155.1	12.76	73.0	15.93	5.63	44.00
46.00	1.1903	1120.6	0.01687	265.47	421.92	1.2186	1.7089	1.537	1.202	1.326	408.	138.2	151.0	12.88	72.1	16.18	5.38	46.00
48.00	1.2529	1111.5	0.01595	268.53	422.69	1.2280	1.7081	1.551	1.223	1.339	399.	137.4	147.0	13.00	71.3	16.45	5.13	48.00
50																		

Refrigerant 134a Properties of Superheated Vapor

Pressure = 0.101325 MPa Saturation temperature = -26.07°C					Pressure = 0.200 MPa Saturation temperature = -10.07°C					Pressure = 0.400 MPa Saturation temperature = 8.94°C				
Temp.,* °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	Vel. Sound, m/s	Temp.,* °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	Vel. Sound, m/s	Temp.,* °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	Vel. Sound, m/s
Saturated					Saturated					Saturated				
Liquid	1374.34	166.07	0.8701	747.1	Liquid	1325.78	186.69	0.9506	672.8	Liquid	1263.84	212.08	1.0432	583.8
Vapor	5.26	382.90	1.7476	145.7	Vapor	10.01	392.71	1.7337	146.9	Vapor	19.52	403.80	1.7229	146.6
-20.00	5.11	387.68	1.7667	147.8										
-10.00	4.89	395.65	1.7976	151.0	-10.00	10.01	392.77	1.7339	147.0					
0.00	4.69	403.74	1.8278	154.2	0.00	9.54	401.21	1.7654	150.6					
10.00	4.50	411.97	1.8574	157.2	10.00	9.13	409.73	1.7961	154.0	10.00	19.41	404.78	1.7263	147.0
20.00	4.34	420.34	1.8864	160.1	20.00	8.76	418.35	1.8260	157.3	20.00	18.45	414.00	1.7583	151.2
30.00	4.18	428.85	1.9150	162.9	30.00	8.42	427.07	1.8552	160.4	30.00	17.61	423.21	1.7892	155.0
40.00	4.04	437.52	1.9431	165.7	40.00	8.12	435.90	1.8839	163.4	40.00	16.87	432.46	1.8192	158.6
50.00	3.91	446.33	1.9708	168.4	50.00	7.83	444.87	1.9121	166.3	50.00	16.20	441.76	1.8485	162.0
60.00	3.78	455.30	1.9981	171.0	60.00	7.57	453.97	1.9398	169.2	60.00	15.60	451.15	1.8771	165.3
70.00	3.67	464.43	2.0251	173.6	70.00	7.33	463.20	1.9671	171.9	70.00	15.05	460.63	1.9051	168.4
80.00	3.56	473.70	2.0518	176.1	80.00	7.11	472.57	1.9940	174.6	80.00	14.54	470.21	1.9326	171.4
90.00	3.46	483.13	2.0781	178.6	90.00	6.89	482.08	2.0206	177.2	90.00	14.08	479.91	1.9597	174.3
100.00	3.36	492.71	2.1041	181.0	100.00	6.70	491.74	2.0468	179.7	100.00	13.65	489.72	1.9864	177.1
110.00	3.27	502.44	2.1298	183.4	110.00	6.51	501.53	2.0727	182.2	110.00	13.24	499.65	2.0126	179.8
120.00	3.19	512.32	2.1553	185.7	120.00	6.34	511.47	2.0983	184.7	120.00	12.87	509.71	2.0386	182.4
130.00	3.11	522.35	2.1805	188.1	130.00	6.17	521.55	2.1236	187.1	130.00	12.51	519.90	2.0641	185.0
140.00	3.03	532.52	2.2054	190.3	140.00	6.01	531.76	2.1486	189.4	140.00	12.18	530.21	2.0894	187.5
150.00	2.96	542.83	2.2301	192.6	150.00	5.87	542.12	2.1734	191.7	150.00	11.87	540.66	2.1144	190.0
Pressure = 0.600 MPa Saturation temperature = 21.58°C					Pressure = 0.800 MPa Saturation temperature = 31.33°C					Pressure = 1.000 MPa Saturation temperature = 39.39°C				
Temp.,* °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	Vel. Sound, m/s	Temp.,* °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	Vel. Sound, m/s	Temp.,* °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	Vel. Sound, m/s
Saturated					Saturated					Saturated				
Liquid	1219.08	229.62	1.1035	524.0	Liquid	1181.92	243.58	1.1495	477.4	Liquid	1149.06	255.44	1.1874	438.6
Vapor	29.13	410.67	1.7178	145.0	Vapor	38.99	415.58	1.7144	142.9	Vapor	49.16	419.31	1.7117	140.6
30.00	27.79	418.97	1.7455	149.0										
40.00	26.41	428.72	1.7772	153.4	40.00	36.98	424.61	1.7437	147.6	40.00	48.95	419.99	1.7139	141.0
50.00	25.21	438.44	1.8077	157.4	50.00	35.03	434.85	1.7758	152.4	50.00	45.86	430.91	1.7482	146.9
60.00	24.16	448.16	1.8374	161.2	60.00	33.36	444.98	1.8067	156.8	60.00	43.34	441.56	1.7807	152.0
70.00	23.22	457.93	1.8662	164.7	70.00	31.90	455.08	1.8366	160.8	70.00	41.21	452.05	1.8117	156.7
80.00	22.37	467.75	1.8944	168.0	80.00	30.62	465.17	1.8656	164.6	80.00	39.36	462.47	1.8416	160.9
90.00	21.59	477.65	1.9221	171.2	90.00	29.46	475.30	1.8939	168.1	90.00	37.74	472.86	1.8706	164.9
100.00	20.88	487.64	1.9492	174.3	100.00	28.41	485.49	1.9215	171.5	100.00	36.29	483.26	1.8989	168.6
110.00	20.22	497.72	1.9759	177.3	110.00	27.46	495.74	1.9486	174.7	110.00	34.99	493.69	1.9265	172.1
120.00	19.61	507.92	2.0022	180.1	120.00	26.58	506.07	1.9753	177.8	120.00	33.80	504.19	1.9535	175.4
130.00	19.04	518.22	2.0280	182.9	130.00	25.77	516.50	2.0015	180.8	130.00	32.71	514.75	1.9800	178.6
140.00	18.51	528.63	2.0536	185.6	140.00	25.01	527.03	2.0272	183.7	140.00	31.70	525.39	2.0061	181.7
150.00	18.01	539.17	2.0787	188.2	150.00	24.31	537.66	2.0527	186.4	150.00	30.76	536.12	2.0318	184.6
160.00	17.54	549.82	2.1036	190.8	160.00	23.65	548.40	2.0777	189.2	160.00	29.90	546.95	2.0571	187.5
170.00	17.10	560.59	2.1282	193.3	170.00	23.03	559.24	2.1025	191.8	170.00	29.08	557.88	2.0820	190.3
180.00	16.68	571.48	2.1525	195.8	180.00	22.45	570.20	2.1270	194.4	180.00	28.32	568.91	2.1066	193.0
190.00	16.29	582.50	2.1766	198.2	190.00	21.89	581.28	2.1511	196.9	190.00	27.60	580.05	2.1309	195.6
200.00	15.91	593.63	2.2003	200.6	200.00	21.37	592.46	2.1750	199.4	200.00	26.92	591.29	2.1550	198.2
Pressure = 1.200 MPa Saturation temperature = 46.32°C					Pressure = 1.400 MPa Saturation temperature = 52.43°C					Pressure = 1.600 MPa Saturation temperature = 57.91°C				
Temp.,* °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	Vel. Sound, m/s	Temp.,* °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	Vel. Sound, m/s	Temp.,* °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	Vel. Sound, m/s
Saturated					Saturated					Saturated				
Liquid	1118.89	265.91	1.2200	405.0	Liquid	1090.50	275.38	1.2488	375.1	Liquid	1063.28	284.11	1.2748	348.1
Vapor	59.73	422.22	1.7092	138.2	Vapor	70.76	424.50	1.7068	135.6	Vapor	82.34	426.27	1.7042	132.9
50.00	58.09	426.51	1.7226	140.7										
60.00	54.32	437.83	1.7571	146.9	60.00	66.61	433.69	1.7347	141.2	60.00	80.74	428.99	1.7124	134.7
70.00	51.26	448.81	1.7896	152.3	70.00	62.25	445.31	1.7691	147.5	70.00	74.43	441.47	1.7493	142.3
80.00	48.69	459.61	1.8206	157.1	80.00	58.74	456.56	1.8014	153.0	80.00	69.61	453.30	1.7833	148.7
90.00	46.49	470.30	1.8504	161.5	90.00	55.79	467.60	1.8322	158.0	90.00	65.71	464.76	1.8153	154.2
100.00	44.55	480.94	1.8794	165.6	100.00	53.24	478.53	1.8619	162.5	100.00	62.43	476.01	1.8458	159.2
110.00	42.83	491.58	1.9075	169.4	110.00	51.03	489.39	1.8906	166.6	110.00	59.62	487.13	1.8753	163.8
120.00	41.28	502.25	1.9350	173.0	120.00	49.05	500.25	1.9186	170.5	120.00	57.14	498.19	1.9038	168.0
130.00	39.87	512.95	1.9619	176.4	130.00	47.28	511.11	1.9459	174.2	130.00	54.95	509.23	1.9315	171.9
140.00	38.58	523.72	1.9882	179.7	140.00	45.67	522.02	1.9726	177.7	140.00	52.98	520.28	1.9586	175.6
150.00	37.39	534.56	2.0142	182.8	150.00	44.19	532.97	1.9988	181.0	150.00	51.18	531.36	1.9851	179.1
160.00	36.29	545.48	2.0397	185.8	160.00	42.83	544.00	2.0246	184.2	160.00	49.54	542.49	2.0111	182.5
170.00	35.26	556.50	2.0648	188.8	170.00	41.57	555.10	2.0499	187.2	170.00	48.03	553.68	2.0366	185.7
180.00	34.31	567.60	2.0896	191.6	180.00	40.41	566.28	2.0748	190.2	180.00	46.63	564.94	2.0617	188.8
190.00	33.40	578.80	2.1141	194.4	190.00	39.31	577.55	2.0994	193.1	190.00	45.32	576.29	2.0865	191.8
200.00	32.56	590.11	2.1382	197.1	200.00	38.28	588.92	2.1237	195.9	200.00	44.10	587.71	2.1109	194.7
210.00	31.76	601.51	2.1621	199.7	210.00	37.32	600.38	2.1477	198.6	210.00	42.96	599.23	2.1350	197.6
220.00	31.01	613.02	2.1856	202.3	220.00	36.41	611.94	2.1714	201.3	220.00	41.88	610.84	2.1588	200.3
230.00	30.29	624.64	2.2090	204.8	230.00	35.55	623.60	2.1948	203.9	230.00	40.87	622.55	2.1823	203.0
240.00	29.61	636.36	2.2320	207.2	240.00	34.73	635.35	2.2179	206.4	240.00	39.91	634.35	2.2055	205.6
250.00	28.96	648.18	2.2548	209.7	250.00	33.96	647.22	2.2408	208.9	250.00	39.00	646.25	2.2285	208.2

*Temperatures are on the ITS-90 scale

Refrigerant 134a Properties of Superheated Vapor (Concluded)

Pressure = 1.800 MPa Saturation temperature = 62.90°C					Pressure = 2.000 MPa Saturation temperature = 67.49°C					Pressure = 2.200 MPa Saturation temperature = 71.74°C				
Temp.,* °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	Vel. Sound, m/s	Temp.,* °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	Vel. Sound, m/s	Temp.,* °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	Vel. Sound, m/s
Saturated					Saturated					Saturated				
Liquid	1036.81	292.26	1.2987	323.2	Liquid	1010.74	299.96	1.3209	300.1	Liquid	984.76	307.32	1.3417	278.4
Vapor	94.53	427.59	1.7014	130.1	Vapor	107.46	428.52	1.6983	127.2	Vapor	121.25	429.08	1.6948	124.3
70.00	88.23	437.17	1.7296	136.5	70.00	104.37	432.22	1.7091	129.9					
80.00	81.54	449.76	1.7657	144.0	80.00	94.85	445.86	1.7483	138.9	80.00	110.03	441.49	1.7303	133.3
90.00	76.38	461.74	1.7992	150.3	90.00	87.97	458.49	1.7835	146.2	90.00	100.70	454.98	1.7680	141.8
100.00	72.17	473.36	1.8308	155.9	100.00	82.58	470.57	1.8164	152.4	100.00	93.78	467.61	1.8023	148.7
110.00	68.64	484.78	1.8610	160.8	110.00	78.17	482.32	1.8474	157.8	110.00	88.25	479.75	1.8344	154.7
120.00	65.60	496.06	1.8900	165.4	120.00	74.44	493.86	1.8772	162.7	120.00	83.70	491.59	1.8649	160.0
130.00	62.91	507.29	1.9183	169.6	130.00	71.18	505.30	1.9059	167.2	130.00	79.79	503.25	1.8942	164.9
140.00	60.53	518.50	1.9457	173.5	140.00	68.33	516.68	1.9338	171.4	140.00	76.41	514.81	1.9226	169.3
150.00	58.37	529.71	1.9725	177.3	150.00	65.78	528.03	1.9609	175.4	150.00	73.40	526.32	1.9501	173.5
160.00	56.42	540.95	1.9988	180.8	160.00	63.47	539.39	1.9875	179.1	160.00	70.71	537.81	1.9769	177.4
170.00	54.62	552.24	2.0246	184.2	170.00	61.37	550.79	2.0135	182.6	170.00	68.28	549.31	2.0032	181.1
180.00	52.97	563.59	2.0499	187.4	180.00	59.45	562.23	2.0390	186.0	180.00	66.06	560.84	2.0289	184.6
190.00	51.44	575.01	2.0748	190.6	190.00	57.67	573.72	2.0641	189.3	190.00	64.02	572.42	2.0542	188.0
200.00	50.01	586.50	2.0993	193.6	200.00	56.02	585.28	2.0888	192.4	200.00	62.13	584.06	2.0790	191.3
210.00	48.68	598.08	2.1236	196.5	210.00	54.49	596.92	2.1131	195.5	210.00	60.38	595.76	2.1035	194.4
220.00	47.43	609.74	2.1475	199.4	220.00	53.05	608.64	2.1371	198.4	220.00	58.74	607.53	2.1276	197.5
230.00	46.25	621.50	2.1710	202.1	230.00	51.70	620.44	2.1608	201.3	230.00	57.21	619.38	2.1514	200.4
240.00	45.14	633.34	2.1944	204.9	240.00	50.43	632.33	2.1842	204.1	240.00	55.77	631.31	2.1749	203.3
250.00	44.09	645.28	2.2174	207.5	250.00	49.23	644.30	2.2073	206.8	250.00	54.42	643.33	2.1981	206.1

Pressure = 2.400 MPa Saturation temperature = 75.70°C					Pressure = 2.600 MPa Saturation temperature = 79.41°C					Pressure = 2.800 MPa Saturation temperature = 82.90°C				
Temp.,* °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	Vel. Sound, m/s	Temp.,* °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	Vel. Sound, m/s	Temp.,* °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	Vel. Sound, m/s
Saturated					Saturated					Saturated				
Liquid	958.58	314.40	1.3616	257.9	Liquid	931.88	321.29	1.3806	238.2	Liquid	904.29	328.05	1.3990	219.1
Vapor	136.07	429.27	1.6908	121.4	Vapor	152.12	429.08	1.6863	118.3	Vapor	169.71	428.50	1.6812	115.3
80.00	127.96	436.42	1.7112	126.9	80.00	150.48	430.22	1.6895	119.3					
90.00	114.90	451.12	1.7523	137.0	90.00	131.08	446.81	1.7359	131.7	90.00	150.13	441.84	1.7183	125.9
100.00	105.89	464.44	1.7885	144.8	100.00	119.15	461.03	1.7745	140.8	100.00	133.85	457.32	1.7603	136.4
110.00	99.00	477.04	1.8218	151.5	110.00	110.50	474.19	1.8093	148.1	110.00	122.89	471.16	1.7970	144.6
120.00	93.44	489.22	1.8532	157.2	120.00	103.72	486.75	1.8417	154.4	120.00	114.63	484.17	1.8305	151.5
130.00	88.79	501.14	1.8831	162.4	130.00	98.17	498.96	1.8724	160.0	130.00	108.00	496.70	1.8620	157.5
140.00	84.77	512.90	1.9119	167.2	140.00	93.46	510.94	1.9017	165.0	140.00	102.49	508.93	1.8919	162.9
150.00	81.27	524.57	1.9398	171.6	150.00	89.39	522.79	1.9301	169.7	150.00	97.78	520.97	1.9207	167.8
160.00	78.15	536.20	1.9670	175.7	160.00	85.80	534.57	1.9576	174.0	160.00	93.66	532.90	1.9486	172.3
170.00	75.35	547.82	1.9935	179.6	170.00	82.59	546.30	1.9844	178.1	170.00	90.01	544.77	1.9757	176.5
180.00	72.81	559.45	2.0195	183.3	180.00	79.70	558.04	2.0106	181.9	180.00	86.74	556.61	2.0021	180.5
190.00	70.48	571.11	2.0449	186.8	190.00	77.07	569.79	2.0362	185.5	190.00	83.78	568.45	2.0279	184.3
200.00	68.34	582.82	2.0699	190.2	200.00	74.65	581.57	2.0614	189.0	200.00	81.08	580.31	2.0533	187.9
210.00	66.36	594.58	2.0945	193.4	210.00	72.43	593.40	2.0861	192.4	210.00	78.59	592.21	2.0782	191.4
220.00	64.51	606.41	2.1188	196.6	220.00	70.36	605.29	2.1105	195.6	220.00	76.29	604.16	2.1027	194.7
230.00	62.79	618.31	2.1427	199.6	230.00	68.44	617.24	2.1345	198.8	230.00	74.15	616.17	2.1268	198.0
240.00	61.18	630.29	2.1662	202.5	240.00	66.64	629.27	2.1581	201.8	240.00	72.16	628.25	2.1505	201.1
250.00	59.66	642.35	2.1895	205.4	250.00	64.95	641.37	2.1815	204.8	250.00	70.30	640.39	2.1740	204.1

Pressure = 3.000 MPa Saturation temperature = 86.20°C					Pressure = 4.000 MPa Saturation temperature = 100.35°C					Pressure = 6.00 MPa Saturation temperature = n/a (supercritical)				
Temp.,* °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	Vel. Sound, m/s	Temp.,* °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	Vel. Sound, m/s	Temp.,* °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	Vel. Sound, m/s
Saturated					Saturated					Saturated				
Liquid	875.30	334.75	1.4171	200.4	Liquid	626.95	376.48	1.5272	101.3	Liquid				
Vapor	189.25	427.47	1.6752	112.2	Vapor	396.29	404.57	1.6024	93.4	Vapor				
90.00	173.82	435.84	1.6983	119.1						110.00	762.66	375.61	1.5174	173.6
100.00	150.47	453.20	1.7455	131.8	110.00	233.68	446.28	1.7131	119.8	120.00	591.77	405.75	1.5950	127.4
110.00	136.36	467.93	1.7845	141.0	120.00	199.79	465.29	1.7621	132.5	130.00	418.90	439.87	1.6807	120.4
120.00	126.23	481.47	1.8194	148.5	130.00	179.83	481.11	1.8018	142.0	140.00	333.91	465.19	1.7428	130.1
130.00	118.34	494.36	1.8518	155.0	140.00	165.73	495.51	1.8371	149.7	150.00	289.37	484.69	1.7894	139.9
140.00	111.89	506.86	1.8824	160.7	150.00	154.89	509.13	1.8697	156.4	160.00	260.70	501.52	1.8288	148.3
150.00	106.45	519.11	1.9117	165.9	160.00	146.10	522.25	1.9004	162.4	170.00	239.96	516.92	1.8639	155.7
160.00	101.75	531.21	1.9399	170.6	170.00	138.74	535.07	1.9296	167.8	180.00	223.87	531.45	1.8963	162.2
170.00	97.62	543.21	1.9673	175.0	180.00	132.41	547.69	1.9578	172.7	190.00	210.82	545.43	1.9269	168.1
180.00	93.94	555.16	1.9940	179.2	190.00	126.88	560.17	1.9850	177.4	200.00	199.88	559.04	1.9559	173.6
190.00	90.62	567.10	2.0201	183.1	200.00	121.97	572.58	2.0115	181.7	210.00	190.50	572.39	1.9839	178.6
200.00	87.61	579.05	2.0456	186.8	210.00	117.55	584.95	2.0374	185.8	220.00	182.31	585.57	2.0109	183.4
210.00	84.84	591.02	2.0706	190.4	220.00	113.56	597.30	2.0627	189.7	230.00	175.06	598.64	2.0371	187.8
220.00	82.30	603.03	2.0952	193.8	230.00	109.90	609.66	2.0875	193.4	240.00	168.56	611.63	2.0626	192.1
230.00	79.94	615.10	2.1195	197.2	240.00	106.55	622.05	2.1119	197.0	250.00	162.68	624.57	2.0876	196.2
240.00	77.74	627.22	2.1433	200.4	250.00	103.44	634.47	2.1359	200.5	260.00	157.33	637.50	2.1121	200.0
250.00	75.69	639.41	2.1668	203.4	260.00	100.56	646.93	2.1595	203.8	270.00	152.41	650.43	2.1361	203.8
260.00	73.77	651.66	2.1900	206.5	270.00	97.87	659.45	2.1827	207.1	280.00	147.88	663.38	2.1598	207.4
270.00	71.96	664.00	2.2130	209.4	280.00	95.35	672.03	2.2057	210.2	290.00	143.67	676.35	2.1830	210.9
280.00	70.25	676.41	2.2356	212.2	290.00	92.98	684.67	2.2283	213.3	300.00	139.75	689.36	2.2059	214.3
290.00	68.63	688.89	2.2580	215.0	300.00	90.75	697.38	2.2507	216.2					
300.00	67.10	701.46	2.2801	217.8										

*Temperatures are on the ITS-90 scale

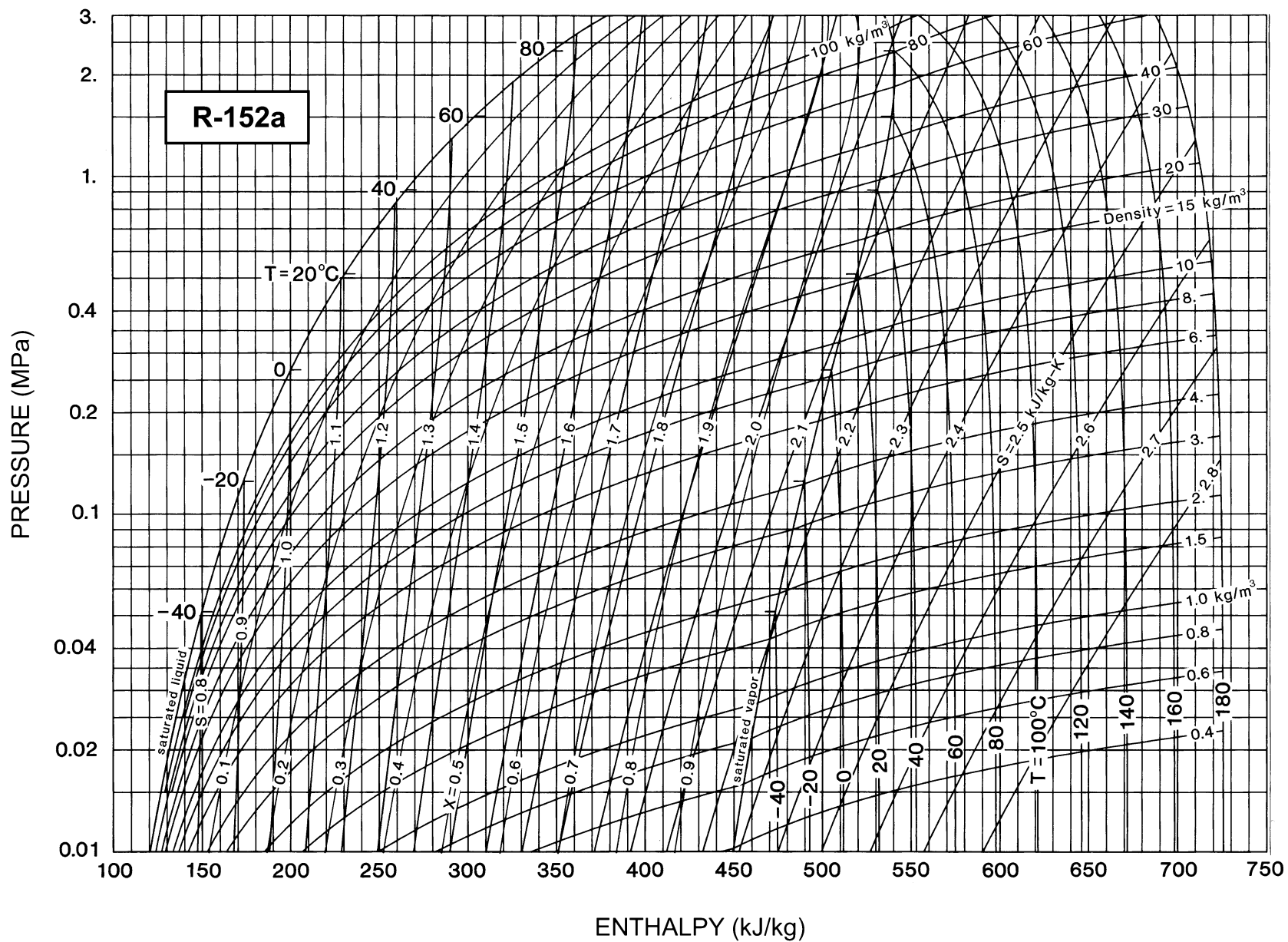


Fig. 9 Pressure-Enthalpy Diagram for Refrigerant 152a

Refrigerant 152a (1,1-Difluoroethane) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, kg/m³ Liquid	Volume, m³/kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p , kJ/(kg·K)			c_p/c_v	Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-118.59a	0.00006	1192.9	303.29	13.79	419.32	0.1119	2.7357	1.477	0.699	1.220	1401.	154.0	—	—	176.3	0.10	31.65	-118.59	
-110.00	0.00019	1177.1	107.74	26.62	425.38	0.1927	2.6368	1.505	0.717	1.214	1337.	157.8	—	—	170.2	0.94	30.23	-110.00	
-100.00	0.00058	1158.7	37.617	41.75	432.59	0.2827	2.5399	1.518	0.740	1.207	1275.	162.0	1714.	5.81	163.4	1.91	28.58	-100.00	
-90.00	0.00153	1140.1	15.052	56.96	439.97	0.3681	2.4593	1.524	0.763	1.201	1219.	166.0	1222.	6.14	156.9	2.89	26.96	-90.00	
-80.00	0.00359	1121.3	6.7438	72.23	447.48	0.4492	2.3920	1.530	0.789	1.196	1166.	169.8	934.8	6.47	150.7	3.86	25.34	-80.00	
-70.00	0.00765	1102.4	3.3197	87.57	455.08	0.5266	2.3357	1.539	0.816	1.192	1115.	173.4	747.5	6.81	144.7	4.84	23.75	-70.00	
-60.00	0.01500	1083.2	1.7682	103.02	462.74	0.6009	2.2885	1.551	0.845	1.190	1066.	176.6	615.9	7.14	139.0	5.82	22.18	-60.00	
-50.00	0.02742	1063.7	1.0064	118.62	470.40	0.6723	2.2487	1.567	0.877	1.189	1016.	179.5	518.4	7.48	133.5	6.81	20.63	-50.00	
-40.00	0.04721	1043.8	0.60583	134.40	478.02	0.7414	2.2152	1.587	0.913	1.190	967.	182.1	443.3	7.82	128.2	7.80	19.09	-40.00	
-30.00	0.07718	1023.5	0.38242	150.39	485.55	0.8085	2.1868	1.610	0.952	1.193	919.	184.2	339.7	8.21	123.1	8.81	17.58	-30.00	
-28.00	0.08469	1019.4	0.35056	153.62	487.04	0.8216	2.1817	1.615	0.960	1.194	909.	184.5	325.3	8.29	122.1	9.01	17.29	-28.00	
-26.00	0.09276	1015.3	0.32186	156.86	488.52	0.8348	2.1767	1.620	0.968	1.195	899.	184.9	312.5	8.36	121.2	9.21	16.99	-26.00	
-24.02b	0.10133	1011.2	0.29622	160.07	489.98	0.8477	2.1719	1.625	0.977	1.196	889.	185.2	301.2	8.44	120.2	9.41	16.69	-24.02	
-24.00	0.10142	1011.1	0.29595	160.11	490.00	0.8478	2.1719	1.625	0.977	1.196	889.	185.2	301.0	8.44	120.2	9.42	16.69	-24.00	
-22.00	0.11072	1006.9	0.27253	163.37	491.47	0.8608	2.1672	1.630	0.985	1.197	880.	185.5	290.7	8.52	119.2	9.62	16.39	-22.00	
-20.00	0.12068	1002.7	0.25131	166.64	492.94	0.8737	2.1627	1.635	0.994	1.199	870.	185.8	281.2	8.59	118.2	9.83	16.10	-20.00	
-18.00	0.13133	998.5	0.23206	169.92	494.40	0.8866	2.1583	1.641	1.003	1.200	860.	186.1	272.4	8.67	117.3	10.03	15.80	-18.00	
-16.00	0.14271	994.2	0.21457	173.21	495.85	0.8994	2.1541	1.647	1.013	1.202	850.	186.3	264.4	8.74	116.4	10.24	15.51	-16.00	
-14.00	0.15484	989.9	0.19865	176.52	497.29	0.9122	2.1500	1.653	1.022	1.203	841.	186.5	256.8	8.82	115.4	10.45	15.22	-14.00	
-12.00	0.16777	985.6	0.18414	179.83	498.72	0.9249	2.1460	1.658	1.032	1.205	831.	186.7	249.8	8.90	114.5	10.66	14.93	-12.00	
-10.00	0.18152	981.3	0.17090	183.16	500.15	0.9375	2.1421	1.665	1.041	1.207	821.	186.9	243.1	8.97	113.6	10.87	14.64	-10.00	
-8.00	0.19614	976.9	0.15879	186.50	501.56	0.9501	2.1383	1.671	1.051	1.209	811.	187.0	236.9	9.05	112.6	11.08	14.35	-8.00	
-6.00	0.21166	972.5	0.14770	189.86	502.96	0.9627	2.1347	1.677	1.062	1.211	801.	187.1	230.9	9.12	111.7	11.30	14.06	-6.00	
-4.00	0.22812	968.1	0.13754	193.22	504.36	0.9752	2.1311	1.684	1.072	1.213	792.	187.2	225.2	9.20	110.8	11.51	13.77	-4.00	
-2.00	0.24555	963.6	0.12821	196.61	505.74	0.9876	2.1277	1.690	1.083	1.215	782.	187.3	219.8	9.27	109.9	11.73	13.48	-2.00	
0.00	0.26399	959.1	0.11963	200.00	507.11	1.0000	2.1243	1.697	1.094	1.218	772.	187.4	214.6	9.35	109.0	11.94	13.20	0.00	
2.00	0.28349	954.6	0.11174	203.41	508.47	1.0124	2.1211	1.704	1.105	1.221	762.	187.4	209.7	9.42	108.1	12.16	12.91	2.00	
4.00	0.30407	950.0	0.10447	206.83	509.82	1.0247	2.1179	1.711	1.116	1.224	752.	187.4	204.9	9.50	107.2	12.39	12.63	4.00	
6.00	0.32578	945.4	0.09776	210.27	511.16	1.0370	2.1148	1.719	1.128	1.227	742.	187.4	200.3	9.57	106.3	12.61	12.35	6.00	
8.00	0.34867	940.8	0.09156	213.72	512.48	1.0492	2.1118	1.726	1.139	1.230	733.	187.3	195.8	9.65	105.4	12.83	12.07	8.00	
10.00	0.37277	936.1	0.08583	217.19	513.78	1.0614	2.1089	1.734	1.152	1.233	723.	187.2	191.5	9.73	104.5	13.06	11.79	10.00	
12.00	0.39812	931.3	0.08052	220.67	515.08	1.0736	2.1060	1.742	1.164	1.237	713.	187.1	187.3	9.80	103.7	13.29	11.51	12.00	
14.00	0.42476	926.6	0.07560	224.17	516.36	1.0857	2.1032	1.750	1.177	1.240	703.	187.0	183.3	9.88	102.8	13.52	11.23	14.00	
16.00	0.45275	921.8	0.07104	227.69	517.62	1.0978	2.1005	1.759	1.190	1.244	693.	186.8	179.3	9.95	101.9	13.76	10.96	16.00	
18.00	0.48211	916.9	0.06680	231.22	518.86	1.1098	2.0978	1.768	1.203	1.249	683.	186.6	175.5	10.03	101.1	13.99	10.68	18.00	
20.00	0.51291	912.0	0.06286	234.77	520.09	1.1219	2.0952	1.776	1.217	1.253	673.	186.4	171.8	10.11	100.2	14.24	10.41	20.00	
22.00	0.54517	907.0	0.05919	238.34	521.30	1.1339	2.0926	1.786	1.231	1.258	663.	186.1	168.1	10.18	99.4	14.48	10.14	22.00	
24.00	0.57894	902.0	0.05577	241.93	522.50	1.1459	2.0901	1.795	1.246	1.263	653.	185.8	164.5	10.26	98.5	14.73	9.87	24.00	
26.00	0.61428	896.9	0.05258	245.53	523.67	1.1578	2.0876	1.805	1.261	1.268	643.	185.5	161.0	10.34	97.7	14.98	9.60	26.00	
28.00	0.65122	891.8	0.04960	249.16	524.83	1.1698	2.0852	1.815	1.277	1.274	633.	185.1	157.6	10.42	96.8	15.23	9.33	28.00	
30.00	0.68982	886.6	0.04682	252.80	525.96	1.1817	2.0828	1.826	1.293	1.280	623.	184.7	154.3	10.50	96.0	15.49	9.06	30.00	
32.00	0.73012	881.4	0.04422	256.47	527.07	1.1936	2.0804	1.837	1.309	1.286	613.	184.3	151.0	10.57	95.1	15.76	8.80	32.00	
34.00	0.77216	876.0	0.04179	260.16	528.16	1.2055	2.0780	1.848	1.326	1.293	602.	183.9	147.8	10.66	94.3	16.03	8.54	34.00	
36.00	0.81600	870.7	0.03951	263.86	529.23	1.2174	2.0757	1.860	1.344	1.300	592.	183.4	144.6	10.74	93.5	16.30	8.27	36.00	
38.00	0.86169	865.2	0.03737	267.60	530.27	1.2292	2.0734	1.872	1.362	1.307	582.	182.9	141.5	10.82	92.6	16.58	8.01	38.00	
40.00	0.90927	859.7	0.03536	271.35	531.28	1.2411	2.0711	1.885	1.381	1.315	572.	182.3	138.5	10.90	91.8	16.87	7.75	40.00	
42.00	0.95879	854.1	0.03348	275.13	532.27	1.2529	2.0689	1.898	1.401	1.324	561.	181.7	135.5	10.99	91.0	17.17	7.50	42.00	
44.00	1.0103	848.4	0.03170	278.93	533.23	1.2648	2.0666	1.912	1.421	1.333	551.	181.1	132.5	11.07	90.2	17.47	7.24	44.00	
46.00	1.0639	842.6	0.03004	282.76	534.16	1.2766	2.0643	1.926	1.443	1.342	541.	180.4	129.6	11.16	89.3	17.78	6.99	46.00	
48.00	1.1196	836.7	0.02842																

Refrigerant 143a (1,1,1-Trifluoroethane) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-111.81a	0.00107	1330.5	14.807	52.52	319.59	0.3142	1.9695	1.211	0.630	1.192	1058.	137.6	912.1	5.91	137.0	4.90	13.72	-111.81
-110.00	0.00129	1326.2	12.430	54.71	320.68	0.3277	1.9579	1.212	0.635	1.191	1049.	138.2	867.9	5.97	135.8	5.00	13.75	-110.00
-100.00	0.00333	1301.9	5.1127	66.87	326.81	0.4000	1.9012	1.220	0.664	1.185	1002.	141.7	680.1	6.34	129.5	5.53	13.80	-100.00
-90.00	0.00761	1277.2	2.3596	79.13	333.06	0.4688	1.8553	1.233	0.694	1.181	954.	144.9	553.4	6.72	123.5	6.10	13.71	-90.00
-80.00	0.01572	1252.2	1.1971	91.55	339.40	0.5348	1.8180	1.250	0.726	1.178	907.	147.8	462.1	7.08	117.8	6.70	13.48	-80.00
-70.00	0.02991	1226.7	0.65675	104.16	345.80	0.5984	1.7879	1.270	0.759	1.177	859.	150.4	393.0	7.45	112.5	7.34	13.11	-70.00
-60.00	0.05307	1200.6	0.38446	116.99	352.21	0.6599	1.7635	1.293	0.794	1.178	811.	152.5	338.8	7.82	107.4	8.02	12.61	-60.00
-50.00	0.08874	1173.9	0.23754	130.05	358.58	0.7197	1.7438	1.318	0.833	1.182	764.	154.2	294.9	8.19	102.5	8.73	12.00	-50.00
-48.00	0.09773	1168.5	0.21695	132.69	359.85	0.7314	1.7403	1.323	0.841	1.184	754.	154.5	287.1	8.26	101.6	8.88	11.86	-48.00
-47.24b	0.10133	1166.4	0.20971	133.70	360.33	0.7359	1.7391	1.325	0.844	1.184	751.	154.6	284.2	8.29	101.2	8.94	11.81	-47.24
-46.00	0.10742	1163.0	0.19849	135.35	361.11	0.7431	1.7370	1.328	0.850	1.185	745.	154.7	279.6	8.33	100.6	9.03	11.72	-46.00
-44.00	0.11786	1157.5	0.18191	138.01	362.37	0.7548	1.7339	1.334	0.858	1.186	735.	154.9	272.3	8.41	99.7	9.18	11.57	-44.00
-42.00	0.12907	1152.0	0.16697	140.69	363.62	0.7664	1.7308	1.339	0.867	1.188	726.	155.1	265.3	8.48	98.8	9.33	11.42	-42.00
-40.00	0.14109	1146.4	0.15350	143.38	364.86	0.7779	1.7279	1.345	0.876	1.189	716.	155.3	258.6	8.56	97.8	9.49	11.27	-40.00
-38.00	0.15398	1140.8	0.14133	146.08	366.10	0.7894	1.7251	1.351	0.885	1.191	707.	155.5	252.0	8.63	96.9	9.65	11.11	-38.00
-36.00	0.16775	1135.1	0.13031	148.79	367.34	0.8008	1.7224	1.357	0.894	1.193	697.	155.6	245.7	8.70	96.0	9.81	10.95	-36.00
-34.00	0.18247	1129.4	0.12032	151.52	368.56	0.8122	1.7198	1.363	0.904	1.195	688.	155.7	239.6	8.78	95.1	9.97	10.79	-34.00
-32.00	0.19816	1123.7	0.11124	154.25	369.78	0.8236	1.7173	1.369	0.913	1.198	678.	155.8	233.6	8.85	94.2	10.13	10.62	-32.00
-30.00	0.21488	1117.9	0.10297	157.00	370.99	0.8348	1.7149	1.375	0.923	1.200	669.	155.8	227.8	8.93	93.3	10.30	10.44	-30.00
-28.00	0.23267	1112.1	0.09544	159.77	372.19	0.8461	1.7126	1.382	0.933	1.203	659.	155.9	222.3	9.18	92.4	10.49	10.27	-28.00
-26.00	0.25156	1106.2	0.08857	162.54	373.39	0.8573	1.7104	1.388	0.944	1.206	650.	155.9	216.8	9.26	91.6	10.66	10.09	-26.00
-24.00	0.27161	1100.3	0.08228	165.33	374.57	0.8685	1.7083	1.395	0.955	1.209	640.	155.8	211.6	9.33	90.7	10.83	9.90	-24.00
-22.00	0.29286	1094.3	0.07652	168.13	375.74	0.8796	1.7062	1.402	0.966	1.212	630.	155.8	206.4	9.41	89.8	11.01	9.72	-22.00
-20.00	0.31535	1088.3	0.07125	170.95	376.91	0.8907	1.7043	1.409	0.977	1.216	621.	155.7	201.4	9.48	89.0	11.19	9.53	-20.00
-18.00	0.33915	1082.2	0.06640	173.78	378.06	0.9018	1.7024	1.417	0.988	1.219	611.	155.6	196.6	9.56	88.1	11.37	9.33	-18.00
-16.00	0.36428	1076.0	0.06194	176.63	379.20	0.9128	1.7005	1.424	1.000	1.223	602.	155.4	191.8	9.64	87.2	11.55	9.14	-16.00
-14.00	0.39081	1069.8	0.05784	179.49	380.33	0.9238	1.6987	1.432	1.012	1.227	592.	155.2	187.2	9.71	86.4	11.74	8.94	-14.00
-12.00	0.41877	1063.6	0.05405	182.37	381.44	0.9347	1.6970	1.440	1.025	1.232	582.	155.0	182.7	9.79	85.5	11.94	8.74	-12.00
-10.00	0.44823	1057.2	0.05056	185.27	382.54	0.9457	1.6953	1.449	1.038	1.237	573.	154.8	178.4	9.87	84.7	12.13	8.53	-10.00
-8.00	0.47923	1050.8	0.04733	188.18	383.63	0.9566	1.6937	1.457	1.051	1.242	563.	154.5	174.1	9.95	83.9	12.33	8.32	-8.00
-6.00	0.51182	1044.3	0.04434	191.11	384.70	0.9675	1.6921	1.466	1.065	1.247	553.	154.2	169.9	10.04	83.0	12.53	8.12	-6.00
-4.00	0.54606	1037.7	0.04158	194.05	385.75	0.9783	1.6906	1.476	1.079	1.253	544.	153.9	165.8	10.12	82.2	12.74	7.90	-4.00
-2.00	0.58199	1031.0	0.03901	197.02	386.79	0.9892	1.6890	1.485	1.093	1.260	534.	153.5	161.8	10.21	81.4	12.96	7.69	-2.00
0.00	0.61967	1024.3	0.03662	200.00	387.81	1.0000	1.6876	1.495	1.109	1.266	524.	153.1	157.9	10.29	80.5	13.17	7.47	0.00
2.00	0.65916	1017.4	0.03440	203.00	388.81	1.0108	1.6861	1.505	1.124	1.273	515.	152.6	154.1	10.38	79.7	13.40	7.25	2.00
4.00	0.70051	1010.5	0.03234	206.03	389.79	1.0216	1.6846	1.516	1.141	1.281	505.	152.1	150.3	10.47	78.9	13.63	7.03	4.00
6.00	0.74378	1003.5	0.03042	209.07	390.75	1.0324	1.6832	1.528	1.158	1.289	495.	151.6	146.6	10.57	78.1	13.87	6.81	6.00
8.00	0.78901	996.3	0.02862	212.13	391.68	1.0432	1.6818	1.539	1.176	1.298	485.	151.0	143.0	10.66	77.2	14.12	6.59	8.00
10.00	0.83628	989.1	0.02695	215.22	392.60	1.0539	1.6804	1.552	1.194	1.307	475.	150.4	139.5	10.76	76.4	14.38	6.36	10.00
12.00	0.88564	981.7	0.02538	218.33	393.48	1.0647	1.6790	1.565	1.214	1.317	465.	149.8	136.0	10.86	75.6	14.64	6.14	12.00
14.00	0.93714	974.2	0.02392	221.47	394.35	1.0755	1.6775	1.578	1.234	1.328	455.	149.1	132.6	10.96	74.8	14.92	5.91	14.00
16.00	0.99085	966.5	0.02255	224.63	395.18	1.0863	1.6761	1.593	1.256	1.340	445.	148.4	129.3	11.07	74.0	15.21	5.68	16.00
18.00	1.0468	958.7	0.02126	227.81	395.98	1.0970	1.6747	1.608	1.278	1.353	435.	147.6	126.0	11.18	73.2	15.51	5.45	18.00
20.00	1.1052	950.8	0.02005	231.02	396.76	1.1078	1.6732	1.624	1.302	1.366	425.	146.8	122.7	11.29	72.4	15.82	5.22	20.00
22.00	1.1659	942.7	0.01892	234.27	397.50	1.1186	1.6717	1.641	1.328	1.381	415.	145.9	119.5	11.40	71.5	16.15	4.99	22.00
24.00	1.2290	934.4	0.01785	237.54	398.20	1.1295	1.6701	1.659	1.355	1.398	405.	145.0	116.4	11.52	70.7	16.50	4.76	24.00
26.00	1.2947	926.0	0.01685	240.84	398.87	1.1403	1.6685	1.679	1.384	1.416	394.	144.0	113.3	11.64	69.9	16.87	4.53	26.00
28.00	1.3630	917.3	0.01591	244.18	399.49	1.1512	1.6669	1.699	1.416	1.435	384.	143.0	110.2	11.77	69.1	17.26	4.30	28.00
30.00	1.4340	908.4	0.01501	247.56	400.07	1.1621	1.6652	1.722	1.449	1.457	374.	141.9	107.2	11.91	68.3	17.67	4.07	30.00
32.00	1.5077	899.3	0.01417	250.97	400.61	1.1730	1.6634	1.746	1.486	1.480	363.	140.8	104.2	12.04	67.5	18.11	3.84	32.00
34.00	1.5842	890.0	0.01338	254.42	401.09	1.1840	1.6616	1.772	1.526	1.507	352.	139.6	101.2	12.19	66.6	18.58	3.61	34.00
36.00	1.6636	880.4	0.01262	257.91	401.52	1.1951	1.6596	1.801	1.570	1.536	342.	138.4	98.3	12.34	65.8	19.09	3.38	36.00
38.00	1.7460	870.5	0.01191	261.45	401.89	1.2062	1.6575	1.832	1.618	1.569	331.	137.1	95.4	12.50	65.0	19.63	3.16	38.00
40.00	1.8314	860.3	0.01123	265.04	402.19	1.2174	1.6553	1.867	1.671	1.606	320.	135.7	92.5	12.67	64.2	20.22	2.93	40.00
42.00	1.9200	849.7	0.01059	268.68	402.42	1.2286	1.6530	1.906	1.732	1.648	309.	134.3	89.7	12.85	63.3	20.87	2.71	42.00
44.00	2.0117	838.7	0.00998	272.39	402.56	1.2400	1.6505	1.949	1.799	1.696	298.	132.8	86.8	13.03	62.5	21.57	2.49	44.00
46.00	2.1068	827.3	0.00940	276.15	402.62	1.2515	1.6478	1.998	1.877	1.752	286.	131.2	84.0	13.24	61.7	22.35	2.27	46.00
48.00	2.2053	815.4	0.00884	279.98	402.58	1.2631	1.6448	2.054	1.966	1.817	275.	129.6	81.1	13.45	60.8	23.20	2.06	48.00
50.00	2.3073	803.0	0.00831	283.90	402.43	1.2748	1.6416	2.118	2.070	1.894	263.	127.9	78.3	13.69	60.0	24.16	1.85	

Refrigerant 245fa (1,1,1,3,3-Pentafluoropropane) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat <i>c_p</i> , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
−50.00	0.00286	1523.5	4.8232	137.62	368.35	0.7482	1.7822	1.196	0.718	1.097	1054.	122.8	1749.	7.71	107.2	7.50	23.48	−50.00
−40.00	0.00582	1500.5	2.4705	149.72	375.45	0.8012	1.7694	1.221	0.740	1.095	987.	125.1	1301.	8.06	103.2	8.06	22.26	−40.00
−30.00	0.01104	1477.1	1.3545	162.03	382.69	0.8529	1.7604	1.240	0.763	1.094	929.	127.3	1020.	8.41	99.5	8.64	21.03	−30.00
−20.00	0.01967	1453.3	0.78749	174.52	390.03	0.9032	1.7545	1.257	0.787	1.094	877.	129.3	827.5	8.76	95.8	9.24	19.78	−20.00
−10.00	0.03324	1428.9	0.48154	187.18	397.45	0.9522	1.7513	1.273	0.811	1.094	829.	131.0	687.7	9.12	92.3	9.86	18.52	−10.00
0.00	0.05359	1404.0	0.30756	200.00	404.93	1.0000	1.7502	1.290	0.837	1.095	783.	132.5	581.6	9.47	88.8	10.49	17.25	0.00
2.00	0.05866	1399.0	0.28251	202.59	406.43	1.0094	1.7503	1.294	0.842	1.096	774.	132.7	563.4	9.53	88.2	10.62	17.00	2.00
4.00	0.06411	1393.9	0.25987	205.18	407.93	1.0188	1.7504	1.297	0.848	1.096	765.	133.0	546.1	9.60	87.5	10.75	16.74	4.00
6.00	0.06996	1388.8	0.23939	207.78	409.44	1.0281	1.7505	1.301	0.853	1.097	756.	133.2	529.5	9.67	86.8	10.88	16.48	6.00
8.00	0.07622	1383.7	0.22082	210.39	410.94	1.0374	1.7508	1.305	0.859	1.097	747.	133.4	513.6	9.74	86.2	11.01	16.23	8.00
10.00	0.08293	1378.5	0.20397	213.00	412.45	1.0467	1.7511	1.309	0.864	1.098	738.	133.6	498.5	9.81	85.5	11.15	15.97	10.00
12.00	0.09009	1373.3	0.18864	215.63	413.95	1.0559	1.7514	1.312	0.870	1.098	729.	133.8	483.9	9.88	84.9	11.28	15.72	12.00
14.00	0.09774	1368.1	0.17469	218.26	415.46	1.0651	1.7518	1.316	0.875	1.099	721.	134.0	470.0	9.95	84.2	11.41	15.46	14.00
14.90b	0.10133	1365.7	0.16885	219.44	416.13	1.0692	1.7520	1.318	0.878	1.099	717.	134.1	464.0	9.98	83.9	11.47	15.34	14.90
16.00	0.10589	1362.8	0.16197	220.90	416.97	1.0742	1.7523	1.320	0.881	1.100	712.	134.2	456.7	10.02	83.6	11.55	15.20	16.00
18.00	0.11457	1357.5	0.15035	223.54	418.47	1.0833	1.7528	1.324	0.887	1.100	703.	134.3	443.8	10.09	82.9	11.69	14.95	18.00
20.00	0.12380	1352.2	0.13972	226.20	419.98	1.0924	1.7534	1.328	0.893	1.101	695.	134.4	431.5	10.16	82.3	11.82	14.69	20.00
22.00	0.13360	1346.9	0.13000	228.86	421.48	1.1014	1.7540	1.332	0.899	1.102	686.	134.6	419.6	10.23	81.7	11.96	14.43	22.00
24.00	0.14400	1341.5	0.12108	231.54	422.99	1.1104	1.7547	1.337	0.905	1.103	677.	134.7	408.2	10.30	81.0	12.10	14.18	24.00
26.00	0.15503	1336.1	0.11289	234.22	424.49	1.1194	1.7554	1.341	0.911	1.104	669.	134.7	397.2	10.37	80.4	12.24	13.92	26.00
28.00	0.16670	1330.6	0.10536	236.91	425.99	1.1283	1.7562	1.345	0.917	1.105	660.	134.8	386.6	10.44	79.8	12.38	13.66	28.00
30.00	0.17904	1325.1	0.09843	239.60	427.49	1.1372	1.7570	1.350	0.923	1.106	652.	134.9	376.4	10.51	79.2	12.52	13.41	30.00
32.00	0.19209	1319.6	0.09205	242.31	428.99	1.1461	1.7578	1.354	0.929	1.107	643.	134.9	366.5	10.59	78.6	12.66	13.15	32.00
34.00	0.20586	1314.0	0.08616	245.03	430.49	1.1549	1.7587	1.359	0.936	1.108	635.	134.9	356.9	10.66	77.9	12.81	12.89	34.00
36.00	0.22038	1308.4	0.08072	247.75	431.99	1.1637	1.7597	1.364	0.942	1.110	626.	134.9	347.7	10.73	77.3	12.95	12.64	36.00
38.00	0.23568	1302.7	0.07569	250.49	433.48	1.1725	1.7606	1.368	0.949	1.111	618.	134.9	338.8	10.80	76.7	13.10	12.38	38.00
40.00	0.25179	1297.0	0.07103	253.24	434.97	1.1813	1.7616	1.373	0.956	1.112	609.	134.9	330.1	10.87	76.1	13.24	12.13	40.00
42.00	0.26873	1291.2	0.06671	255.99	436.46	1.1900	1.7626	1.378	0.962	1.114	601.	134.8	321.8	10.94	75.5	13.39	11.87	42.00
44.00	0.28654	1285.4	0.06271	258.76	437.95	1.1987	1.7637	1.383	0.969	1.115	592.	134.7	313.7	11.01	74.9	13.54	11.62	44.00
46.00	0.30523	1279.6	0.05899	261.53	439.43	1.2074	1.7648	1.388	0.976	1.117	584.	134.6	305.8	11.09	74.3	13.69	11.36	46.00
48.00	0.32485	1273.7	0.05554	264.32	440.91	1.2160	1.7659	1.394	0.984	1.119	575.	134.5	298.2	11.16	73.7	13.84	11.11	48.00
50.00	0.34542	1267.7	0.05232	267.11	442.38	1.2246	1.7670	1.399	0.991	1.121	567.	134.4	290.8	11.23	73.1	13.99	10.85	50.00
52.00	0.36696	1261.7	0.04933	269.92	443.85	1.2333	1.7682	1.405	0.998	1.123	559.	134.2	283.6	11.31	72.5	14.15	10.60	52.00
54.00	0.38951	1255.6	0.04653	272.74	445.32	1.2418	1.7694	1.410	1.006	1.125	550.	134.0	276.6	11.38	72.0	14.30	10.35	54.00
56.00	0.41311	1249.5	0.04393	275.57	446.78	1.2504	1.7706	1.416	1.013	1.127	542.	133.8	269.8	11.46	71.4	14.46	10.10	56.00
58.00	0.43777	1243.3	0.04149	278.41	448.24	1.2590	1.7718	1.422	1.021	1.129	533.	133.6	263.1	11.53	70.8	14.62	9.84	58.00
60.00	0.46353	1237.0	0.03922	281.26	449.69	1.2675	1.7730	1.428	1.029	1.131	525.	133.4	256.7	11.61	70.2	14.78	9.59	60.00
62.00	0.49043	1230.7	0.03709	284.13	451.13	1.2760	1.7743	1.434	1.038	1.134	516.	133.1	250.4	11.69	69.6	14.94	9.34	62.00
64.00	0.51849	1224.3	0.03509	287.01	452.57	1.2845	1.7756	1.441	1.046	1.137	508.	132.8	244.3	11.76	69.0	15.11	9.09	64.00
66.00	0.54774	1217.8	0.03322	289.90	454.00	1.2930	1.7768	1.447	1.055	1.140	500.	132.5	238.3	11.84	68.5	15.27	8.85	66.00
68.00	0.57823	1211.3	0.03147	292.80	455.43	1.3014	1.7781	1.454	1.063	1.143	491.	132.1	232.5	11.92	67.9	15.44	8.60	68.00
70.00	0.60998	1204.7	0.02982	295.71	456.85	1.3099	1.7794	1.461	1.072	1.146	483.	131.8	226.8	12.01	67.3	15.61	8.35	70.00
72.00	0.64302	1198.0	0.02828	298.64	458.25	1.3183	1.7807	1.468	1.082	1.149	474.	131.4	221.3	12.09	66.8	15.79	8.10	72.00
74.00	0.67739	1191.2	0.02682	301.59	459.66	1.3267	1.7820	1.476	1.091	1.153	466.	131.0	215.9	12.17	66.2	15.96	7.86	74.00
76.00	0.71313	1184.3	0.02545	304.55	461.05	1.3351	1.7834	1.483	1.101	1.157	457.	130.5	210.6	12.26	65.6	16.14	7.61	76.00
78.00	0.75026	1177.3	0.02416	307.52	462.43	1.3435	1.7847	1.491	1.111	1.161	449.	130.0	205.4	12.34	65.0	16.32	7.37	78.00
80.00	0.78882	1170.3	0.02295	310.50	463.80	1.3519	1.7860	1.499	1.122	1.165	441.	129.5	200.3	12.43	64.5	16.51	7.13	80.00
82.00	0.82886	1163.1	0.02180	313.51	465.16	1.3603	1.7873	1.508	1.133	1.169	432.	129.0	195.4	12.52	63.9	16.69	6.89	82.00
84.00	0.87039	1155.8	0.02072	316.53	466.51	1.3687	1.7886	1.517	1.144	1.174	424.	128.4	190.5	12.61	63.3	16.89	6.65	84.00
86.00	0.91347	1148.4	0.01970	319.56	467.85	1.31												

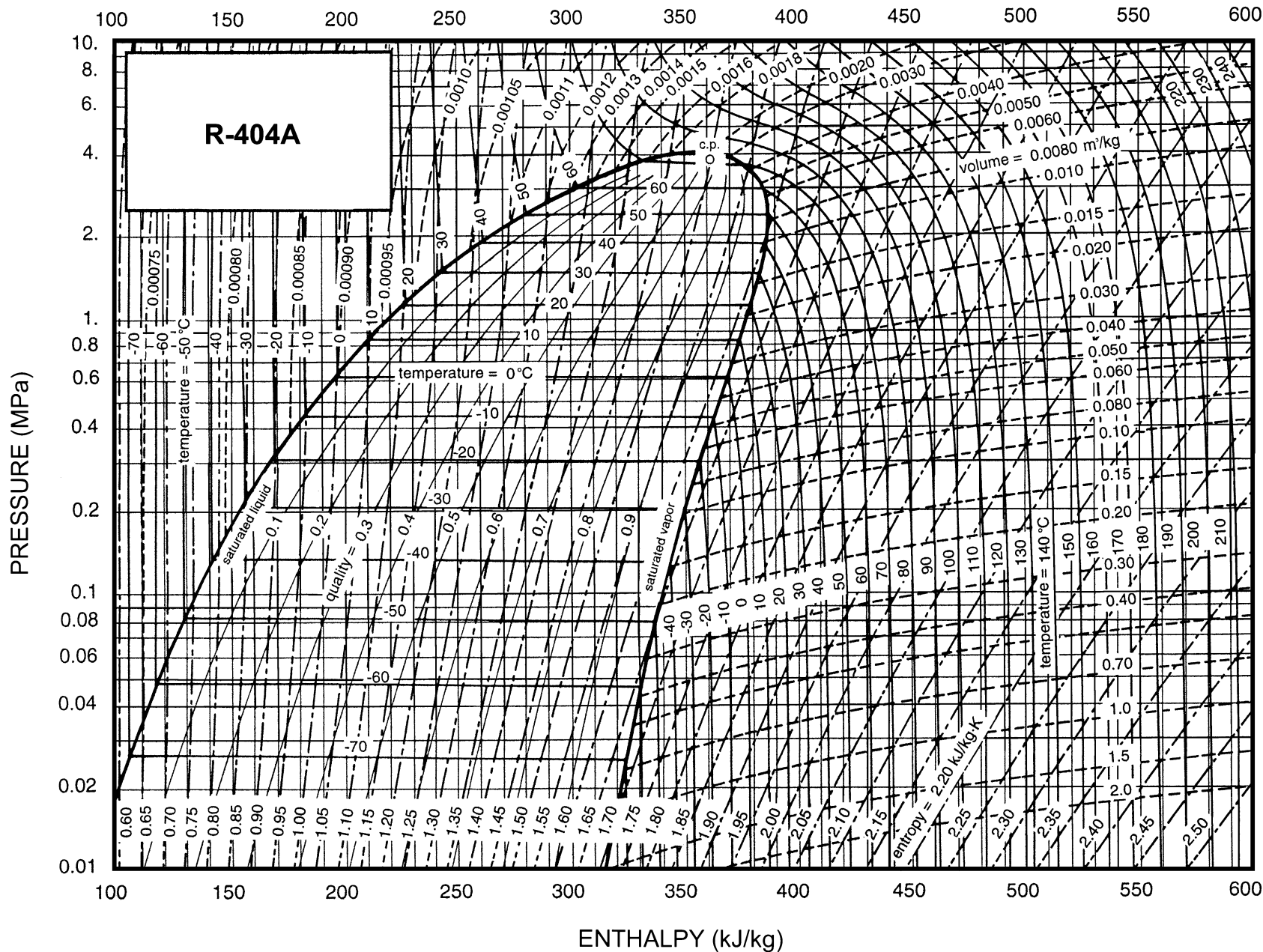


Fig. 10 Pressure-Enthalpy Diagram for Refrigerant 404A
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Refrigerant 404A [R-125/143a/134a (44/52/4)] Properties of Liquid on the Bubble Line and Vapor on the Dew Line

Pressure, MPa	Temperature, °C		Density, Volume, kg/m ³ m ³ /kg		Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Pressure, MPa
	Bubble	Dew	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
0.00500	-94.18	-93.00	1444.4	3.05033	83.20	310.67	0.4810	1.7496	1.147	0.637	1.163	959.	132.8	760.4	7.20	123.6	6.00	17.77	0.00500
0.00600	-91.96	-90.80	1438.3	2.57089	85.75	311.99	0.4952	1.7415	1.149	0.643	1.162	947.	133.4	723.1	7.29	122.3	6.12	17.57	0.00600
0.00700	-90.03	-88.89	1432.9	2.22501	87.98	313.15	0.5074	1.7347	1.151	0.649	1.161	937.	134.0	693.2	7.37	121.2	6.23	17.39	0.00700
0.00800	-88.31	-87.19	1428.1	1.96336	89.95	314.17	0.5181	1.7290	1.153	0.653	1.161	928.	134.5	668.3	7.44	120.2	6.33	17.23	0.00800
0.00900	-86.77	-85.67	1423.8	1.75831	91.74	315.10	0.5277	1.7240	1.155	0.657	1.160	920.	134.9	647.2	7.50	119.3	6.42	17.08	0.00900
0.01000	-85.36	-84.27	1419.9	1.59315	93.36	315.94	0.5364	1.7196	1.157	0.661	1.160	913.	135.3	628.9	7.56	118.5	6.50	16.95	0.01000
0.02000	-75.43	-74.45	1392.0	0.83310	104.92	321.94	0.5963	1.6923	1.171	0.690	1.159	863.	137.8	520.6	7.97	113.1	7.10	15.99	0.02000
0.04000	-64.18	-63.29	1359.7	0.43580	118.21	328.80	0.6617	1.6680	1.191	0.725	1.159	807.	140.3	429.8	8.43	107.2	7.77	14.84	0.04000
0.06000	-56.87	-56.03	1338.3	0.29818	126.98	333.25	0.7028	1.6553	1.206	0.749	1.161	772.	141.7	383.1	8.73	103.5	8.25	14.07	0.06000
0.08000	-51.30	-50.50	1321.7	0.22768	133.73	336.63	0.7336	1.6470	1.218	0.769	1.164	745.	142.5	352.4	8.96	100.8	8.65	13.47	0.08000
0.10000	-46.75	-45.98	1308.0	0.18460	139.30	339.37	0.7584	1.6410	1.228	0.786	1.166	723.	143.1	329.8	9.14	98.6	8.97	12.97	0.10000
0.10132b	-46.48	-45.71	1307.2	0.18233	139.64	339.53	0.7599	1.6406	1.229	0.787	1.166	722.	143.2	328.5	9.15	98.4	8.99	12.94	0.10132
0.12000	-42.87	-42.12	1296.1	0.15547	144.09	341.70	0.7793	1.6364	1.238	0.801	1.169	705.	143.5	312.1	9.28	96.7	9.25	12.54	0.12000
0.14000	-39.47	-38.74	1285.5	0.13440	148.33	343.72	0.7975	1.6327	1.246	0.815	1.172	689.	143.8	297.6	9.42	95.1	9.51	12.16	0.14000
0.16000	-36.42	-35.72	1276.0	0.11844	152.14	345.52	0.8136	1.6296	1.254	0.828	1.175	674.	144.0	285.4	9.54	93.7	9.74	11.81	0.16000
0.18000	-33.66	-32.97	1267.2	0.10591	155.62	347.14	0.8282	1.6270	1.262	0.840	1.177	661.	144.2	274.9	9.65	92.4	9.95	11.50	0.18000
0.20000	-31.13	-30.45	1259.1	0.09580	158.83	348.61	0.8414	1.6248	1.269	0.851	1.180	649.	144.3	265.7	9.75	91.3	10.15	11.20	0.20000
0.22000	-28.79	-28.12	1251.5	0.08747	161.81	349.97	0.8536	1.6228	1.276	0.861	1.183	638.	144.3	257.5	9.84	90.2	10.33	10.93	0.22000
0.24000	-26.61	-25.95	1244.4	0.08049	164.61	351.22	0.8650	1.6211	1.282	0.871	1.186	628.	144.3	250.2	9.93	89.2	10.51	10.68	0.24000
0.26000	-24.56	-23.91	1237.6	0.07454	167.25	352.39	0.8756	1.6196	1.288	0.881	1.189	618.	144.3	243.5	10.02	88.3	10.66	10.44	0.26000
0.28000	-22.63	-21.99	1231.2	0.06941	169.75	353.48	0.8855	1.6182	1.294	0.891	1.192	609.	144.3	237.4	10.10	87.4	10.83	10.22	0.28000
0.30000	-20.80	-20.17	1225.1	0.06494	172.13	354.51	0.8949	1.6169	1.300	0.900	1.195	601.	144.2	231.8	10.13	86.6	11.11	10.00	0.30000
0.32000	-19.06	-18.44	1219.2	0.06101	174.40	355.48	0.9038	1.6158	1.306	0.908	1.198	593.	144.1	226.6	10.21	85.9	11.26	9.80	0.32000
0.34000	-17.40	-16.80	1213.5	0.05753	176.57	356.40	0.9123	1.6147	1.312	0.917	1.201	585.	144.0	221.8	10.29	85.1	11.40	9.60	0.34000
0.36000	-15.82	-15.22	1208.0	0.05442	178.65	357.27	0.9203	1.6138	1.317	0.925	1.204	577.	143.9	217.3	10.36	84.4	11.54	9.41	0.36000
0.38000	-14.30	-13.71	1202.8	0.05163	180.66	358.09	0.9280	1.6129	1.322	0.934	1.207	570.	143.8	213.1	10.43	83.8	11.67	9.23	0.38000
0.40000	-12.84	-12.26	1197.7	0.04910	182.60	358.88	0.9354	1.6120	1.328	0.942	1.210	563.	143.7	209.1	10.49	83.2	11.80	9.06	0.40000
0.42000	-11.44	-10.86	1192.7	0.04681	184.47	359.64	0.9425	1.6113	1.333	0.949	1.213	557.	143.5	205.4	10.56	82.5	11.93	8.89	0.42000
0.44000	-10.09	-9.51	1187.9	0.04472	186.28	360.36	0.9494	1.6105	1.338	0.957	1.216	550.	143.4	201.8	10.62	82.0	12.05	8.73	0.44000
0.46000	-8.78	-8.21	1183.2	0.04280	188.04	361.05	0.9560	1.6098	1.343	0.965	1.219	544.	143.2	198.5	10.68	81.4	12.18	8.57	0.46000
0.48000	-7.51	-6.95	1178.6	0.04104	189.75	361.71	0.9624	1.6092	1.348	0.972	1.222	538.	143.0	195.3	10.74	80.9	12.30	8.42	0.48000
0.50000	-6.28	-5.73	1174.1	0.03941	191.41	362.35	0.9685	1.6085	1.353	0.980	1.225	532.	142.9	192.2	10.79	80.3	12.41	8.28	0.50000
0.55000	-3.37	-2.83	1163.4	0.03584	195.37	363.84	0.9831	1.6071	1.365	0.998	1.234	518.	142.4	185.1	10.93	79.1	12.70	7.93	0.55000
0.60000	-0.65	-0.12	1153.1	0.03285	199.10	365.21	0.9968	1.6058	1.377	1.016	1.242	505.	141.9	178.8	11.06	77.9	12.97	7.60	0.60000
0.65000	1.90	2.42	1143.4	0.03030	202.64	366.46	1.0095	1.6046	1.389	1.033	1.250	493.	141.3	172.9	11.18	76.9	13.24	7.29	0.65000
0.70000	4.32	4.82	1134.0	0.02810	206.00	367.62	1.0215	1.6036	1.400	1.051	1.259	481.	140.8	167.6	11.30	75.8	13.50	7.00	0.70000
0.75000	6.60	7.10	1124.9	0.02619	209.21	368.69	1.0329	1.6025	1.412	1.068	1.268	470.	140.2	162.7	11.41	74.9	13.75	6.73	0.75000
0.80000	8.77	9.26	1116.1	0.02450	212.29	369.69	1.0437	1.6016	1.424	1.085	1.277	460.	139.6	158.1	11.52	74.0	14.01	6.47	0.80000
0.85000	10.85	11.33	1107.6	0.02301	215.26	370.62	1.0540	1.6007	1.435	1.102	1.287	450.	139.0	153.9	11.63	73.1	14.26	6.22	0.85000
0.90000	12.83	13.30	1099.3	0.02167	218.11	371.48	1.0639	1.5998	1.447	1.120	1.296	440.	138.4	149.9	11.74	72.3	14.51	5.98	0.90000
0.95000	14.74	15.20	1091.2	0.02047	220.87	372.29	1.0733	1.5989	1.459	1.137	1.306	431.	137.7	146.1	11.84	71.5	14.76	5.75	0.95000
1.00000	16.57	17.02	1083.3	0.01939	223.54	373.04	1.0824	1.5981	1.471	1.155	1.317	422.	137.1	142.6	11.94	70.7	15.00	5.53	1.00000
1.10000	20.03	20.47	1068.0	0.01750	228.65	374.41	1.0996	1.5965	1.495	1.190	1.339	404.	135.8	136.0	12.14	69.3	15.50	5.12	1.10000
1.20000	23.27	23.69	1053.1	0.01592	233.50	375.60	1.1158	1.5949	1.520	1.228	1.363	388.	134.4	130.0	12.34	67.9	16.00	4.74	1.20000
1.30000	26.31	26.72	1038.7	0.01457	238.12	376.65	1.1309	1.5933	1.547	1.266	1.388	373.	133.0	124.5	12.54	66.7	16.51	4.38	1.30000
1.40000	29.18	29.58	1024.5	0.01340	242.54	377.55	1.1453	1.5916	1.574	1.307	1.416	358.	131.6	119.5	12.74	65.5	17.04	4.05	1.40000
1.50000	31.90	32.29	1010.7	0.01238	246.80	378.34	1.1590	1.5900	1.603	1.350	1.446	344.	130.2	114.8	12.93	64.3	17.58	3.74	1.50000

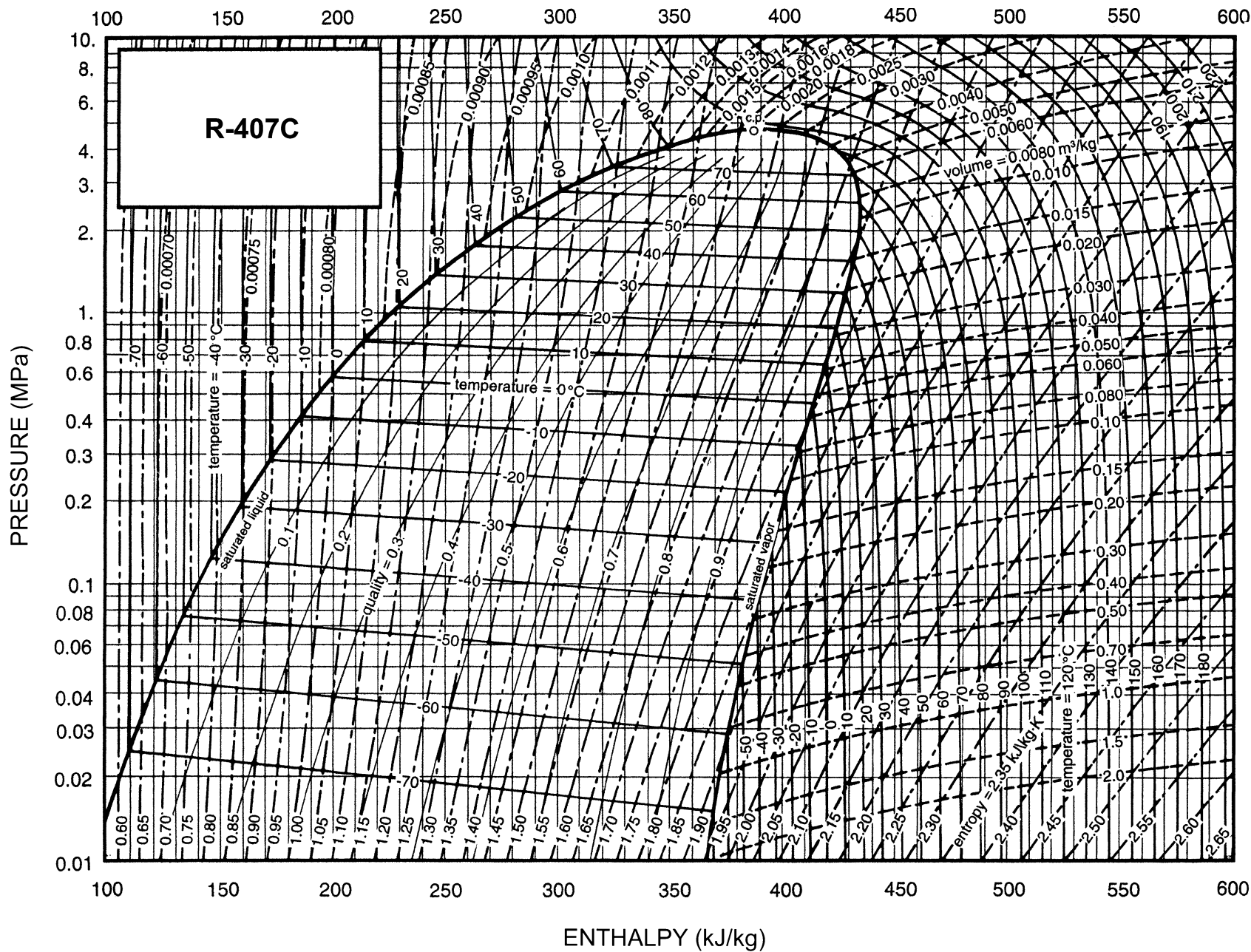


Fig. 11 Pressure-Enthalpy Diagram for Refrigerant 407C

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Refrigerant 407C [R-32/125/134a (23/25/52)] Properties of Liquid on the Bubble Line and Vapor on the Dew Line

Pressure, MPa	Temperature, °C		Density, Volume, kg/m ³ m ³ /kg		Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p , kJ/(kg·K)			c_p/c_v	Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Pressure, MPa
	Bubble	Dew	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
0.01000	−82.82	−74.96	1496.6	1.89611	91.52	365.89	0.5302	1.9437	1.246	0.667	1.181	1000.	149.0	722.4	8.22	148.0	6.43	24.80	0.01000	
0.02000	−72.81	−65.15	1468.1	0.98986	104.03	371.89	0.5942	1.9071	1.255	0.692	1.180	948.	151.8	593.0	8.63	142.1	7.06	22.98	0.02000	
0.04000	−61.51	−54.07	1435.2	0.51699	118.30	378.64	0.6635	1.8730	1.268	0.725	1.181	891.	154.6	486.9	9.09	135.7	7.79	20.95	0.04000	
0.06000	−54.18	−46.89	1413.5	0.35346	127.63	382.97	0.7068	1.8543	1.278	0.748	1.184	854.	156.1	433.2	9.39	131.5	8.28	19.65	0.06000	
0.08000	−48.61	−41.44	1396.8	0.26976	134.78	386.21	0.7389	1.8416	1.287	0.767	1.186	827.	157.1	398.2	9.62	128.5	8.65	18.68	0.08000	
0.10000	−44.06	−36.98	1382.9	0.21867	140.65	388.83	0.7648	1.8321	1.295	0.783	1.189	805.	157.8	372.6	9.81	126.0	8.96	17.89	0.10000	
0.10132b	−43.79	−36.71	1382.1	0.21597	141.01	388.99	0.7663	1.8315	1.295	0.784	1.189	803.	157.8	371.1	9.82	125.9	8.98	17.84	0.10132	
0.12000	−40.19	−33.19	1371.0	0.18413	145.69	391.04	0.7865	1.8245	1.302	0.798	1.192	786.	158.3	352.6	9.97	123.9	9.23	17.23	0.12000	
0.14000	−36.80	−29.87	1360.4	0.15918	150.12	392.95	0.8053	1.8183	1.308	0.811	1.195	769.	158.7	336.3	10.11	122.1	9.47	16.65	0.14000	
0.16000	−33.77	−26.90	1350.9	0.14027	154.10	394.64	0.8220	1.8130	1.314	0.823	1.198	755.	159.0	322.6	10.23	120.5	9.68	16.13	0.16000	
0.18000	−31.02	−24.21	1342.2	0.12544	157.73	396.15	0.8370	1.8084	1.320	0.835	1.201	741.	159.2	310.9	10.34	119.0	9.88	15.67	0.18000	
0.20000	−28.50	−21.74	1334.1	0.11348	161.07	397.52	0.8507	1.8043	1.326	0.845	1.203	729.	159.4	300.6	10.45	117.7	10.06	15.25	0.20000	
0.22000	−26.17	−19.46	1326.6	0.10363	164.17	398.78	0.8632	1.8007	1.331	0.856	1.206	718.	159.6	291.5	10.55	116.5	10.23	14.86	0.22000	
0.24000	−24.00	−17.34	1319.5	0.09537	167.07	399.94	0.8748	1.7974	1.336	0.865	1.209	708.	159.6	283.3	10.64	115.3	10.39	14.50	0.24000	
0.26000	−21.96	−15.35	1312.8	0.08834	169.80	401.01	0.8857	1.7945	1.341	0.875	1.212	698.	159.7	275.9	10.72	114.3	10.54	14.17	0.26000	
0.28000	−20.05	−13.47	1306.5	0.08228	172.38	402.01	0.8959	1.7918	1.346	0.884	1.215	689.	159.7	269.1	10.80	113.3	10.68	13.85	0.28000	
0.30000	−18.23	−11.70	1300.4	0.07700	174.83	402.95	0.9055	1.7893	1.351	0.892	1.218	680.	159.8	262.9	10.88	112.3	10.82	13.56	0.30000	
0.32000	−16.51	−10.01	1294.6	0.07236	177.17	403.83	0.9145	1.7869	1.355	0.901	1.221	672.	159.7	257.2	10.96	111.4	10.95	13.28	0.32000	
0.34000	−14.86	−8.41	1289.0	0.06824	179.41	404.67	0.9232	1.7848	1.360	0.909	1.224	664.	159.7	251.9	11.03	110.6	11.08	13.01	0.34000	
0.36000	−13.29	−6.87	1283.7	0.06457	181.55	405.45	0.9314	1.7827	1.364	0.917	1.226	656.	159.7	246.9	11.10	109.8	11.20	12.76	0.36000	
0.38000	−11.79	−5.40	1278.5	0.06127	183.61	406.20	0.9392	1.7808	1.369	0.925	1.229	649.	159.6	242.3	11.16	109.0	11.32	12.51	0.38000	
0.40000	−10.34	−3.99	1273.5	0.05829	185.60	406.91	0.9468	1.7790	1.373	0.932	1.232	642.	159.6	237.9	11.22	108.2	11.44	12.28	0.40000	
0.42000	−8.95	−2.63	1268.7	0.05559	187.52	407.59	0.9540	1.7773	1.377	0.940	1.235	635.	159.5	233.8	11.29	107.5	11.55	12.06	0.42000	
0.44000	−7.61	−1.32	1264.0	0.05312	189.37	408.24	0.9609	1.7757	1.382	0.947	1.238	629.	159.4	229.9	11.34	106.8	11.66	11.85	0.44000	
0.46000	−6.31	−0.05	1259.4	0.05086	191.17	408.85	0.9676	1.7741	1.386	0.954	1.241	623.	159.3	226.2	11.40	106.2	11.76	11.64	0.46000	
0.48000	−5.06	1.17	1255.0	0.04878	192.91	409.44	0.9741	1.7726	1.390	0.961	1.244	616.	159.2	222.7	11.46	105.5	11.87	11.44	0.48000	
0.50000	−3.84	2.36	1250.6	0.04687	194.61	410.01	0.9803	1.7712	1.394	0.968	1.247	611.	159.1	219.3	11.51	104.9	11.97	11.25	0.50000	
0.55000	−0.96	5.17	1240.2	0.04266	198.65	411.33	0.9951	1.7679	1.404	0.985	1.254	597.	158.8	211.6	11.65	103.4	12.22	10.80	0.55000	
0.60000	1.73	7.79	1230.4	0.03913	202.45	412.54	1.0088	1.7649	1.414	1.002	1.262	584.	158.4	204.6	11.77	102.0	12.45	10.39	0.60000	
0.65000	4.26	10.25	1221.0	0.03613	206.04	413.64	1.0217	1.7622	1.423	1.018	1.270	571.	158.1	198.3	11.89	100.7	12.68	10.00	0.65000	
0.70000	6.65	12.58	1212.0	0.03355	209.45	414.64	1.0338	1.7596	1.433	1.034	1.277	560.	157.7	192.5	12.00	99.5	12.89	9.63	0.70000	
0.75000	8.91	14.78	1203.3	0.03129	212.71	415.57	1.0452	1.7572	1.443	1.050	1.285	549.	157.3	187.2	12.11	98.4	13.11	9.29	0.75000	
0.80000	11.06	16.87	1195.0	0.02931	215.82	416.43	1.0561	1.7549	1.452	1.066	1.293	538.	156.8	182.3	12.22	97.3	13.32	8.97	0.80000	
0.85000	13.11	18.86	1186.9	0.02755	218.81	417.23	1.0664	1.7528	1.462	1.081	1.302	528.	156.4	177.6	12.33	96.2	13.52	8.66	0.85000	
0.90000	15.07	20.77	1179.1	0.02598	221.69	417.97	1.0763	1.7507	1.471	1.097	1.310	519.	155.9	173.3	12.43	95.2	13.72	8.37	0.90000	
0.95000	16.95	22.59	1171.5	0.02457	224.47	418.65	1.0857	1.7488	1.481	1.112	1.319	509.	155.5	169.3	12.53	94.2	13.92	8.09	0.95000	
1.00000	18.76	24.35	1164.1	0.02330	227.15	419.29	1.0948	1.7469	1.490	1.127	1.327	501.	155.0	165.5	12.63	93.3	14.12	7.83	1.00000	
1.10000	22.19	27.67	1149.8	0.02109	232.28	420.44	1.1120	1.7433	1.510	1.158	1.345	484.	154.0	158.4	12.82	91.5	14.51	7.33	1.10000	
1.20000	25.39	30.77	1136.0	0.01923	237.13	421.44	1.1281	1.7400	1.530	1.190	1.365	468.	152.9	152.1	13.00	89.9	14.90	6.87	1.20000	
1.30000	28.40	33.68	1122.8	0.01765	241.74	422.30	1.1431	1.7367	1.550	1.222	1.385	452.	151.9	146.3	13.18	88.3	15.29	6.45	1.30000	
1.40000	31.24	36.42	1109.9	0.01629	246.15	423.04	1.1574	1.7337	1.571	1.255	1.406	438.	150.8	140.9	13.35	86.8	15.69	6.05	1.40000	
1.50000	33.94	39.02	1097.4	0.01510	250.38	423.68	1.1709	1.7307	1.592	1.289	1.428	424.	149.7	136.0	13.53	85.4	16.09	5.68	1.50000	
1.60000	36.50	41.49	1085.1	0.01405	254.44	424.21	1.1838	1.7277	1.615	1.324	1.452	411.	148.6	131.3	13.70	84.1	16.51	5.33	1.60000	
1.70000	38.95	43.84	1073.1	0.01312	258.38	424.66	1.1961	1.7248	1.638	1.360	1.477	398.	147.5	127.0	13.87	82.8	16.93	5.00	1.70000	
1.80000	41.29	46.09	1061.3	0.01229	262.18	425.02	1.2080	1.7220	1.662	1.398	1.504	386.	146.3	122.9	14.04	81.5	17.37	4.69	1.80000	
1.90000	43.54	48.25	1049.6	0.01154	265.88	425.31	1.2194	1.7191	1.688	1.438	1.532	374.	145.2	119.1	14.21	80.3	17.83	4.40	1.90000	
2.0000																				

Refrigerant 410A [R-32/125 (50/50)] Properties of Liquid on the Bubble Line and Vapor on the Dew Line

Pres- sure, MPa	Temperature, °C		Density, Volume, kg/m³ m³/kg		Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Pres- sure, MPa
	Bubble	Dew	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
0.01000	-88.54	-88.50	1462.0	2.09550	78.00	377.63	0.4650	2.0879	1.313	0.666	1.227	1031.	159.6	560.3	8.20	168.6	6.60	23.95	0.01000
0.02000	-79.05	-79.01	1434.3	1.09540	90.48	383.18	0.5309	2.0388	1.317	0.695	1.227	979.	162.7	473.2	8.63	162.6	7.06	22.17	0.02000
0.04000	-68.33	-68.29	1402.4	0.57278	104.64	389.31	0.6018	1.9916	1.325	0.733	1.230	923.	165.8	398.9	9.11	155.9	7.61	20.20	0.04000
0.06000	-61.39	-61.35	1381.4	0.39184	113.86	393.17	0.6461	1.9650	1.333	0.761	1.234	888.	167.5	360.2	9.43	151.7	7.97	18.94	0.06000
0.08000	-56.13	-56.08	1365.1	0.29918	120.91	396.04	0.6789	1.9465	1.340	0.785	1.238	861.	168.6	334.4	9.66	148.5	8.26	18.00	0.08000
0.10000	-51.83	-51.78	1351.7	0.24259	126.69	398.33	0.7052	1.9324	1.347	0.805	1.242	839.	169.4	315.4	9.86	146.0	8.50	17.23	0.10000
0.10132b	-51.57	-51.52	1350.9	0.23961	127.04	398.47	0.7068	1.9316	1.348	0.806	1.242	838.	169.5	314.3	9.87	145.8	8.51	17.19	0.10132
0.12000	-48.17	-48.12	1340.1	0.20433	131.64	400.24	0.7273	1.9211	1.353	0.823	1.246	821.	170.0	300.3	10.02	143.8	8.71	16.59	0.12000
0.14000	-44.96	-44.91	1329.9	0.17668	136.00	401.89	0.7464	1.9116	1.359	0.839	1.250	805.	170.5	288.0	10.17	141.9	8.89	16.03	0.14000
0.16000	-42.10	-42.05	1320.7	0.15572	139.90	403.33	0.7634	1.9034	1.365	0.854	1.254	790.	170.9	277.5	10.30	140.2	9.06	15.53	0.16000
0.18000	-39.51	-39.45	1312.2	0.13928	143.46	404.62	0.7786	1.8963	1.371	0.868	1.257	777.	171.2	268.5	10.42	138.7	9.22	15.09	0.18000
0.20000	-37.13	-37.07	1304.4	0.12602	146.73	405.78	0.7925	1.8900	1.376	0.881	1.261	766.	171.4	260.5	10.52	137.3	9.36	14.68	0.20000
0.22000	-34.93	-34.87	1297.1	0.11510	149.76	406.84	0.8052	1.8843	1.381	0.894	1.265	755.	171.6	253.4	10.62	136.0	9.50	14.30	0.22000
0.24000	-32.89	-32.83	1290.3	0.10593	152.60	407.81	0.8170	1.8791	1.386	0.906	1.268	744.	171.7	247.0	10.72	134.8	9.63	13.95	0.24000
0.26000	-30.97	-30.90	1283.9	0.09813	155.27	408.71	0.8280	1.8744	1.391	0.917	1.272	735.	171.8	241.2	10.81	133.7	9.75	13.63	0.26000
0.28000	-29.16	-29.10	1277.7	0.09141	157.79	409.54	0.8383	1.8700	1.396	0.928	1.276	726.	171.9	235.9	10.89	132.7	9.87	13.33	0.28000
0.30000	-27.45	-27.38	1271.9	0.08556	160.19	410.31	0.8481	1.8659	1.401	0.938	1.279	717.	171.9	231.0	10.97	131.7	9.98	13.04	0.30000
0.32000	-25.83	-25.76	1266.3	0.08041	162.47	411.04	0.8573	1.8622	1.405	0.948	1.283	709.	172.0	226.4	11.04	130.7	10.09	12.77	0.32000
0.34000	-24.28	-24.21	1260.9	0.07584	164.66	411.72	0.8660	1.8586	1.410	0.958	1.287	701.	172.0	222.2	11.11	129.8	10.20	12.51	0.34000
0.36000	-22.80	-22.73	1255.8	0.07177	166.75	412.36	0.8743	1.8553	1.414	0.968	1.290	694.	172.0	218.2	11.18	128.9	10.30	12.27	0.36000
0.38000	-21.39	-21.31	1250.8	0.06811	168.76	412.96	0.8823	1.8521	1.419	0.977	1.294	687.	171.9	214.5	11.25	128.1	10.40	12.03	0.38000
0.40000	-20.03	-19.95	1246.0	0.06481	170.70	413.54	0.8899	1.8491	1.423	0.986	1.298	680.	171.9	211.0	11.31	127.3	10.49	11.81	0.40000
0.42000	-18.72	-18.64	1241.3	0.06180	172.57	414.08	0.8972	1.8463	1.427	0.995	1.301	673.	171.9	207.7	11.31	126.5	10.64	11.59	0.42000
0.44000	-17.45	-17.38	1236.8	0.05907	174.38	414.60	0.9042	1.8436	1.432	1.004	1.305	667.	171.8	204.6	11.32	125.8	10.78	11.39	0.44000
0.46000	-16.24	-16.16	1232.4	0.05656	176.13	415.09	0.9110	1.8410	1.436	1.012	1.308	661.	171.7	201.6	11.38	125.1	10.87	11.19	0.46000
0.48000	-15.06	-14.98	1228.1	0.05425	177.83	415.56	0.9175	1.8385	1.440	1.021	1.312	655.	171.7	198.7	11.43	124.4	10.96	11.00	0.48000
0.50000	-13.91	-13.83	1223.9	0.05212	179.48	416.00	0.9238	1.8361	1.444	1.029	1.316	649.	171.6	196.0	11.49	123.7	11.05	10.81	0.50000
0.55000	-11.20	-11.12	1214.0	0.04746	183.41	417.04	0.9388	1.8305	1.455	1.049	1.325	635.	171.3	189.7	11.63	122.1	11.28	10.38	0.55000
0.60000	-8.68	-8.59	1204.5	0.04354	187.11	417.96	0.9527	1.8254	1.465	1.068	1.334	623.	171.0	184.0	11.76	120.6	11.49	9.98	0.60000
0.65000	-6.30	-6.22	1195.5	0.04021	190.60	418.80	0.9657	1.8207	1.475	1.088	1.344	610.	170.7	178.8	11.88	119.2	11.70	9.60	0.65000
0.70000	-4.07	-3.98	1186.9	0.03734	193.92	419.56	0.9779	1.8163	1.485	1.106	1.353	599.	170.4	174.1	12.01	117.9	11.91	9.25	0.70000
0.75000	-1.95	-1.86	1178.6	0.03484	197.08	420.25	0.9894	1.8122	1.495	1.125	1.363	588.	170.0	169.7	12.12	116.6	12.11	8.92	0.75000
0.80000	0.07	0.16	1170.6	0.03264	200.10	420.88	1.0004	1.8083	1.505	1.143	1.373	577.	169.6	165.6	12.24	115.4	12.31	8.61	0.80000
0.85000	1.99	2.08	1162.9	0.03069	203.00	421.45	1.0108	1.8046	1.515	1.161	1.383	567.	169.2	161.8	12.34	114.3	12.51	8.31	0.85000
0.90000	3.83	3.92	1155.5	0.02894	205.79	421.97	1.0207	1.8011	1.525	1.179	1.393	558.	168.8	158.2	12.45	113.2	12.71	8.03	0.90000
0.95000	5.59	5.69	1148.2	0.02738	208.49	422.45	1.0303	1.7978	1.535	1.197	1.403	549.	168.4	154.8	12.56	112.1	12.91	7.77	0.95000
1.00000	7.28	7.38	1141.2	0.02597	211.09	422.89	1.0394	1.7946	1.545	1.215	1.414	540.	168.0	151.6	12.66	111.1	13.11	7.51	1.00000
1.10000	10.48	10.59	1127.6	0.02351	216.06	423.64	1.0568	1.7885	1.565	1.251	1.435	522.	167.1	145.7	12.87	109.1	13.51	7.04	1.10000
1.20000	13.48	13.58	1114.5	0.02145	220.76	424.27	1.0729	1.7828	1.586	1.287	1.458	506.	166.1	140.3	13.06	107.3	13.92	6.60	1.20000
1.30000	16.28	16.39	1102.0	0.01970	225.22	424.78	1.0881	1.7774	1.607	1.324	1.482	491.	165.1	135.4	13.25	105.5	14.35	6.19	1.30000
1.40000	18.93	19.04	1089.8	0.01818	229.48	425.18	1.1024	1.7723	1.629	1.362	1.507	476.	164.2	130.9	13.43	103.9	14.79	5.81	1.40000
1.50000	21.44	21.55	1078.0	0.01686	233.56	425.49	1.1160	1.7674	1.651	1.402	1.533	462.	163.1	126.7	13.60	102.3	15.25	5.45	1.50000
1.60000	23.83	23.94	1066.5	0.01570	237.49	425.72	1.1290	1.7627	1.675	1.442	1.561	449.	162.1	122.8	13.78	100.8	15.73	5.12	1.60000
1.70000	26.11	26.22	1055.3	0.01467	241.29	425.86	1.1414	1.7581	1.699	1.485	1.590	436.	161.1	119.1	13.95	99.3	16.23	4.80	1.70000
1.80000	28.29	28.40	1044.2	0.01375	244.96	425.93	1.1533	1.7536	1.725	1.529	1.622	423.	160.0	115.6	14.12	97.9	16.76	4.51	1.80000
1.90000	30.37	30.49	1033.3	0.01292	248.52	425.93	1.1648	1.7492	1.751	1.576	1.655	411.	159.0	112.3	14.28	96.5	17.32	4.22	1.90000
2.00000	32.38	32.49	1022.6	0.01217	251.99	425.87	1.1759	1.7448	1.779										

Refrigerant 507A [R-125/143a (50/50)] Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure**, MPa	Density, kg/m³ Liquid	Volume, m³/kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-100.00	0.00310	1471.4	4.6772	77.43	303.23	0.4473	1.7515	1.134	0.617	1.164	984.	129.6	858.0	7.03	125.6	5.62	18.29	-100.00
-95.00	0.00479	1457.5	3.1090	83.11	306.19	0.4796	1.7319	1.137	0.630	1.162	957.	131.2	759.3	7.23	122.6	5.90	17.82	-95.00
-90.00	0.00720	1443.4	2.1231	88.81	309.17	0.5112	1.7144	1.142	0.643	1.161	930.	132.6	678.9	7.43	119.7	6.18	17.35	-90.00
-85.00	0.01055	1429.3	1.4856	94.54	312.18	0.5420	1.6988	1.148	0.657	1.159	904.	134.1	612.1	7.63	116.9	6.47	16.87	-85.00
-80.00	0.01509	1415.1	1.0628	100.29	315.20	0.5722	1.6849	1.155	0.671	1.158	878.	135.4	555.7	7.83	114.1	6.77	16.37	-80.00
-75.00	0.02113	1400.8	0.77578	106.09	318.24	0.6018	1.6725	1.162	0.686	1.158	853.	136.6	507.4	8.02	111.4	7.07	15.87	-75.00
-70.00	0.02903	1386.4	0.57673	111.93	321.29	0.6309	1.6614	1.171	0.702	1.158	828.	137.8	465.5	8.22	108.8	7.39	15.35	-70.00
-65.00	0.03916	1371.8	0.43596	117.81	324.33	0.6594	1.6516	1.180	0.718	1.159	804.	138.9	428.8	8.42	106.2	7.71	14.83	-65.00
-60.00	0.05198	1357.0	0.33458	123.74	327.38	0.6875	1.6429	1.190	0.734	1.160	780.	139.8	396.3	8.62	103.7	8.03	14.29	-60.00
-55.00	0.06795	1342.1	0.26036	129.72	330.42	0.7152	1.6352	1.200	0.752	1.162	755.	140.7	367.4	8.84	101.2	8.38	13.75	-55.00
-50.00	0.08759	1326.9	0.20517	135.75	333.44	0.7425	1.6284	1.211	0.770	1.164	731.	141.4	341.5	9.04	98.8	8.73	13.20	-50.00
-48.00	0.09661	1320.8	0.18713	138.18	334.64	0.7533	1.6259	1.216	0.778	1.165	722.	141.6	331.8	9.11	97.9	8.87	12.98	-48.00
-47.01b	0.10132	1317.7	0.17894	139.39	335.24	0.7586	1.6247	1.218	0.782	1.166	717.	141.8	327.2	9.15	97.4	8.94	12.87	-47.01
-46.00	0.10634	1314.6	0.17099	140.62	335.85	0.7641	1.6235	1.221	0.786	1.167	712.	141.9	322.5	9.19	97.0	9.01	12.75	-46.00
-44.00	0.11682	1308.4	0.15650	143.07	337.04	0.7748	1.6212	1.226	0.793	1.168	703.	142.1	313.6	9.26	96.0	9.16	12.53	-44.00
-42.00	0.12809	1302.1	0.14348	145.53	338.23	0.7854	1.6191	1.231	0.801	1.170	693.	142.3	305.0	9.34	95.1	9.30	12.30	-42.00
-40.00	0.14020	1295.8	0.13175	148.00	339.42	0.7960	1.6170	1.236	0.810	1.171	684.	142.4	296.7	9.41	94.2	9.45	12.08	-40.00
-38.00	0.15318	1289.5	0.12116	150.49	340.60	0.8066	1.6151	1.241	0.818	1.173	674.	142.6	288.8	9.49	93.2	9.60	11.85	-38.00
-36.00	0.16708	1283.1	0.11159	152.98	341.78	0.8171	1.6132	1.246	0.827	1.175	665.	142.7	281.0	9.57	92.3	9.75	11.62	-36.00
-34.00	0.18194	1276.6	0.10292	155.48	342.95	0.8275	1.6115	1.252	0.835	1.177	655.	142.8	273.6	9.64	91.4	9.90	11.39	-34.00
-32.00	0.19780	1270.1	0.09505	157.99	344.11	0.8380	1.6098	1.258	0.844	1.180	646.	142.9	266.4	9.72	90.5	10.06	11.15	-32.00
-30.00	0.21471	1263.6	0.08791	160.52	345.27	0.8483	1.6082	1.263	0.853	1.182	637.	142.9	259.4	9.80	89.6	10.21	10.92	-30.00
-28.00	0.23271	1257.0	0.08140	163.06	346.42	0.8587	1.6067	1.269	0.862	1.185	627.	142.9	252.7	9.88	88.7	10.37	10.69	-28.00
-26.00	0.25185	1250.3	0.07546	165.61	347.57	0.8690	1.6052	1.275	0.872	1.188	618.	142.9	246.1	9.96	87.8	10.53	10.45	-26.00
-24.00	0.27218	1243.6	0.07004	168.17	348.70	0.8792	1.6038	1.281	0.882	1.191	608.	142.9	239.8	10.05	87.0	10.69	10.22	-24.00
-22.00	0.29374	1236.8	0.06508	170.74	349.82	0.8894	1.6025	1.288	0.891	1.194	599.	142.8	233.6	10.01	86.1	10.99	9.98	-22.00
-20.00	0.31658	1229.9	0.06054	173.33	350.94	0.8996	1.6012	1.294	0.902	1.197	589.	142.8	227.6	10.11	85.2	11.16	9.74	-20.00
-18.00	0.34076	1223.0	0.05638	175.93	352.05	0.9098	1.6001	1.301	0.912	1.201	580.	142.6	221.8	10.20	84.3	11.33	9.51	-18.00
-16.00	0.36631	1216.0	0.05255	178.55	353.14	0.9199	1.5989	1.308	0.923	1.205	570.	142.5	216.2	10.29	83.5	11.50	9.27	-16.00
-14.00	0.39329	1208.9	0.04903	181.18	354.23	0.9300	1.5978	1.315	0.933	1.209	561.	142.3	210.7	10.39	82.6	11.68	9.03	-14.00
-12.00	0.42176	1201.8	0.04579	183.82	355.30	0.9401	1.5968	1.323	0.945	1.213	552.	142.1	205.3	10.48	81.8	11.86	8.79	-12.00
-10.00	0.45176	1194.5	0.04279	186.48	356.37	0.9501	1.5957	1.330	0.956	1.218	542.	141.9	200.1	10.58	80.9	12.04	8.55	-10.00
-8.00	0.48335	1187.2	0.04003	189.15	357.41	0.9601	1.5948	1.338	0.968	1.223	533.	141.6	195.0	10.67	80.0	12.23	8.31	-8.00
-6.00	0.51658	1179.8	0.03748	191.84	358.45	0.9701	1.5938	1.346	0.980	1.228	523.	141.3	190.1	10.77	79.2	12.42	8.07	-6.00
-4.00	0.55150	1172.3	0.03511	194.54	359.47	0.9801	1.5929	1.355	0.993	1.234	514.	141.0	185.2	10.87	78.3	12.61	7.83	-4.00
-2.00	0.58817	1164.6	0.03292	197.26	360.48	0.9901	1.5920	1.363	1.006	1.240	504.	140.6	180.5	10.97	77.5	12.81	7.59	-2.00
0.00	0.62665	1156.9	0.03089	200.00	361.47	1.0000	1.5912	1.372	1.019	1.247	494.	140.2	175.9	11.07	76.7	13.02	7.35	0.00
2.00	0.66698	1149.1	0.02900	202.76	362.44	1.0099	1.5903	1.382	1.033	1.254	485.	139.8	171.4	11.17	75.8	13.23	7.11	2.00
4.00	0.70924	1141.1	0.02724	205.53	363.40	1.0198	1.5895	1.392	1.048	1.261	475.	139.3	167.0	11.28	75.0	13.45	6.87	4.00
6.00	0.75347	1133.1	0.02560	208.32	364.33	1.0297	1.5886	1.402	1.063	1.269	465.	138.8	162.6	11.38	74.1	13.67	6.63	6.00
8.00	0.79973	1124.9	0.02408	211.13	365.25	1.0396	1.5878	1.413	1.079	1.278	456.	138.2	158.4	11.49	73.3	13.90	6.39	8.00
10.00	0.84809	1116.6	0.02265	213.97	366.15	1.0495	1.5870	1.424	1.096	1.287	446.	137.6	154.3	11.60	72.5	14.14	6.15	10.00
12.00	0.89860	1108.1	0.02132	216.82	367.02	1.0594	1.5862	1.436	1.113	1.297	436.	137.0	150.2	11.71	71.6	14.39	5.91	12.00
14.00	0.95133	1099.4	0.02008	219.69	367.87	1.0693	1.5853	1.448	1.131	1.307	426.	136.3	146.2	11.83	70.8	14.65	5.67	14.00
16.00	1.0063	1090.7	0.01892	222.59	368.70	1.0792	1.5845	1.461	1.151	1.319	416.	135.6	142.3	11.94	70.0	14.91	5.43	16.00
18.00	1.0637	1081.7	0.01783	225.52	369.49	1.0890	1.5836	1.475	1.171	1.332	407.	134.9	138.5	12.06	69.1	15.19	5.19	18.00
20.00	1.1235	1072.6	0.01680	228.46	370.26	1.0989	1.5827	1.490	1.193	1.346	397.	134.1	134.7	12.19	68.3	15.49	4.95	20.00
22.00	1.1857	1063.2	0.01584	231.44	371.00	1.1089	1.5817	1.506	1.216	1.360	386.	133.2	131.0	12.32	67.5	15.80	4.72	22.00
24.00	1.2505	1053.7	0.01494	234.44	371.71	1.1188	1.5808	1.522	1.241	1.377	376.	132.3	127.3	12.45	66.7	16.12	4.48	24.00
26.00	1.3179	1043.9	0.01409	237.47	372.38	1.1287	1.5797	1.540										

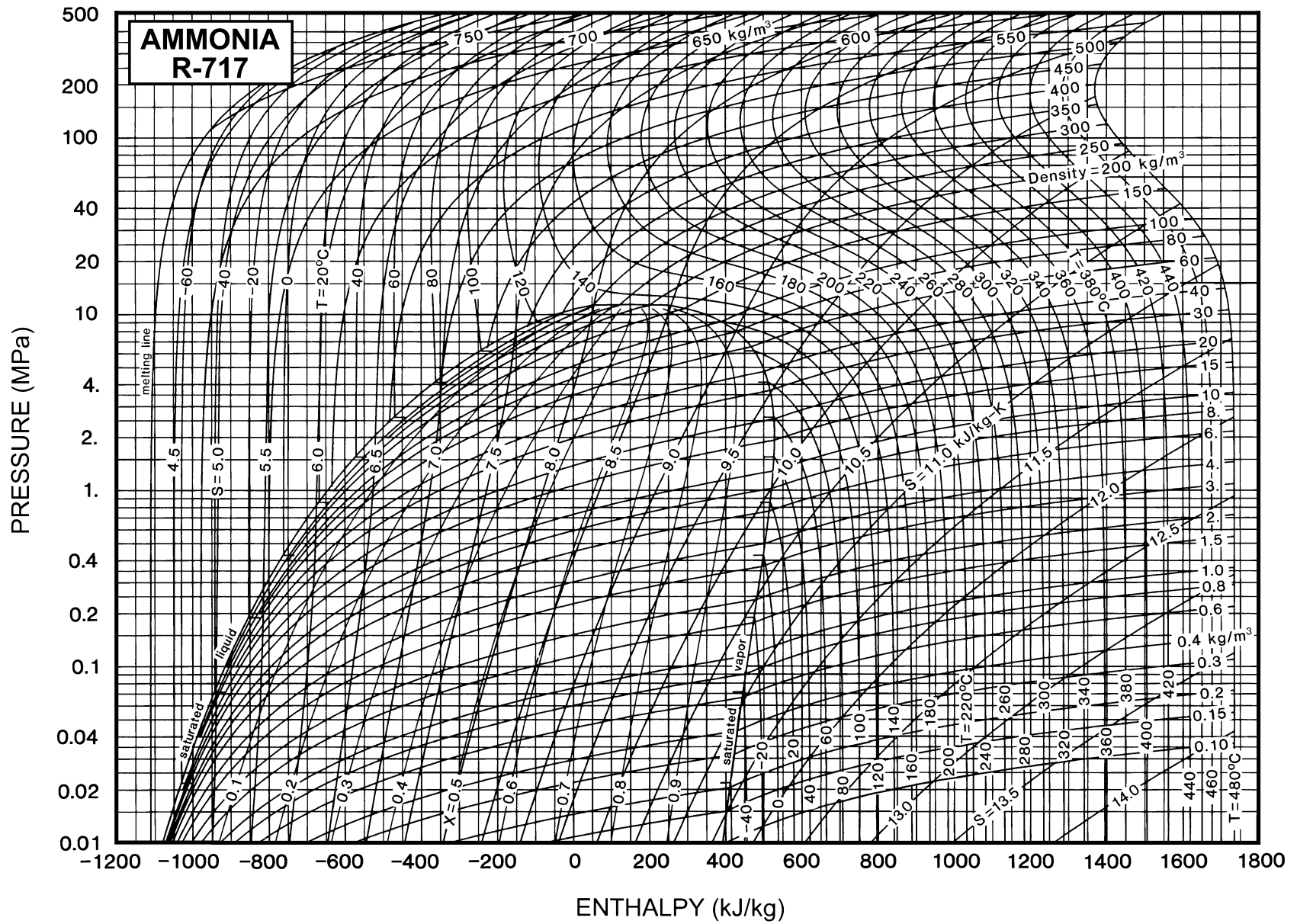


Fig. 12 Pressure-Enthalpy Diagram for Refrigerant 717 (Ammonia)

Note: The reference states for enthalpy and entropy differ from those in the table.

Refrigerant 717 (Ammonia) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat <i>c_p</i> , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-77.65a	0.00609	732.9	15.602	-143.15	1341.23	-0.4716	7.1213	4.202	2.063	1.325	2124.	354.1	559.6	6.84	819.0	19.64	62.26	-77.65
-70.00	0.01094	724.7	9.0079	-110.81	1355.55	-0.3094	6.9088	4.245	2.086	1.327	2051.	360.5	475.0	7.03	792.1	19.73	59.10	-70.00
-60.00	0.02189	713.6	4.7057	-68.06	1373.73	-0.1040	6.6602	4.303	2.125	1.330	1967.	368.4	391.3	7.30	757.0	19.93	55.05	-60.00
-50.00	0.04084	702.1	2.6277	-24.73	1391.19	0.0945	6.4396	4.360	2.178	1.335	1890.	375.6	328.9	7.57	722.3	20.24	51.11	-50.00
-40.00	0.07169	690.2	1.5533	19.17	1407.76	0.2867	6.2425	4.414	2.244	1.342	1816.	382.2	281.2	7.86	688.1	20.64	47.26	-40.00
-38.00	0.07971	687.7	1.4068	28.01	1410.96	0.3245	6.2056	4.424	2.259	1.343	1802.	383.4	273.1	7.92	681.4	20.73	46.51	-38.00
-36.00	0.08845	685.3	1.2765	36.88	1414.11	0.3619	6.1694	4.434	2.275	1.345	1787.	384.6	265.3	7.98	674.6	20.83	45.75	-36.00
-34.00	0.09795	682.8	1.1604	45.77	1417.23	0.3992	6.1339	4.444	2.291	1.347	1773.	385.8	257.9	8.03	667.9	20.93	45.00	-34.00
-33.33b	0.10133	682.0	1.1242	48.76	1418.26	0.4117	6.1221	4.448	2.297	1.348	1768.	386.2	255.5	8.05	665.7	20.97	44.75	-33.33
-32.00	0.10826	680.3	1.0567	54.67	1420.29	0.4362	6.0992	4.455	2.308	1.349	1759.	387.0	250.8	8.09	661.3	21.04	44.26	-32.00
-30.00	0.11943	677.8	0.96396	63.60	1423.31	0.4730	6.0651	4.465	2.326	1.351	1744.	388.1	244.1	8.15	654.6	21.15	43.52	-30.00
-28.00	0.13151	675.3	0.88082	72.55	1426.28	0.5096	6.0317	4.474	2.344	1.353	1730.	389.2	237.6	8.21	648.0	21.26	42.78	-28.00
-26.00	0.14457	672.8	0.80614	81.52	1429.21	0.5460	5.9989	4.484	2.363	1.355	1716.	390.2	231.4	8.27	641.5	21.38	42.05	-26.00
-24.00	0.15864	670.3	0.73896	90.51	1432.08	0.5821	5.9667	4.494	2.383	1.358	1702.	391.2	225.5	8.33	634.9	21.51	41.32	-24.00
-22.00	0.17379	667.7	0.67840	99.52	1434.91	0.6180	5.9351	4.504	2.403	1.360	1687.	392.2	219.8	8.39	628.4	21.63	40.60	-22.00
-20.00	0.19008	665.1	0.62373	108.55	1437.68	0.6538	5.9041	4.514	2.425	1.363	1673.	393.2	214.4	8.45	622.0	21.77	39.88	-20.00
-18.00	0.20756	662.6	0.57428	117.60	1440.39	0.6893	5.8736	4.524	2.446	1.365	1659.	394.1	209.2	8.51	615.5	21.90	39.16	-18.00
-16.00	0.22630	660.0	0.52949	126.67	1443.06	0.7246	5.8437	4.534	2.469	1.368	1645.	395.0	204.2	8.57	609.1	22.05	38.45	-16.00
-14.00	0.24637	657.3	0.48885	135.76	1445.66	0.7597	5.8143	4.543	2.493	1.371	1631.	395.8	199.3	8.63	602.8	22.19	37.74	-14.00
-12.00	0.26782	654.7	0.45192	144.88	1448.21	0.7946	5.7853	4.553	2.517	1.375	1616.	396.7	194.7	8.69	596.4	22.35	37.04	-12.00
-10.00	0.29071	652.1	0.41830	154.01	1450.70	0.8293	5.7569	4.564	2.542	1.378	1602.	397.5	190.2	8.75	590.1	22.50	36.34	-10.00
-8.00	0.31513	649.4	0.38767	163.16	1453.14	0.8638	5.7289	4.574	2.568	1.382	1588.	398.2	185.9	8.81	583.9	22.67	35.65	-8.00
-6.00	0.34114	646.7	0.35970	172.34	1455.51	0.8981	5.7013	4.584	2.594	1.385	1574.	398.9	181.7	8.87	577.7	22.83	34.96	-6.00
-4.00	0.36880	644.0	0.33414	181.54	1457.81	0.9323	5.6741	4.595	2.622	1.389	1559.	399.6	177.7	8.93	571.5	23.00	34.27	-4.00
-2.00	0.39819	641.3	0.31074	190.76	1460.06	0.9662	5.6474	4.606	2.651	1.393	1545.	400.2	173.8	8.99	565.3	23.18	33.59	-2.00
0.00	0.42938	638.6	0.28930	200.00	1462.24	1.0000	5.6210	4.617	2.680	1.398	1531.	400.8	170.1	9.06	559.2	23.37	32.91	0.00
2.00	0.46246	635.8	0.26962	209.27	1464.35	1.0336	5.5951	4.628	2.710	1.402	1516.	401.4	166.5	9.12	553.1	23.55	32.24	2.00
4.00	0.49748	633.1	0.25153	218.55	1466.40	1.0670	5.5695	4.639	2.742	1.407	1502.	401.9	162.9	9.18	547.1	23.75	31.57	4.00
6.00	0.53453	630.3	0.23489	227.87	1468.37	1.1003	5.5442	4.651	2.774	1.412	1487.	402.4	159.5	9.24	541.1	23.95	30.91	6.00
8.00	0.57370	627.5	0.21956	237.20	1470.28	1.1334	5.5192	4.663	2.807	1.417	1473.	402.8	156.2	9.30	535.1	24.15	30.24	8.00
10.00	0.61505	624.6	0.20543	246.57	1472.11	1.1664	5.4946	4.676	2.841	1.422	1458.	403.2	153.0	9.36	529.1	24.37	29.59	10.00
12.00	0.65866	621.8	0.19237	255.95	1473.88	1.1992	5.4703	4.689	2.877	1.428	1443.	403.6	149.9	9.43	523.2	24.58	28.94	12.00
14.00	0.70463	618.9	0.18031	265.37	1475.56	1.2318	5.4463	4.702	2.913	1.434	1429.	403.9	146.9	9.49	517.3	24.81	28.29	14.00
16.00	0.75303	616.0	0.16914	274.81	1477.17	1.2643	5.4226	4.716	2.951	1.440	1414.	404.2	144.0	9.55	511.5	25.04	27.65	16.00
18.00	0.80395	613.1	0.15879	284.28	1478.70	1.2967	5.3991	4.730	2.990	1.446	1399.	404.4	141.1	9.61	505.6	25.27	27.01	18.00
20.00	0.85748	610.2	0.14920	293.78	1480.16	1.3289	5.3759	4.745	3.030	1.453	1384.	404.6	138.3	9.68	499.9	25.52	26.38	20.00
22.00	0.91369	607.2	0.14029	303.31	1481.53	1.3610	5.3529	4.760	3.071	1.460	1370.	404.8	135.6	9.74	494.1	25.77	25.75	22.00
24.00	0.97268	604.3	0.13201	312.87	1482.82	1.3929	5.3301	4.776	3.113	1.468	1355.	404.9	133.0	9.80	488.4	26.03	25.12	24.00
26.00	1.0345	601.3	0.12431	322.47	1484.02	1.4248	5.3076	4.793	3.158	1.475	1340.	404.9	130.4	9.87	482.7	26.29	24.50	26.00
28.00	1.0993	598.2	0.11714	332.09	1485.14	1.4565	5.2853	4.810	3.203	1.484	1324.	405.0	127.9	9.93	477.0	26.57	23.89	28.00
30.00	1.1672	595.2	0.11046	341.76	1486.17	1.4881	5.2631	4.828	3.250	1.492	1309.	404.9	125.5	10.00	471.4	26.85	23.28	30.00
32.00	1.2382	592.1	0.10422	351.45	1487.11	1.5196	5.2412	4.847	3.299	1.501	1294.	404.8	123.1	10.06	465.7	27.14	22.67	32.00
34.00	1.3124	589.0	0.09840	361.19	1487.95	1.5509	5.2194	4.867	3.349	1.510	1279.	404.7	120.7	10.13	460.1	27.43	22.07	34.00
36.00	1.3900	585.8	0.09296	370.96	1488.70	1.5822	5.1978	4.888	3.401	1.520	1263.	404.5	118.4	10.19	454.6	27.74	21.47	36.00
38.00	1.4709	582.6	0.08787	380.78	1489.36	1.6134	5.1763	4.909	3.455	1.530	1248.	404.3	116.2	10.26	449.1	28.05	20.88	38.00
40.00	1.5554	579.4	0.08310	390.64	1489.91	1.6446	5.1549	4.932	3.510	1.541	1232.	404.0	114.0	10.33	443.5	28.38	20.29	40.00
42.00	1.6435	576.2	0.07863	400.54	1490.36	1.6756	5.1337	4.956	3.568	1.553	1216.	403.7	111.9	10.39	438.0	28.71	19.71	42.00
44.00	1.7353	572.9	0.07445	410.48	1490.70	1.7065	5.1126	4.981	3.628	1.565	1201.	403.3	109.8	10.46	432.6	29.06	19.13	44.00
46.00	1.8310	569.6	0.07052	420.48	1490.94	1.7374	5.0915	5.007	3.691	1.577	1185.	402.9	107.8	10.53	427.1	29.41	18.56	46.00
48.00	1.930																	

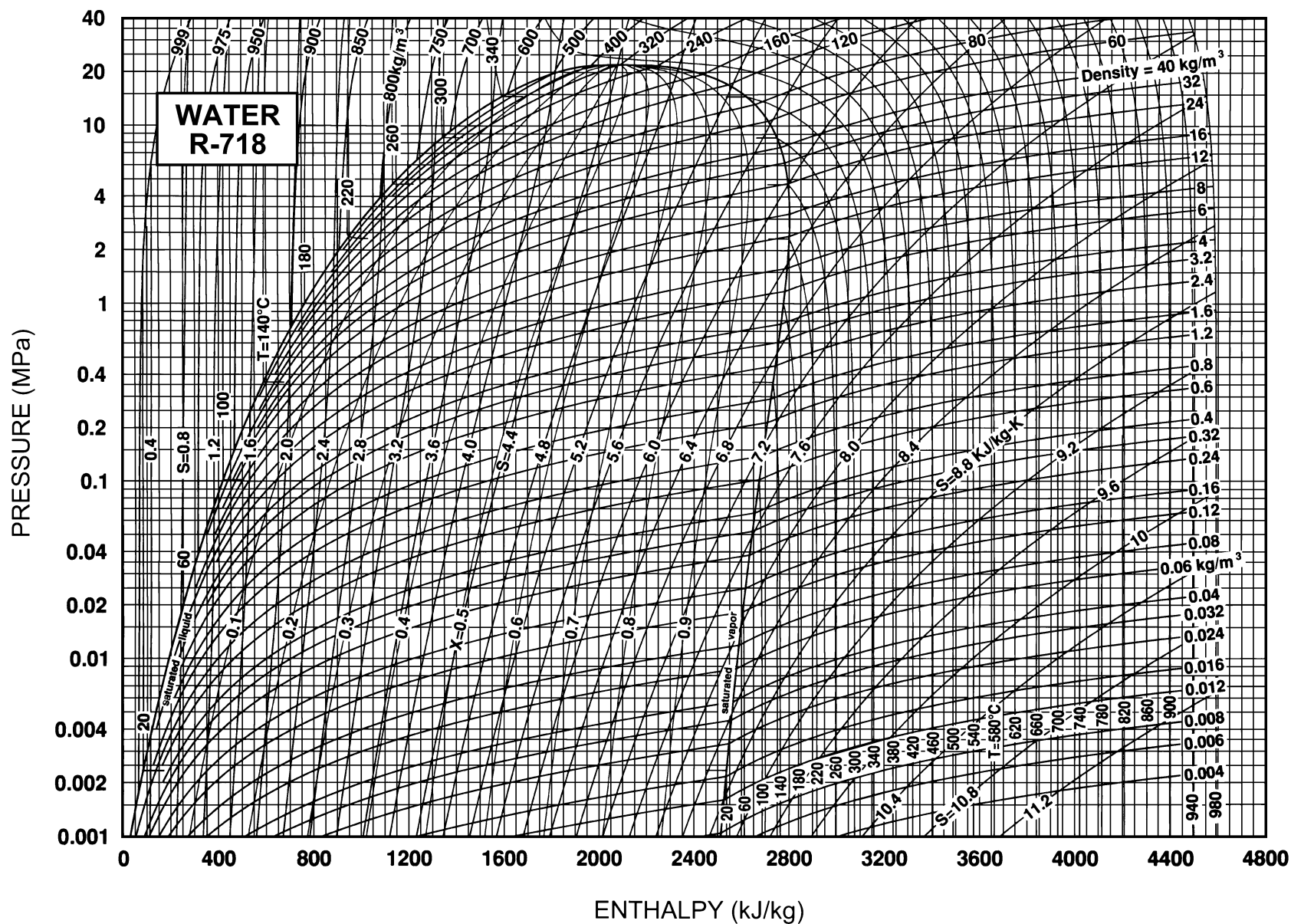


Fig. 13 Pressure-Enthalpy Diagram for Refrigerant 718 (Water/Steam)

Refrigerant 718 (Water/Steam) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, kg/m ³		Volume, m ³ /kg		Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
0.01a	0.00061	999.8	205.99		0.00	2500.92	0.0000	9.1555	4.220	1.884	1.329	1402.	409.0	1791.2	9.22	561.0	17.07	75.65	0.01	
5.00	0.00087	999.9	147.01		21.02	2510.06	0.0763	9.0248	4.205	1.889	1.328	1426.	412.6	1518.3	9.34	570.5	17.34	74.94	5.00	
10.00	0.00123	999.7	106.30		42.02	2519.21	0.1511	8.8998	4.196	1.895	1.328	1447.	416.2	1306.0	9.46	580.0	17.62	74.22	10.00	
15.00	0.00171	999.1	77.875		62.98	2528.33	0.2245	8.7803	4.189	1.900	1.328	1466.	419.7	1137.6	9.59	589.3	17.92	73.49	15.00	
20.00	0.00234	998.2	57.757		83.91	2537.43	0.2965	8.6660	4.184	1.906	1.327	1482.	423.2	1001.6	9.73	598.4	18.23	72.74	20.00	
25.00	0.00317	997.0	43.337		104.83	2546.51	0.3672	8.5566	4.182	1.912	1.327	1497.	426.6	890.1	9.87	607.2	18.55	71.97	25.00	
30.00	0.00425	995.6	32.878		125.73	2555.55	0.4368	8.4520	4.180	1.918	1.327	1509.	430.0	797.4	10.01	615.5	18.89	71.19	30.00	
35.00	0.00563	994.0	25.205		146.63	2564.55	0.5051	8.3517	4.180	1.925	1.327	1520.	433.4	719.3	10.16	623.3	19.24	70.40	35.00	
40.00	0.00738	992.2	19.515		167.53	2573.51	0.5724	8.2555	4.180	1.931	1.327	1529.	436.7	653.0	10.31	630.6	19.60	69.60	40.00	
45.00	0.00959	990.2	15.252		188.43	2582.43	0.6386	8.1633	4.180	1.939	1.327	1536.	440.0	596.1	10.46	637.3	19.97	68.78	45.00	
50.00	0.01235	988.0	12.027		209.34	2591.29	0.7038	8.0748	4.182	1.947	1.328	1542.	443.2	546.8	10.62	643.6	20.36	67.94	50.00	
55.00	0.01576	985.7	9.5643		230.26	2600.09	0.7680	7.9898	4.183	1.955	1.328	1547.	446.4	504.0	10.77	649.2	20.77	67.10	55.00	
60.00	0.01995	983.2	7.6672		251.18	2608.83	0.8313	7.9081	4.185	1.965	1.328	1551.	449.5	466.4	10.93	654.3	21.19	66.24	60.00	
65.00	0.02504	980.5	6.1935		272.12	2617.50	0.8937	7.8296	4.187	1.975	1.329	1553.	452.6	433.2	11.10	659.0	21.62	65.37	65.00	
70.00	0.03120	977.7	5.0395		293.07	2626.10	0.9551	7.7540	4.190	1.986	1.330	1555.	455.6	403.9	11.26	663.1	22.07	64.48	70.00	
75.00	0.03860	974.8	4.1289		314.03	2634.60	1.0158	7.6812	4.193	1.999	1.331	1555.	458.5	377.7	11.43	666.8	22.53	63.58	75.00	
80.00	0.04741	971.8	3.4052		335.01	2643.02	1.0756	7.6111	4.197	2.012	1.332	1554.	461.4	354.3	11.59	670.0	23.01	62.67	80.00	
85.00	0.05787	968.6	2.8258		356.01	2651.33	1.1346	7.5434	4.201	2.027	1.333	1553.	464.2	333.3	11.76	672.8	23.51	61.75	85.00	
90.00	0.07018	965.3	2.3591		377.04	2659.53	1.1929	7.4781	4.205	2.043	1.334	1550.	466.9	314.4	11.93	675.3	24.02	60.82	90.00	
95.00	0.08461	961.9	1.9806		398.09	2667.61	1.2504	7.4151	4.210	2.061	1.335	1547.	469.6	297.3	12.10	677.3	24.55	59.87	95.00	
99.97b	0.10133	958.4	1.6732		419.06	2675.53	1.3069	7.3544	4.216	2.080	1.337	1543.	472.2	281.8	12.27	679.1	25.09	58.92	99.97	
100.00	0.10142	958.3	1.6718		419.17	2675.57	1.3072	7.3541	4.216	2.080	1.337	1543.	472.2	281.7	12.27	679.1	25.10	58.91	100.00	
105.00	0.12090	954.7	1.4184		440.27	2683.39	1.3633	7.2952	4.222	2.101	1.339	1538.	474.7	267.6	12.44	680.5	25.66	57.94	105.00	
110.00	0.14338	950.9	1.2093		461.42	2691.06	1.4188	7.2381	4.228	2.124	1.341	1533.	477.1	254.7	12.61	681.7	26.24	56.96	110.00	
115.00	0.16918	947.1	1.0358		482.59	2698.58	1.4737	7.1828	4.236	2.150	1.343	1527.	479.5	242.9	12.78	682.6	26.85	55.97	115.00	
120.00	0.19867	943.1	0.89121		503.81	2705.93	1.5279	7.1291	4.244	2.177	1.346	1520.	481.7	232.1	12.96	683.2	27.47	54.97	120.00	
125.00	0.23224	939.0	0.77003		525.07	2713.10	1.5816	7.0770	4.252	2.207	1.349	1512.	483.9	222.1	13.13	683.6	28.11	53.96	125.00	
130.00	0.27028	934.8	0.66800		546.38	2720.08	1.6346	7.0264	4.261	2.239	1.352	1504.	486.0	212.9	13.30	683.7	28.76	52.93	130.00	
135.00	0.31323	930.5	0.58173		567.74	2726.87	1.6872	6.9772	4.272	2.274	1.355	1496.	487.9	204.4	13.47	683.6	29.44	51.90	135.00	
140.00	0.36154	926.1	0.50845		589.16	2733.44	1.7392	6.9293	4.283	2.311	1.359	1486.	489.8	196.5	13.65	683.3	30.14	50.86	140.00	
145.00	0.41568	921.6	0.44596		610.64	2739.80	1.7907	6.8826	4.294	2.351	1.363	1476.	491.6	189.2	13.82	682.8	30.86	49.80	145.00	
150.00	0.47616	917.0	0.39245		632.18	2745.93	1.8418	6.8371	4.307	2.394	1.368	1466.	493.3	182.5	13.99	682.0	31.60	48.74	150.00	
155.00	0.54350	912.3	0.34646		653.79	2751.81	1.8924	6.7926	4.321	2.440	1.373	1455.	494.8	176.1	14.16	681.1	32.35	47.67	155.00	
160.00	0.61823	907.4	0.30678		675.47	2757.44	1.9426	6.7491	4.335	2.488	1.379	1443.	496.3	170.2	14.34	680.0	33.13	46.59	160.00	
165.00	0.70093	902.5	0.27243		697.24	2762.81	1.9923	6.7066	4.351	2.540	1.385	1431.	497.6	164.7	14.51	678.6	33.93	45.50	165.00	
170.00	0.79219	897.5	0.24259		719.08	2767.90	2.0417	6.6650	4.368	2.594	1.392	1419.	498.9	159.6	14.68	677.0	34.75	44.41	170.00	
175.00	0.89260	892.3	0.21658		741.02	2772.71	2.0906	6.6241	4.386	2.652	1.399	1405.	500.0	154.7	14.85	675.3	35.59	43.30	175.00	
180.00	1.0028	887.0	0.19384		763.05	2777.21	2.1392	6.5840	4.405	2.713	1.407	1392.	501.0	150.1	15.03	673.3	36.45	42.19	180.00	
185.00	1.1235	881.6	0.17390		785.19	2781.41	2.1875	6.5447	4.425	2.777	1.416	1378.	501.9	145.8	15.20	671.1	37.33	41.07	185.00	
190.00	1.2552	876.1	0.15636		807.43	2785.28	2.2355	6.5059	4.447	2.844	1.425	1363.	502.7	141.8	15.37	668.8	38.24	39.95	190.00	
195.00	1.3988	870.4	0.14089		829.79	2788.82	2.2832	6.4678	4.471	2.915	1.436	1348.	503.4	137.9	15.54	666.1	39.16	38.81	195.00	
200.00	1.5549	864.7	0.12721		852.27	2792.01	2.3305	6.4302	4.496	2.990	1.447	1332.	503.9	134.3	15.71	663.3	40.11	37.67	200.00	
205.00	1.7243	858.8	0.11508		874.88	2794.83	2.3777	6.3930	4.523	3.068	1.459	1316.	504.3	130.9	15.89	660.3	41.09	36.53	205.00	
210.00	1.9077	852.7	0.10429		897.63	2797.27	2.4245	6.3563	4.551	3.150	1.472	1299.	504.6	127.6	16.06	657.0	42.09	35.38	210.00	
215.00	2.1058	846.5	0.09468		920.53	2799.32	2.4712	6.3200	4.582	3.237	1.486	1282.	504.8	124.5	16.24	653.4	43.11	34.23	215.00	
220.00	2.3196	840.2	0.08609		943.58	2800.95	2.5177	6.2840	4.615	3.329	1.501	1264.	504.8	121.5	16.41	649.7	44.17	33.07	220.00	
225.00	2.5497	833.7	0.07840		966.80	2802.15	2.5640	6.2483	4.650	3.426	1.518	1246.	504.6	118.7	16.59	645.6	45.26	31.90	225.00	
230.00	2.7971	827.1	0.0.																	

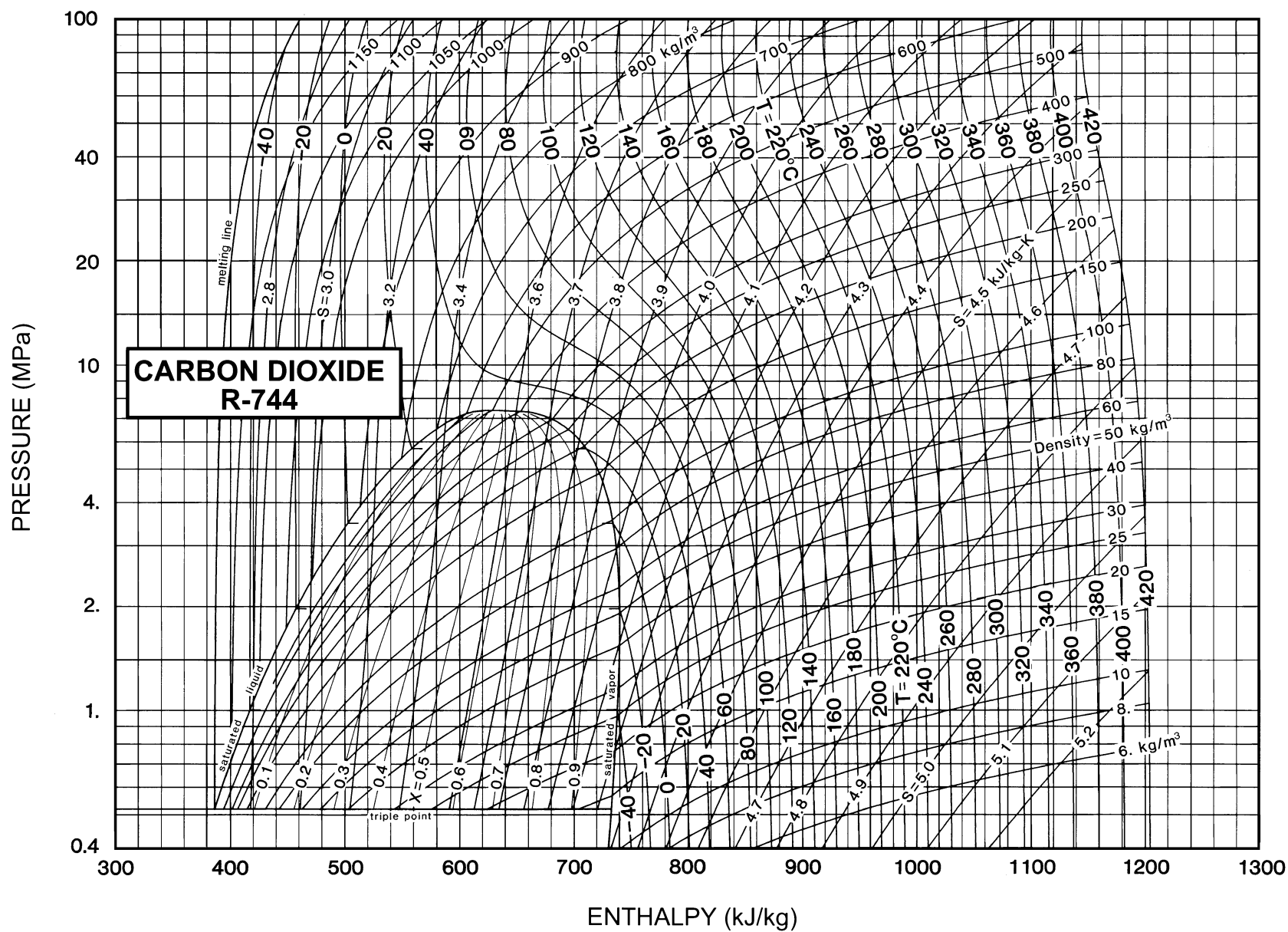
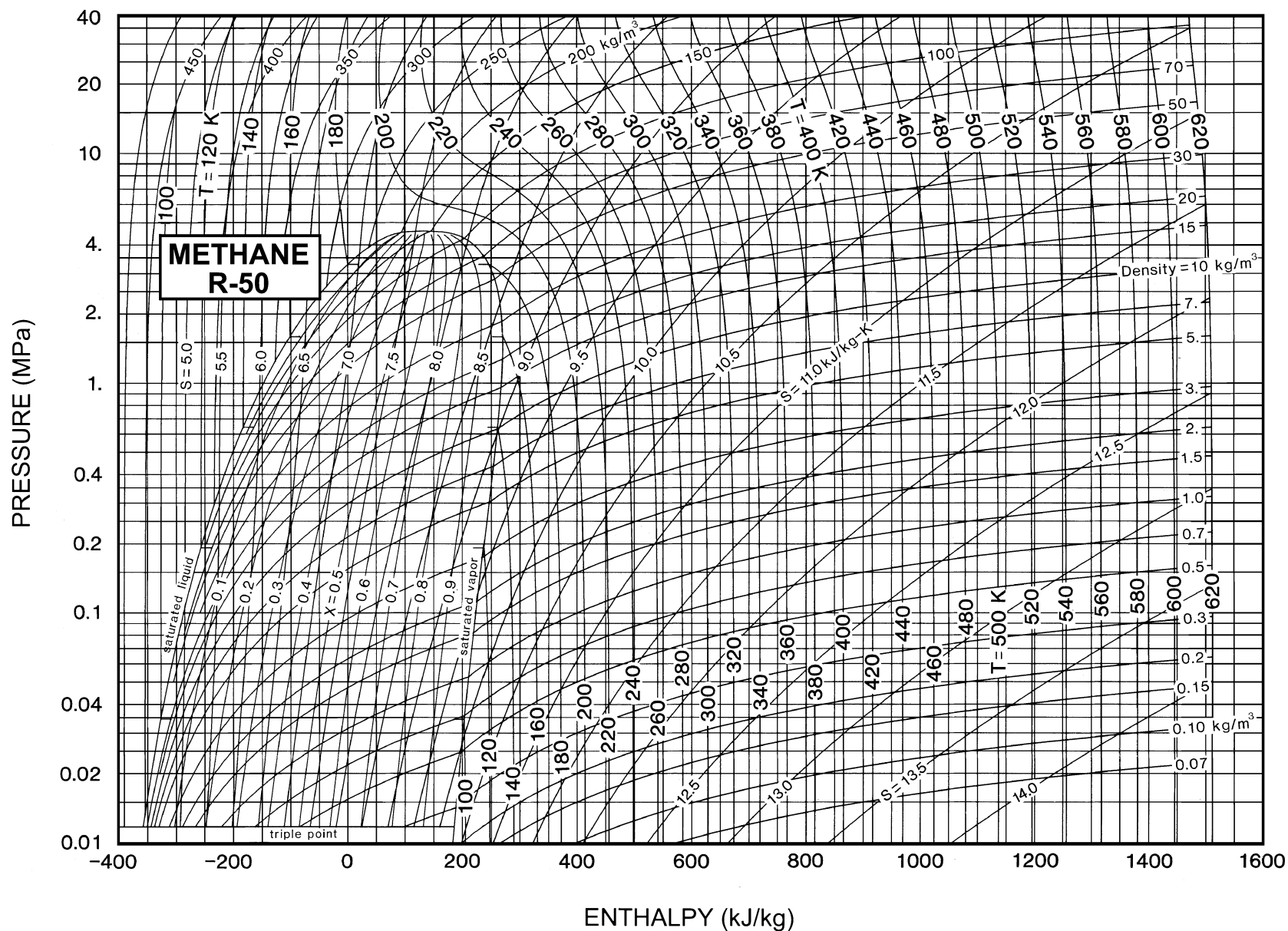


Fig. 14 Pressure-Enthalpy Diagram for Refrigerant 744 (Carbon Dioxide)

Note: The reference states for enthalpy and entropy differ from those in the table.

Refrigerant 744 (Carbon Dioxide) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat <i>c_p</i> , kJ/(kg·K)			<i>c_p</i> / <i>c_v</i>	Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-56.56a	0.51796	1178.5	0.07267	80.04	430.42	0.5213	2.1390	1.953	0.909	1.444	976.	222.8	256.7	10.95	180.6	11.01	17.16	-56.56	
-50.00	0.68234	1154.6	0.05579	92.94	432.68	0.5794	2.1018	1.971	0.952	1.468	928.	223.4	229.3	11.31	172.1	11.58	15.53	-50.00	
-48.00	0.73949	1147.1	0.05162	96.90	433.29	0.5968	2.0909	1.978	0.967	1.477	914.	223.5	221.6	11.42	169.5	11.76	15.04	-48.00	
-46.00	0.80015	1139.6	0.04782	100.88	433.86	0.6142	2.0801	1.985	0.982	1.486	900.	223.6	214.3	11.53	166.9	11.95	14.56	-46.00	
-44.00	0.86445	1132.0	0.04435	104.87	434.39	0.6314	2.0694	1.993	0.998	1.496	885.	223.6	207.2	11.64	164.4	12.14	14.07	-44.00	
-42.00	0.93252	1124.2	0.04118	108.88	434.88	0.6486	2.0589	2.002	1.015	1.507	871.	223.6	200.3	11.75	161.8	12.34	13.60	-42.00	
-40.00	1.0045	1116.4	0.03828	112.90	435.32	0.6656	2.0485	2.012	1.033	1.518	856.	223.5	193.8	11.87	159.3	12.54	13.12	-40.00	
-38.00	1.0805	1108.5	0.03562	116.95	435.72	0.6826	2.0382	2.022	1.052	1.530	842.	223.4	187.4	11.98	156.8	12.75	12.65	-38.00	
-36.00	1.1607	1100.5	0.03318	121.01	436.07	0.6995	2.0281	2.033	1.072	1.544	827.	223.2	181.3	12.10	154.3	12.97	12.18	-36.00	
-34.00	1.2452	1092.4	0.03093	125.10	436.37	0.7163	2.0180	2.045	1.094	1.558	813.	223.1	175.4	12.22	151.8	13.20	11.72	-34.00	
-32.00	1.3342	1084.1	0.02886	129.20	436.62	0.7331	2.0079	2.059	1.116	1.573	798.	222.8	169.7	12.34	149.3	13.43	11.26	-32.00	
-30.00	1.4278	1075.7	0.02696	133.34	436.82	0.7498	1.9980	2.073	1.141	1.590	783.	222.5	164.2	12.46	146.9	13.68	10.80	-30.00	
-28.00	1.5261	1067.2	0.02519	137.50	436.96	0.7665	1.9880	2.089	1.166	1.608	768.	222.2	158.9	12.59	144.4	13.94	10.35	-28.00	
-26.00	1.6293	1058.6	0.02356	141.69	437.04	0.7831	1.9781	2.105	1.194	1.627	753.	221.8	153.8	12.72	141.9	14.20	9.90	-26.00	
-24.00	1.7375	1049.8	0.02205	145.91	437.06	0.7997	1.9683	2.124	1.223	1.648	738.	221.4	148.8	12.85	139.5	14.49	9.46	-24.00	
-22.00	1.8509	1040.8	0.02065	150.16	437.01	0.8163	1.9584	2.144	1.255	1.671	723.	220.9	144.0	12.98	137.1	14.78	9.02	-22.00	
-20.00	1.9696	1031.7	0.01934	154.45	436.89	0.8328	1.9485	2.165	1.289	1.696	708.	220.4	139.3	13.12	134.6	15.09	8.59	-20.00	
-19.00	2.0310	1027.0	0.01873	156.61	436.81	0.8411	1.9436	2.177	1.307	1.709	700.	220.1	137.1	13.18	133.4	15.25	8.37	-19.00	
-18.00	2.0938	1022.3	0.01813	158.77	436.70	0.8494	1.9386	2.189	1.326	1.723	692.	219.8	134.8	13.26	132.2	15.42	8.16	-18.00	
-17.00	2.1581	1017.6	0.01756	160.95	436.58	0.8576	1.9337	2.201	1.346	1.738	684.	219.5	132.6	13.33	131.0	15.59	7.95	-17.00	
-16.00	2.2237	1012.8	0.01700	163.14	436.44	0.8659	1.9287	2.215	1.366	1.753	676.	219.2	130.4	13.40	129.8	15.77	7.74	-16.00	
-15.00	2.2908	1008.0	0.01647	165.34	436.27	0.8742	1.9237	2.228	1.388	1.768	668.	218.8	128.3	13.47	128.6	15.95	7.53	-15.00	
-14.00	2.3593	1003.1	0.01595	167.55	436.09	0.8825	1.9187	2.243	1.410	1.785	660.	218.5	126.2	13.55	127.4	16.14	7.32	-14.00	
-13.00	2.4294	998.1	0.01545	169.78	435.89	0.8908	1.9137	2.258	1.433	1.802	651.	218.1	124.1	13.63	126.2	16.34	7.11	-13.00	
-12.00	2.5010	993.1	0.01497	172.01	435.66	0.8991	1.9086	2.273	1.457	1.821	643.	217.7	122.0	13.70	125.0	16.54	6.90	-12.00	
-11.00	2.5740	988.1	0.01450	174.26	435.41	0.9074	1.9036	2.290	1.483	1.840	635.	217.4	120.0	13.78	123.8	16.74	6.70	-11.00	
-10.00	2.6487	982.9	0.01405	176.52	435.14	0.9157	1.8985	2.307	1.509	1.860	626.	216.9	118.0	13.86	122.5	16.96	6.50	-10.00	
-9.00	2.7249	977.7	0.01361	178.80	434.84	0.9240	1.8934	2.325	1.537	1.881	617.	216.5	116.1	13.95	121.3	17.18	6.29	-9.00	
-8.00	2.8027	972.5	0.01319	181.09	434.51	0.9324	1.8882	2.345	1.566	1.904	609.	216.1	114.1	14.03	120.1	17.42	6.09	-8.00	
-7.00	2.8821	967.1	0.01278	183.39	434.17	0.9408	1.8830	2.365	1.597	1.927	600.	215.6	112.2	14.12	118.9	17.66	5.89	-7.00	
-6.00	2.9632	961.7	0.01238	185.71	433.79	0.9491	1.8778	2.386	1.629	1.952	591.	215.2	110.3	14.20	117.7	17.91	5.70	-6.00	
-5.00	3.0459	956.2	0.01200	188.05	433.38	0.9576	1.8725	2.408	1.663	1.979	582.	214.7	108.4	14.30	116.5	18.17	5.50	-5.00	
-4.00	3.1303	950.6	0.01162	190.40	432.95	0.9660	1.8672	2.432	1.699	2.007	573.	214.2	106.6	14.39	115.3	18.44	5.30	-4.00	
-3.00	3.2164	945.0	0.01126	192.77	432.48	0.9744	1.8618	2.457	1.737	2.037	564.	213.7	104.8	14.48	114.1	18.73	5.11	-3.00	
-2.00	3.3042	939.2	0.01091	195.16	431.99	0.9829	1.8563	2.484	1.777	2.068	555.	213.1	102.9	14.58	112.9	19.03	4.92	-2.00	
-1.00	3.3938	933.4	0.01057	197.57	431.46	0.9914	1.8509	2.512	1.819	2.102	546.	212.6	101.2	14.68	111.6	19.34	4.73	-1.00	
0.00	3.4851	927.4	0.01024	200.00	430.89	1.0000	1.8453	2.542	1.865	2.138	536.	212.0	99.4	14.79	110.4	19.67	4.54	0.00	
1.00	3.5783	921.4	0.00992	202.45	430.29	1.0086	1.8397	2.574	1.913	2.176	527.	211.5	97.6	14.89	109.2	20.02	4.35	1.00	
2.00	3.6733	915.2	0.00961	204.93	429.65	1.0172	1.8340	2.609	1.965	2.218	518.	210.9	95.9	15.00	108.0	20.38	4.17	2.00	
3.00	3.7701	909.0	0.00931	207.43	428.97	1.0259	1.8282	2.645	2.020	2.262	508.	210.3	94.2	15.12	106.8	20.76	3.99	3.00	
4.00	3.8688	902.6	0.00901	209.95	428.25	1.0346	1.8223	2.685	2.080	2.309	499.	209.6	92.5	15.24	105.5	21.17	3.80	4.00	
5.00	3.9695	896.0	0.00872	212.50	427.48	1.0434	1.8163	2.727	2.144	2.360	489.	209.0	90.8	15.36	104.3	21.60	3.62	5.00	
6.00	4.0720	889.4	0.00845	215.08	426.67	1.0523	1.8102	2.772	2.213	2.416	480.	208.3	89.1	15.49	103.1	22.06	3.45	6.00	
7.00	4.1765	882.6	0.00817	217.69	425.81	1.0612	1.8041	2.822	2.289	2.476	470.	207.6	87.5	15.62	101.8	22.54	3.27	7.00	
8.00	4.2831	875.6	0.00791	220.34	424.89	1.0702	1.7977	2.875	2.370	2.541	460.	206.9	85.8	15.76	100.6	23.06	3.10	8.00	
9.00	4.3916	868.4	0.00765	223.01	423.92	1.0792	1.7913	2.934	2.460	2.612	451.	206.2	84.2	15.91	99.4	23.61	2.93	9.00	
10.00	4.5022	861.1	0.00740	225.73	422.88	1.0884	1.7847	2.998	2.558	2.690	441.	205.4	82.6	16.06	98.1	24.21	2.76	10.00	
11.00	4.6149	853.6	0.00715	228.49	421.79	1.0976	1.7779	3.068	2.666	2.776	431.	204.6	80.9	16.22	96.9	24.84	2.59	11.00	
12.00	4.7297	845.9	0.00691	231.29	420.62	1.1070	1.7710	3.145	2.786	2.871	421.	203.8	79.3	16.39	95.6	25.53	2.42	12.00	
13.00	4.8466	837.9	0.00668	234.13	419.37	1.1165	1.7638	3.232	2.919	2.977									



Refrigerant 50 (Methane) Properties of Saturated Liquid and Saturated Vapor

Temp., °C	Pres- sure, MPa	Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-182.46a	0.01170	451.5	3.9881	-71.82	472.44	-0.7099	5.2911	3.368	2.110	1.341	1539.	249.1	293.0	3.50	273.9	10.20	18.76	-182.46
-180.00	0.01590	448.2	3.0071	-63.53	477.22	-0.6199	5.1853	3.377	2.118	1.343	1516.	252.2	189.5	3.73	208.3	9.15	18.09	-180.00
-175.00	0.02823	441.4	1.7755	-46.58	486.76	-0.4429	4.9910	3.399	2.137	1.348	1470.	258.0	163.9	3.93	202.1	9.78	16.74	-175.00
-170.00	0.04723	434.5	1.1081	-29.49	495.99	-0.2735	4.8208	3.426	2.162	1.355	1422.	263.4	143.4	4.12	195.5	10.42	15.43	-170.00
-165.00	0.07509	427.4	0.72466	-12.24	504.85	-0.1108	4.6704	3.457	2.192	1.365	1373.	268.3	126.8	4.32	188.7	11.09	14.17	-165.00
-161.48b	0.10133	422.4	0.55054	0.00	510.83	0.0000	4.5746	3.481	2.218	1.373	1338.	271.5	116.8	4.46	183.9	11.58	13.30	-161.48
-160.00	0.11429	420.2	0.49291	5.19	513.28	0.0459	4.5363	3.492	2.229	1.377	1323.	272.7	112.9	4.52	181.8	11.79	12.94	-160.00
-155.00	0.16757	412.7	0.34665	22.82	521.22	0.1973	4.4156	3.533	2.274	1.392	1273.	276.5	101.3	4.73	174.8	12.53	11.75	-155.00
-150.00	0.23784	405.0	0.25077	40.69	528.60	0.3440	4.3058	3.580	2.328	1.412	1221.	279.7	91.4	4.95	167.7	13.30	10.60	-150.00
-145.00	0.32817	397.1	0.18583	58.84	535.34	0.4866	4.2049	3.635	2.393	1.436	1168.	282.3	82.8	5.17	160.5	14.13	9.49	-145.00
-140.00	0.44177	388.8	0.14054	77.30	541.38	0.6257	4.1111	3.701	2.472	1.466	1114.	284.3	75.2	5.40	153.4	15.01	8.43	-140.00
-135.00	0.58192	380.2	0.10813	96.13	546.63	0.7618	4.0228	3.780	2.569	1.504	1059.	285.6	68.6	5.63	146.3	15.96	7.42	-135.00
-130.00	0.75201	371.1	0.08440	115.39	550.97	0.8956	3.9384	3.876	2.690	1.552	1002.	286.2	62.7	5.88	139.2	16.99	6.44	-130.00
-125.00	0.95550	361.6	0.06666	135.17	554.29	1.0276	3.8566	3.996	2.842	1.613	943.	286.2	57.3	6.15	132.1	18.13	5.52	-125.00
-120.00	1.1959	351.4	0.05315	155.58	556.43	1.1585	3.7759	4.148	3.038	1.694	882.	285.4	52.4	6.43	125.0	19.39	4.64	-120.00
-118.00	1.3033	347.2	0.04865	163.94	556.91	1.2108	3.7437	4.220	3.133	1.733	858.	284.8	50.5	6.55	122.1	19.95	4.31	-118.00
-116.00	1.4174	342.8	0.04457	172.44	557.16	1.2631	3.7112	4.302	3.240	1.777	832.	284.2	48.7	6.68	119.3	20.53	3.98	-116.00
-114.00	1.5384	338.3	0.04087	181.08	557.15	1.3155	3.6785	4.393	3.362	1.827	807.	283.4	47.0	6.81	116.4	21.15	3.66	-114.00
-112.00	1.6668	333.6	0.03750	189.88	556.87	1.3681	3.6454	4.497	3.501	1.885	780.	282.5	45.3	6.95	113.5	21.81	3.35	-112.00
-110.00	1.8026	328.8	0.03442	198.85	556.28	1.4209	3.6117	4.615	3.662	1.951	754.	281.4	43.6	7.09	110.7	22.52	3.04	-110.00
-108.00	1.9462	323.7	0.03160	208.03	555.37	1.4741	3.5773	4.751	3.848	2.028	726.	280.2	42.0	7.24	107.8	23.28	2.75	-108.00
-106.00	2.0978	318.4	0.02900	217.42	554.09	1.5278	3.5419	4.910	4.068	2.119	698.	278.9	40.4	7.40	104.9	24.12	2.46	-106.00
-104.00	2.2578	312.9	0.02662	227.06	552.39	1.5821	3.5054	5.097	4.331	2.227	670.	277.4	38.8	7.57	102.0	25.05	2.19	-104.00
-102.00	2.4264	307.1	0.02441	236.99	550.24	1.6372	3.4675	5.322	4.650	2.358	641.	275.7	37.2	7.76	99.0	26.09	1.92	-102.00
-100.00	2.6040	301.0	0.02236	247.25	547.56	1.6934	3.4278	5.596	5.044	2.520	610.	273.9	35.6	7.96	96.1	27.28	1.66	-100.00
-95.00	3.0895	283.6	0.01781	274.80	537.86	1.8408	3.3174	6.654	6.608	3.153	529.	268.4	31.7	8.55	88.6	31.27	1.07	-95.00
-90.00	3.6399	261.7	0.01384	306.71	521.52	2.0062	3.1791	9.10	10.37	4.64	437.	261.3	27.5	9.39	81.2	38.68	0.55	-90.00
-85.00	4.2648	227.5	0.00993	349.75	488.81	2.2241	2.9632	21.88	30.57	12.16	320.	250.2	22.3	10.95	77.5	62.99	0.13	-85.00
-82.59c	4.5992	162.7	0.00615	415.59	415.59	2.5624	2.5624	∞	∞	∞	0.	0.0	—	—	∞	∞	0.00	-82.59

*Temperatures are on the ITS-90 scale

a = triple point

b = normal boiling point

c = critical point

Refrigerant 50 (Methane) Properties of Gas at 0.101 325 MPa (one standard atmosphere)

Temp., °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	C_p , kJ/ (kg·K)	c_p/c_v	Vel. Sound, m/s	Visc., μPa·s	Therm Cond., mW/(m·K)	Temp., °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	C_p , kJ/ (kg·K)	c_p/c_v	Vel. Sound, m/s	Visc., μPa·s	Therm Cond., mW/(m·K)
-161.5a	1.8164	510.83	4.5746	2.218	1.373	271.5	4.46	11.58	50.0	0.6058	966.50	6.8565	2.293	1.295	465.1	11.98	37.86
-160.0	1.7899	514.11	4.6037	2.208	1.371	273.5	4.52	11.74	60.0	0.5875	989.57	6.9269	2.321	1.290	471.4	12.29	39.35
-155.0	1.7064	525.08	4.6986	2.183	1.366	280.3	4.71	12.30	70.0	0.5703	1012.92	6.9959	2.350	1.285	477.6	12.60	40.87
-150.0	1.6310	535.95	4.7887	2.165	1.362	286.9	4.90	12.87	80.0	0.5541	1036.57	7.0638	2.380	1.281	483.7	12.90	42.42
-145.0	1.5626	546.74	4.8746	2.151	1.359	293.2	5.10	13.45	90.0	0.5388	1060.52	7.1307	2.411	1.276	489.6	13.20	44.01
-140.0	1.5000	557.47	4.9567	2.141	1.356	299.4	5.29	14.03	100.0	0.5243	1084.79	7.1967	2.443	1.271	495.5	13.49	45.63
-135.0	1.4425	568.15	5.0355	2.132	1.354	305.4	5.48	14.62	110.0	0.5106	1109.39	7.2617	2.476	1.266	501.2	13.79	47.28
-130.0	1.3894	578.79	5.1112	2.125	1.351	311.2	5.67	15.21	120.0	0.4975	1134.32	7.3259	2.510	1.262	506.8	14.08	48.96
-120.0	1.2947	599.99	5.2543	2.116	1.348	322.5	6.06	16.40	130.0	0.4852	1159.60	7.3894	2.545	1.257	512.3	14.36	50.67
-110.0	1.2124	621.11	5.3879	2.109	1.345	333.3	6.44	17.58	140.0	0.4734	1185.22	7.4522	2.580	1.253	517.7	14.64	52.41
-100.0	1.1403	642.18	5.5133	2.106	1.343	343.8	6.81	18.77	150.0	0.4622	1211.21	7.5143	2.616	1.248	523.1	14.92	54.18
-90.0	1.0764	663.23	5.6315	2.104	1.341	353.8	7.19	19.96	160.0	0.4515	1237.55	7.5759	2.652	1.244	528.3	15.20	55.97
-80.0	1.0194	684.27	5.7433	2.105	1.339	363.5	7.56	21.15	170.0	0.4413	1264.25	7.6368	2.689	1.240	533.5	15.47	57.79
-70.0	0.9683	705.33	5.8496	2.107	1.337	372.9	7.92	22.31	180.0	0.4315	1291.32	7.6972	2.726	1.236	538.6	15.74	59.63
-60.0	0.9221	726.42	5.9509	2.111	1.335	382.0	8.29	23.49	190.0	0.4222	1318.76	7.7571	2.763	1.232	543.7	16.01	61.50
-50.0	0.8802	747.57	6.0479	2.118	1.332	390.7	8.64	24.68	200.0	0.4132	1346.57	7.8165	2.800	1.228	548.7	16.28	63.39
-40.0	0.8419	768.78	6.1409	2.126	1.330	399.2	9.00	25.89	210.0	0.4047	1374.76	7.8755	2.837	1.224	553.6	16.54	65.30
-30.0	0.8069	790.10	6.2304	2.137	1.327	407.5	9.35	27.12	220.0	0.3965	1403.32	7.9340	2.875	1.221	558.5	16.80	67.23
-20.0	0.7747	811.53	6.3168	2.149	1.324	415.4	9.69	28.36	230.0	0.3886	1432.26	7.9921	2.912	1.217	563.4	17.06	69.18
-10.0	0.7450	833.09	6.4003	2.164	1.320	423.2	10.03	29.63	240.0	0.3810	1461.57	8.0498	2.950	1.214	568.2	17.31	71.15
0.0	0.7175	854.82	6.4814	2.181	1.316	430.7	10.37	30.93	250.0	0.3737	1491.26	8.1071	2.988	1.211	572.9	17.56	73.14
10.0	0.6919	876.72	6.5601	2.200	1.312	437.9	10.70	32.25	260.0	0.3667	1521.32	8.1640	3.025	1.207	577.6	17.81	75.14
20.0	0.6682	898.82	6.6368	2.221	1.308	445.0	11.02	33.61	270.0	0.3599	1551.76	8.2205	3.062	1.204	582.3	18.06	77.16
30.0	0.6460	921.14	6.7117	2.243	1.304	451.9	11.35	34.99	280.0	0.3534	1582.57	8.2768	3.100	1.201	586.9	18.31	79.20
40.0	0.6252	943.69	6.7849	2.268	1.299	458.6	11.66	36.41	290.0	0.3471	1613.75	8.3326	3.137	1.198	591.5	18.55	81.25
									300.0	0.3411	1645.31	8.3882	3.174	1.196	596.0	18.79	83.31

a = saturated vapor at the normal boiling point

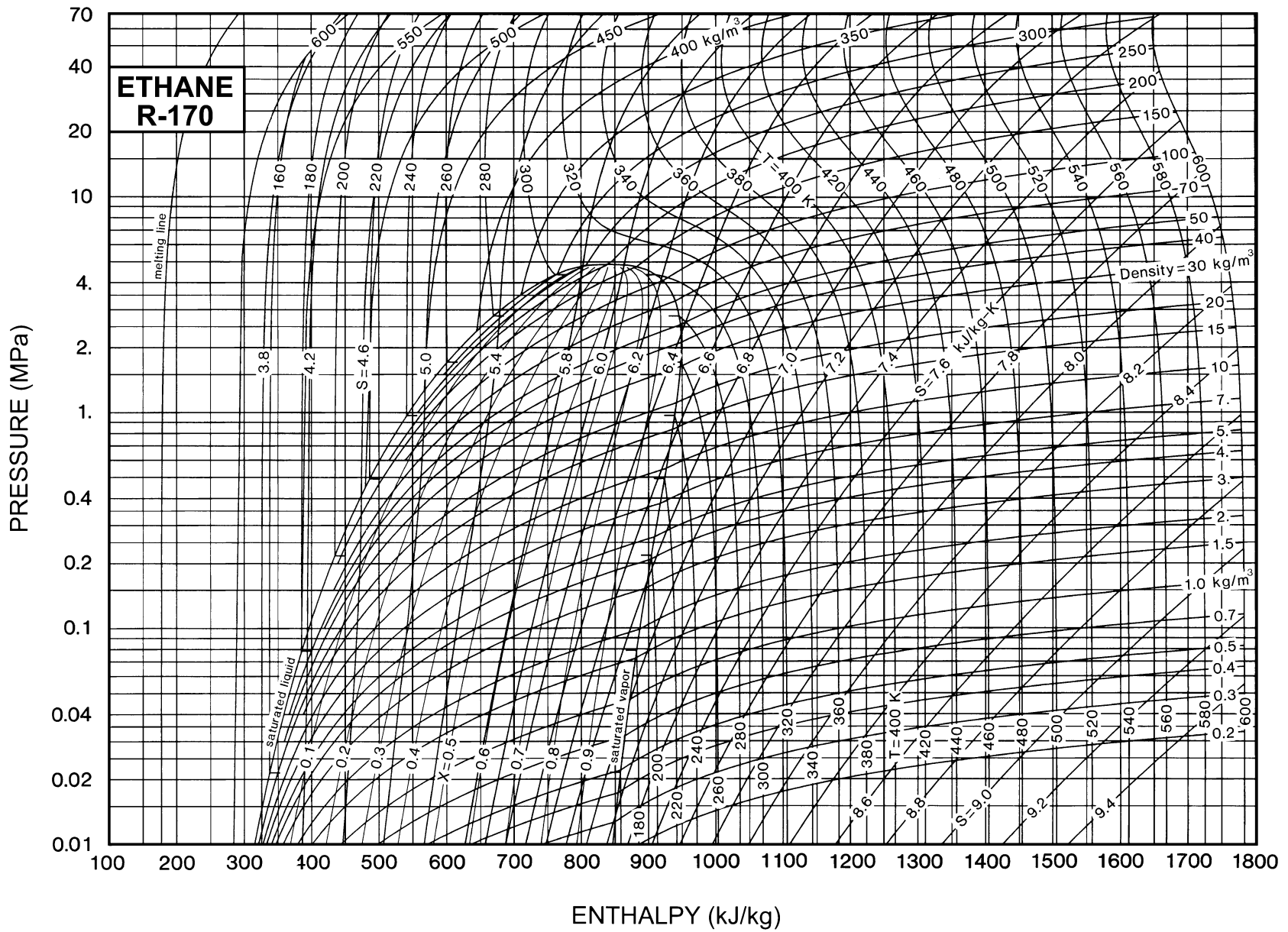


Fig. 16 Pressure-Enthalpy Diagram for Refrigerant 170 (Ethane)
Note: The reference states for enthalpy and entropy differ from those in the table.

Refrigerant 170 (Ethane) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, kg/m ³		Volume, m ³ /kg		Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c _p , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-175.00	0.00001	643.2	3650.1			-203.34	384.40	-1.4833	4.5049	2.319	1.182	1.305	1950.	188.2	938.4	3.26	249.7	3.35	30.35	-175.00
-170.00	0.00002	637.8	1349.5			-191.67	390.36	-1.3673	4.2752	2.346	1.188	1.302	1917.	192.7	788.2	3.41	245.5	3.64	29.51	-170.00
-165.00	0.00005	632.4	553.41			-179.91	396.38	-1.2560	4.0725	2.355	1.191	1.300	1882.	197.2	672.9	3.55	241.2	3.93	28.67	-165.00
-160.00	0.00013	626.9	248.15			-168.13	402.45	-1.1496	3.8931	2.354	1.192	1.298	1846.	201.5	582.8	3.70	236.7	4.23	27.83	-160.00
-155.00	0.00027	621.4	120.22			-156.38	408.60	-1.0479	3.7339	2.348	1.189	1.296	1809.	205.8	511.0	3.84	232.0	4.54	26.99	-155.00
-150.00	0.00055	615.8	62.310			-144.66	414.80	-0.9508	3.5921	2.341	1.184	1.294	1772.	210.0	453.0	3.99	227.3	4.85	26.15	-150.00
-145.00	0.00103	610.2	34.255			-132.97	421.05	-0.8577	3.4654	2.335	1.177	1.293	1736.	214.2	405.3	4.14	222.5	5.17	25.31	-145.00
-140.00	0.00186	604.6	19.833			-121.30	427.33	-0.7685	3.3520	2.330	1.169	1.293	1699.	218.2	365.6	4.29	217.6	5.50	24.48	-140.00
-135.00	0.00318	599.0	12.018			-109.66	433.63	-0.6826	3.2500	2.328	1.163	1.292	1661.	222.1	332.0	4.44	212.7	5.83	23.64	-135.00
-130.00	0.00521	593.3	7.5823			-98.01	439.93	-0.5998	3.1580	2.329	1.161	1.291	1624.	225.8	303.4	4.59	207.8	6.18	22.81	-130.00
-125.00	0.00823	587.6	4.9578			-86.35	446.20	-0.5198	3.0749	2.332	1.162	1.291	1587.	229.3	278.7	4.74	202.8	6.53	21.98	-125.00
-120.00	0.01259	581.8	3.3464			-74.67	452.42	-0.4423	2.9994	2.338	1.170	1.290	1550.	232.7	257.1	4.90	197.9	6.89	21.15	-120.00
-115.00	0.01867	576.0	2.3237			-62.96	458.58	-0.3671	2.9306	2.346	1.183	1.290	1512.	235.8	238.2	5.05	192.9	7.27	20.33	-115.00
-110.00	0.02696	570.1	1.6549			-51.19	464.66	-0.2940	2.8678	2.357	1.201	1.290	1475.	238.7	221.4	5.21	188.0	7.66	19.51	-110.00
-105.00	0.03799	564.1	1.2057			-39.37	470.64	-0.2227	2.8104	2.369	1.225	1.290	1437.	241.4	206.4	5.36	183.0	8.06	18.69	-105.00
-100.00	0.05236	558.1	0.89645			-27.47	476.52	-0.1531	2.7576	2.384	1.254	1.291	1400.	243.8	192.9	5.52	178.2	8.47	17.88	-100.00
-95.00	0.07075	552.0	0.67885			-15.48	482.28	-0.0851	2.7090	2.401	1.288	1.293	1362.	246.0	180.6	5.68	173.3	8.90	17.07	-95.00
-90.00	0.09388	545.7	0.52261			-3.41	487.91	-0.0185	2.6641	2.421	1.326	1.295	1324.	248.0	169.5	5.84	168.5	9.35	16.26	-90.00
-88.60b	0.10133	544.0	0.48698			0.00	489.47	0.0000	2.6522	2.426	1.337	1.296	1313.	248.6	166.6	5.88	167.1	9.48	16.04	-88.60
-85.00	0.12253	539.4	0.40836			8.78	493.40	0.0469	2.6226	2.442	1.368	1.298	1286.	249.8	159.3	6.00	163.7	9.81	15.46	-85.00
-80.00	0.15753	533.0	0.32340			21.08	498.75	0.1111	2.5841	2.466	1.412	1.303	1247.	251.3	149.9	6.16	159.0	10.30	14.67	-80.00
-78.00	0.17350	530.4	0.29561			26.04	500.85	0.1365	2.5695	2.476	1.431	1.305	1232.	251.8	146.4	6.23	157.1	10.50	14.35	-78.00
-76.00	0.19068	527.7	0.27071			31.02	502.92	0.1617	2.5553	2.486	1.451	1.308	1217.	252.3	143.0	6.30	155.2	10.70	14.04	-76.00
-74.00	0.20914	525.1	0.24835			36.02	504.96	0.1868	2.5415	2.497	1.471	1.310	1201.	252.8	139.6	6.36	153.3	10.91	13.72	-74.00
-72.00	0.22892	522.4	0.22823			41.04	506.97	0.2117	2.5280	2.508	1.491	1.313	1186.	253.2	136.4	6.43	151.5	11.12	13.41	-72.00
-70.00	0.25010	519.7	0.21009			46.09	508.96	0.2364	2.5149	2.520	1.512	1.316	1171.	253.6	133.2	6.50	149.7	11.33	13.10	-70.00
-68.00	0.27272	517.0	0.19369			51.16	510.92	0.2611	2.5021	2.532	1.533	1.319	1155.	253.9	130.2	6.56	147.8	11.55	12.78	-68.00
-66.00	0.29687	514.3	0.17885			56.26	512.85	0.2856	2.4897	2.545	1.555	1.323	1140.	254.2	127.2	6.63	146.0	11.77	12.47	-66.00
-64.00	0.32258	511.5	0.16538			61.39	514.74	0.3099	2.4776	2.558	1.577	1.327	1124.	254.4	124.3	6.70	144.2	12.00	12.16	-64.00
-62.00	0.34994	508.7	0.15314			66.54	516.61	0.3342	2.4657	2.571	1.600	1.331	1108.	254.6	121.5	6.77	142.4	12.23	11.86	-62.00
-60.00	0.37900	505.9	0.14200			71.72	518.44	0.3583	2.4542	2.585	1.624	1.335	1093.	254.8	118.8	6.84	140.6	12.46	11.55	-60.00
-58.00	0.40983	503.1	0.13183			76.93	520.24	0.3824	2.4429	2.600	1.648	1.340	1077.	254.9	116.1	6.91	138.8	12.70	11.24	-58.00
-56.00	0.44250	500.2	0.12255			82.17	522.00	0.4063	2.4318	2.615	1.673	1.345	1061.	254.9	113.5	6.99	137.0	12.95	10.94	-56.00
-54.00	0.47707	497.3	0.11405			87.44	523.73	0.4302	2.4210	2.631	1.698	1.350	1046.	254.9	111.0	7.06	135.2	13.20	10.64	-54.00
-52.00	0.51360	494.4	0.10626			92.74	525.42	0.4539	2.4104	2.647	1.724	1.356	1030.	254.9	108.5	7.13	133.5	13.45	10.33	-52.00
-50.00	0.55216	491.5	0.09912			98.07	527.07	0.4776	2.4000	2.664	1.751	1.362	1014.	254.8	106.1	7.21	131.7	13.71	10.03	-50.00
-48.00	0.59283	488.5	0.09254			103.44	528.68	0.5012	2.3899	2.682	1.778	1.369	998.	254.7	103.7	7.28	130.0	13.98	9.73	-48.00
-46.00	0.63567	485.4	0.08649			108.85	530.25	0.5247	2.3799	2.700	1.807	1.376	982.	254.5	101.4	7.36	128.2	14.25	9.44	-46.00
-44.00	0.68074	482.4	0.08091			114.29	531.78	0.5481	2.3700	2.719	1.836	1.383	966.	254.3	99.1	7.44	126.5	14.53	9.14	-44.00
-42.00	0.72813	479.3	0.07576			119.78	533.26	0.5715	2.3603	2.739	1.867	1.391	950.	254.0	96.9	7.51	124.8	14.82	8.85	-42.00
-40.00	0.77789	476.1	0.07100			125.30	534.70	0.5949	2.3508	2.760	1.898	1.400	934.	253.6	94.7	7.60	123.1	15.11	8.55	-40.00
-38.00	0.83010	473.0	0.06658			130.86	536.08	0.6182	2.3414	2.782	1.931	1.409	918.	253.2	92.6	7.68	121.4	15.41	8.26	-38.00
-36.00	0.88483	469.7	0.06250			136.47	537.42	0.6414	2.3321	2.805	1.964	1.419	902.	252.8	90.5	7.76	119.7	15.72	7.97	-36.00
-34.00	0.94215	466.5	0.05870			142.12	538.70	0.6646	2.3229	2.829	2.000	1.430	885.	252.3	88.5	7.85	118.1	16.04	7.68	-34.00
-32.00	1.0021	463.2	0.05517			147.82	539.93	0.6878	2.3138	2.855	2.036	1.441	869.	251.7	86.5	7.93	116.4	16.37	7.40	-32.00
-30.00	1.0649	459.8	0.05189			153.56	541.10	0.7110	2.3048	2.881	2.075	1.453	852.	251.1	84.5	8.02	114.8	16.71	7.11	-30.00
-28.00	1.1304	456.4	0.04883			159.36	542.20	0.7341	2.2958	2.909	2.115	1.467	836.	250.4	82.6	8.11	113.1	17.05	6.83	-28.00
-26.00	1.1988	452.9	0.0459																	

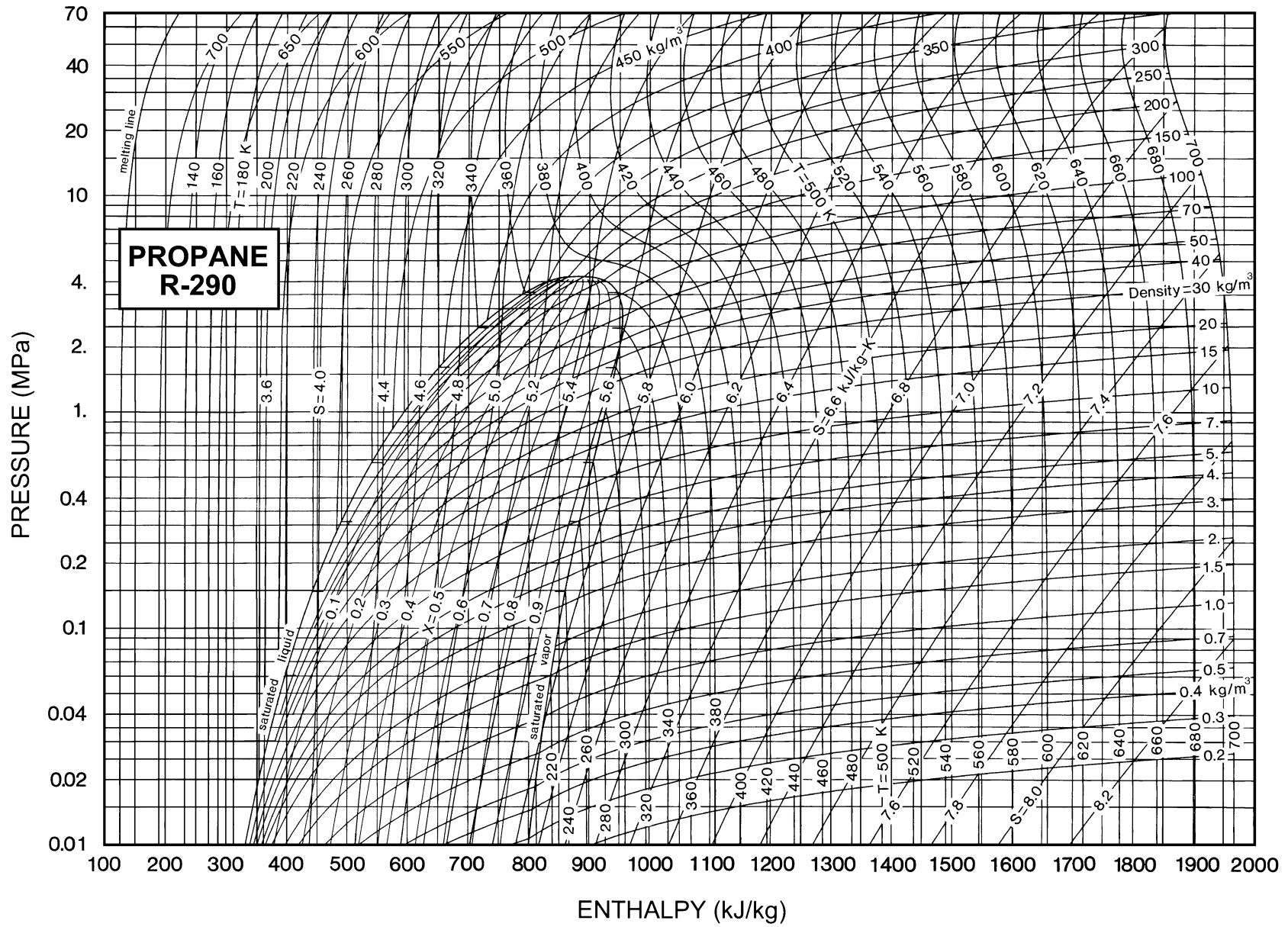
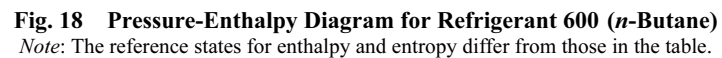


Fig. 17 Pressure-Enthalpy Diagram for Refrigerant 290 (Propane)

Note: The reference states for enthalpy and entropy differ from those in the table.

Refrigerant 290 (Propane) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, kg/m ³	Volume, m ³ /kg	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat <i>c_p</i> , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-150.00	0.00001	694.9	4340.8	-123.36	402.32	-0.6872	3.5819	1.959	1.020	1.227	1869.	168.8	1352.	3.55	193.1	3.68	31.84	-150.00
-140.00	0.00003	684.8	869.55	-103.72	412.68	-0.5338	3.3449	1.971	1.052	1.219	1799.	174.9	992.0	3.80	188.0	4.28	30.29	-140.00
-130.00	0.00012	674.8	224.81	-83.94	423.33	-0.3906	3.1534	1.985	1.083	1.211	1731.	180.8	766.4	4.05	182.4	4.90	28.76	-130.00
-120.00	0.00041	664.6	71.174	-64.01	434.26	-0.2560	2.9978	2.001	1.115	1.204	1664.	186.4	614.9	4.31	176.7	5.55	27.24	-120.00
-110.00	0.00116	654.4	26.518	-43.90	445.45	-0.1288	2.8708	2.021	1.148	1.198	1598.	191.7	507.3	4.56	170.7	6.23	25.73	-110.00
-100.00	0.00289	644.1	11.281	-23.58	456.87	-0.0080	2.7670	2.043	1.183	1.193	1532.	196.8	427.5	4.82	164.6	6.94	24.23	-100.00
-90.00	0.00642	633.6	5.3500	-3.02	468.49	0.1075	2.6820	2.069	1.221	1.189	1467.	201.5	365.9	5.08	158.5	7.67	22.74	-90.00
-80.00	0.01300	623.1	2.7761	17.82	480.25	0.2182	2.6125	2.098	1.263	1.186	1402.	205.9	317.0	5.34	152.3	8.43	21.27	-80.00
-70.00	0.02433	612.4	1.5522	38.98	492.14	0.3249	2.5557	2.132	1.308	1.183	1338.	209.9	277.3	5.60	146.1	9.22	19.81	-70.00
-60.00	0.04258	601.4	0.92393	60.50	504.09	0.4282	2.5094	2.169	1.358	1.182	1273.	213.4	244.4	5.85	140.0	10.04	18.36	-60.00
-50.00	0.07043	590.3	0.57957	82.43	516.07	0.5285	2.4718	2.211	1.412	1.183	1209.	216.3	216.8	6.11	134.1	10.88	16.94	-50.00
-40.00	0.11095	578.8	0.37998	104.81	528.03	0.6263	2.4416	2.258	1.472	1.185	1145.	218.7	193.2	6.36	128.2	11.76	15.53	-40.00
-42.08b	0.10129	581.2	0.41358	100.11	525.54	0.6061	2.4473	2.248	1.459	1.185	1158.	218.3	197.8	6.31	129.4	11.57	15.82	-42.08
-38.00	0.12088	576.5	0.35085	109.35	530.41	0.6456	2.4363	2.268	1.484	1.186	1132.	219.1	188.9	6.41	127.0	11.94	15.25	-38.00
-36.00	0.13148	574.1	0.32442	113.90	532.79	0.6648	2.4312	2.278	1.497	1.187	1119.	219.5	184.7	6.47	125.9	12.12	14.98	-36.00
-34.00	0.14279	571.8	0.30039	118.48	535.17	0.6839	2.4264	2.288	1.510	1.188	1106.	219.8	180.7	6.52	124.7	12.30	14.70	-34.00
-32.00	0.15483	569.4	0.27852	123.08	537.54	0.7030	2.4218	2.299	1.523	1.189	1093.	220.1	176.7	6.57	123.6	12.48	14.42	-32.00
-30.00	0.16764	567.0	0.25858	127.70	539.91	0.7220	2.4173	2.310	1.536	1.190	1080.	220.4	172.9	6.62	122.4	12.67	14.15	-30.00
-28.00	0.18125	564.6	0.24036	132.34	542.28	0.7409	2.4131	2.321	1.550	1.191	1067.	220.7	169.2	6.67	121.3	12.86	13.87	-28.00
-26.00	0.19569	562.2	0.22370	137.01	544.63	0.7598	2.4091	2.332	1.564	1.192	1055.	220.9	165.5	6.73	120.2	13.05	13.60	-26.00
-24.00	0.21100	559.8	0.20844	141.70	546.99	0.7785	2.4053	2.344	1.578	1.193	1042.	221.1	162.0	6.78	119.1	13.24	13.32	-24.00
-22.00	0.22720	557.3	0.19444	146.41	549.33	0.7973	2.4016	2.356	1.593	1.195	1029.	221.3	158.6	6.83	117.9	13.44	13.05	-22.00
-20.00	0.24433	554.9	0.18158	151.15	551.67	0.8159	2.3981	2.368	1.607	1.196	1016.	221.4	155.2	6.89	116.8	13.63	12.78	-20.00
-18.00	0.26242	552.4	0.16975	155.91	554.00	0.8346	2.3948	2.380	1.622	1.198	1003.	221.6	152.0	6.94	115.7	13.83	12.51	-18.00
-16.00	0.28151	549.9	0.15885	160.70	556.32	0.8531	2.3916	2.393	1.637	1.199	990.	221.6	148.8	6.99	114.6	14.03	12.24	-16.00
-14.00	0.30163	547.3	0.14880	165.51	558.63	0.8716	2.3886	2.406	1.653	1.201	977.	221.7	145.7	7.05	113.6	14.23	11.97	-14.00
-12.00	0.32281	544.8	0.13952	170.36	560.94	0.8901	2.3857	2.420	1.669	1.203	964.	221.7	142.7	7.10	112.5	14.44	11.71	-12.00
-10.00	0.34510	542.2	0.13093	175.23	563.23	0.9085	2.3830	2.433	1.685	1.206	951.	221.7	139.7	7.16	111.4	14.65	11.44	-10.00
-8.00	0.36852	539.6	0.12299	180.12	565.51	0.9269	2.3804	2.447	1.702	1.208	938.	221.6	136.8	7.22	110.3	14.86	11.18	-8.00
-6.00	0.39312	537.0	0.11562	185.05	567.78	0.9452	2.3779	2.461	1.718	1.210	925.	221.5	134.0	7.27	109.3	15.08	10.91	-6.00
-4.00	0.41892	534.3	0.10879	190.00	570.04	0.9635	2.3755	2.476	1.736	1.213	912.	221.4	131.3	7.33	108.2	15.30	10.65	-4.00
-2.00	0.44597	531.7	0.10244	194.98	572.29	0.9818	2.3733	2.491	1.753	1.216	899.	221.2	128.6	7.39	107.2	15.52	10.39	-2.00
0.00	0.47430	529.0	0.09653	200.00	574.52	1.0000	2.3711	2.507	1.771	1.219	886.	221.0	125.9	7.45	106.1	15.74	10.13	0.00
2.00	0.50394	526.2	0.09103	205.05	576.74	1.0182	2.3691	2.523	1.790	1.222	873.	220.8	123.4	7.51	105.1	15.97	9.87	2.00
4.00	0.53495	523.5	0.08591	210.12	578.94	1.0364	2.3671	2.539	1.809	1.225	859.	220.5	120.8	7.57	104.1	16.21	9.61	4.00
6.00	0.56734	520.7	0.08113	215.23	581.13	1.0545	2.3653	2.556	1.828	1.229	846.	220.2	118.4	7.63	103.1	16.44	9.35	6.00
8.00	0.60117	517.9	0.07666	220.38	583.29	1.0727	2.3635	2.573	1.848	1.232	833.	219.8	116.0	7.69	102.1	16.69	9.10	8.00
10.00	0.63646	515.0	0.07249	225.56	585.44	1.0908	2.3618	2.591	1.869	1.236	820.	219.4	113.6	7.75	101.0	16.93	8.84	10.00
12.00	0.67327	512.1	0.06858	230.77	587.57	1.1089	2.3601	2.609	1.890	1.241	807.	219.0	111.3	7.82	100.1	17.18	8.59	12.00
14.00	0.71162	509.2	0.06492	236.02	589.68	1.1269	2.3586	2.628	1.912	1.245	794.	218.5	109.0	7.88	99.1	17.44	8.34	14.00
16.00	0.75156	506.3	0.06149	241.31	591.77	1.1450	2.3570	2.647	1.934	1.250	780.	218.0	106.8	7.95	98.1	17.70	8.09	16.00
18.00	0.79312	503.3	0.05827	246.63	593.83	1.1631	2.3556	2.667	1.957	1.255	767.	217.4	104.6	8.02	97.1	17.97	7.84	18.00
20.00	0.83635	500.2	0.05524	251.99	595.87	1.1811	2.3542	2.688	1.981	1.261	754.	216.8	102.4	8.09	96.1	18.25	7.59	20.00
22.00	0.88128	497.2	0.05240	257.40	597.88	1.1992	2.3528	2.709	2.006	1.267	741.	216.1	100.3	8.16	95.2	18.53	7.35	22.00
24.00	0.92796	494.0	0.04972	262.84	599.87	1.2173	2.3515	2.731	2.031	1.273	727.	215.4	98.2	8.23	94.2	18.82	7.10	24.00
26.00	0.97643	490.9	0.04720	268.33	601.82	1.2353	2.3501	2.754	2.058	1.280	714.	214.6	96.2	8.31	93.3	19.11	6.86	26.00
28.00	1.0267	487.7	0.04483	273.86	603.75	1.2534	2.3488	2.778	2.085	1.287	700.	213.8	94.2	8.38	92.3	19.42	6.62	28.00
30.00	1.0789	484.4	0.04259	279.43	605.64	1.2715	2.3475	2.803	2.114	1.295	687.	213.0	92.2	8.46	91.4	19.73	6.38	30.00
32.00	1.1330	481.1	0.04047	285.05	607.49	1.2896	2.3463	2.829	2.144	1.303	674.	212.1	90.3	8.54	90.5	20.05	6.14	32.00
34.00	1.1890	477.7	0.03847	290.72	609.31	1.3078	2.3450	2.856	2.176	1.312	660.							



Refrigerant 600 (*n*-Butane) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, kg/m ³		Volume, m ³ /kg		Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c _p , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-100.00	0.00017	699.2	149.43	-12.42	450.99	0.0377	2.7143	2.010	1.229	1.132	1513.	167.4	785.7	4.51	170.6	6.33	28.03	-100.00		
-95.00	0.00028	694.5	91.091	-2.37	457.16	0.0949	2.6746	2.012	1.245	1.130	1493.	169.6	710.6	4.63	166.8	6.61	27.33	-95.00		
-90.00	0.00046	689.8	57.322	7.70	463.40	0.1506	2.6389	2.015	1.260	1.129	1473.	171.8	646.6	4.74	163.2	6.91	26.64	-90.00		
-85.00	0.00072	685.1	37.133	17.78	469.70	0.2050	2.6070	2.020	1.276	1.127	1452.	174.0	591.3	4.85	159.8	7.21	25.95	-85.00		
-80.00	0.00112	680.4	24.700	27.90	476.07	0.2580	2.5785	2.027	1.293	1.125	1431.	176.1	543.3	4.96	156.5	7.52	25.26	-80.00		
-75.00	0.00168	675.6	16.834	38.05	482.51	0.3099	2.5531	2.036	1.310	1.124	1409.	178.1	501.3	5.08	153.3	7.83	24.58	-75.00		
-70.00	0.00247	670.8	11.731	48.26	489.01	0.3608	2.5305	2.046	1.327	1.123	1386.	180.1	464.3	5.19	150.3	8.16	23.90	-70.00		
-65.00	0.00356	666.0	8.3446	58.52	495.57	0.4107	2.5105	2.058	1.346	1.121	1363.	182.1	431.5	5.31	147.4	8.49	23.22	-65.00		
-60.00	0.00502	661.2	6.0489	68.85	502.19	0.4597	2.4929	2.072	1.364	1.120	1339.	184.0	402.3	5.42	144.6	8.83	22.55	-60.00		
-55.00	0.00695	656.4	4.4616	79.25	508.87	0.5080	2.4774	2.087	1.384	1.119	1315.	185.8	376.0	5.54	142.0	9.18	21.88	-55.00		
-50.00	0.00947	651.5	3.3443	89.73	515.61	0.5554	2.4640	2.104	1.404	1.118	1291.	187.5	352.4	5.66	139.4	9.55	21.22	-50.00		
-45.00	0.01271	646.6	2.5441	100.30	522.40	0.6022	2.4524	2.121	1.425	1.118	1266.	189.2	331.0	5.78	136.8	9.92	20.56	-45.00		
-40.00	0.01680	641.7	1.9622	110.95	529.24	0.6484	2.4425	2.140	1.446	1.117	1241.	190.8	311.5	5.90	134.4	10.30	19.90	-40.00		
-35.00	0.02192	636.7	1.5327	121.70	536.12	0.6940	2.4342	2.159	1.468	1.117	1215.	192.3	293.8	6.02	132.0	10.69	19.25	-35.00		
-30.00	0.02823	631.7	1.2114	132.56	543.05	0.7391	2.4274	2.179	1.491	1.116	1189.	193.7	277.5	6.14	129.7	11.09	18.60	-30.00		
-25.00	0.03594	626.6	0.96795	143.52	550.02	0.7836	2.4218	2.200	1.515	1.116	1163.	195.1	262.5	6.27	127.5	11.51	17.96	-25.00		
-20.00	0.04526	621.5	0.78128	154.58	557.02	0.8277	2.4175	2.222	1.539	1.116	1137.	196.3	248.6	6.39	125.3	11.94	17.33	-20.00		
-15.00	0.05641	616.3	0.63659	165.76	564.06	0.8714	2.4143	2.244	1.565	1.117	1111.	197.4	235.8	6.52	123.1	12.38	16.69	-15.00		
-10.00	0.06965	611.1	0.52323	177.05	571.12	0.9146	2.4121	2.267	1.591	1.117	1085.	198.4	223.9	6.65	121.0	12.83	16.07	-10.00		
-5.00	0.08522	605.9	0.43356	188.46	578.21	0.9575	2.4109	2.291	1.618	1.118	1058.	199.3	212.8	6.78	118.9	13.29	15.44	-5.00		
0.00	0.10340	600.5	0.36197	200.00	585.31	1.0000	2.4106	2.316	1.646	1.119	1031.	200.1	202.4	6.91	116.8	13.77	14.83	0.00		
-0.53b	0.10132	601.1	0.36890	198.76	584.55	0.9955	2.4106	2.313	1.643	1.119	1034.	200.1	203.5	6.90	117.0	13.72	14.89	-0.53		
2.00	0.11147	598.3	0.33744	204.65	588.16	1.0169	2.4107	2.326	1.657	1.120	1021.	200.4	198.5	6.97	116.0	13.97	14.58	2.00		
4.00	0.12002	596.2	0.31490	209.32	591.01	1.0338	2.4110	2.336	1.669	1.120	1010.	200.7	194.6	7.02	115.2	14.17	14.34	4.00		
6.00	0.12906	594.0	0.29419	214.01	593.86	1.0506	2.4113	2.346	1.681	1.121	999.	200.9	190.9	7.07	114.4	14.37	14.09	6.00		
8.00	0.13863	591.8	0.27512	218.72	596.71	1.0673	2.4118	2.357	1.693	1.122	988.	201.1	187.2	7.13	113.6	14.57	13.85	8.00		
10.00	0.14874	589.6	0.25754	223.45	599.56	1.0840	2.4124	2.367	1.705	1.123	977.	201.3	183.6	7.18	112.8	14.77	13.61	10.00		
12.00	0.15941	587.4	0.24132	228.21	602.42	1.1007	2.4130	2.378	1.717	1.123	967.	201.5	180.1	7.24	112.0	14.98	13.37	12.00		
14.00	0.17066	585.2	0.22633	232.98	605.28	1.1173	2.4138	2.388	1.729	1.124	956.	201.7	176.7	7.30	111.2	15.19	13.13	14.00		
16.00	0.18251	582.9	0.21246	237.78	608.13	1.1339	2.4147	2.399	1.742	1.125	945.	201.8	173.3	7.35	110.4	15.41	12.89	16.00		
18.00	0.19499	580.6	0.19962	242.60	610.99	1.1505	2.4157	2.410	1.755	1.126	934.	201.9	170.1	7.41	109.6	15.62	12.65	18.00		
20.00	0.20810	578.4	0.18772	247.44	613.84	1.1670	2.4168	2.421	1.768	1.127	923.	202.0	166.9	7.47	108.9	15.84	12.41	20.00		
22.00	0.22188	576.1	0.17668	252.31	616.70	1.1834	2.4180	2.432	1.781	1.128	912.	202.0	163.8	7.53	108.1	16.06	12.17	22.00		
24.00	0.23634	573.8	0.16642	257.19	619.55	1.1998	2.4192	2.444	1.794	1.129	901.	202.1	160.7	7.58	107.3	16.28	11.94	24.00		
26.00	0.25151	571.4	0.15688	262.11	622.40	1.2162	2.4206	2.455	1.808	1.130	891.	202.1	157.7	7.64	106.5	16.51	11.70	26.00		
28.00	0.26741	569.1	0.14800	267.04	625.25	1.2325	2.4220	2.467	1.821	1.132	880.	202.1	154.8	7.70	105.8	16.74	11.47	28.00		
30.00	0.28406	566.8	0.13972	272.00	628.10	1.2489	2.4235	2.479	1.835	1.133	869.	202.0	151.9	7.76	105.0	16.97	11.24	30.00		
32.00	0.30149	564.4	0.13201	276.98	630.95	1.2651	2.4251	2.491	1.849	1.134	858.	202.0	149.1	7.82	104.2	17.21	11.01	32.00		
34.00	0.31971	562.0	0.12480	281.98	633.79	1.2814	2.4267	2.503	1.864	1.136	847.	201.9	146.4	7.88	103.5	17.44	10.78	34.00		
36.00	0.33875	559.6	0.11807	287.02	636.63	1.2976	2.4285	2.515	1.878	1.138	836.	201.8	143.7	7.94	102.7	17.69	10.55	36.00		
38.00	0.35863	557.1	0.11177	292.07	639.46	1.3138	2.4302	2.528	1.893	1.139	825.	201.6	141.0	8.01	101.9	17.93	10.32	38.00		
40.00	0.37937	554.7	0.10588	297.15	642.29	1.3299	2.4321	2.541	1.908	1.141	814.	201.4	138.4	8.07	101.2	18.18	10.09	40.00		
42.00	0.40101	552.2	0.10036	302.26	645.12	1.3461	2.4340	2.553	1.924	1.143	803.	201.2	135.9	8.13	100.4	18.43	9.86	42.00		
44.00	0.42355	549.7	0.09518	307.39	647.94	1.3622	2.4359	2.567	1.939	1.145	792.	201.0	133.4	8.20	99.7	18.68	9.64	44.00		
46.00	0.44703	547.2	0.09032	312.55	650.76	1.3783	2.4379	2.580	1.955	1.147	781.	200.7	130.9	8.26	98.9	18.94	9.41	46.00		
48.00	0.47147	544.7	0.08575	317.74	653.57	1.3943	2.4400	2.593	1.971	1.149	770.	200.5	128.5	8.33	98.2	19.20	9.19	48.00		
50.00	0.49690	542.1	0.08146	322.95	656.37	1.4104	2.4421	2.607	1.988	1.151	759.	200.1	126.2	8.39	97.4	19.46	8.97	50.00		
55.00	0.56492	535.6	0.07181	336.10	663.34	1.4504	2.4475	2.643	2.031	1.158	731.	199.2	120.4	8.56	95.6	20.14	8.42	55.00		
60.00	0.63963	528.9	0.06349	349.43	670.25	1.4902	2.4532	2.681	2.076	1.165	703.	198.0	114.9	8.74	93.7	20.84	7.87	60.00		
65.00	0.72142	522.0	0.05628	362.95	677.09	1.5301	2.4590	2.720	2.124	1.173	675.	19								

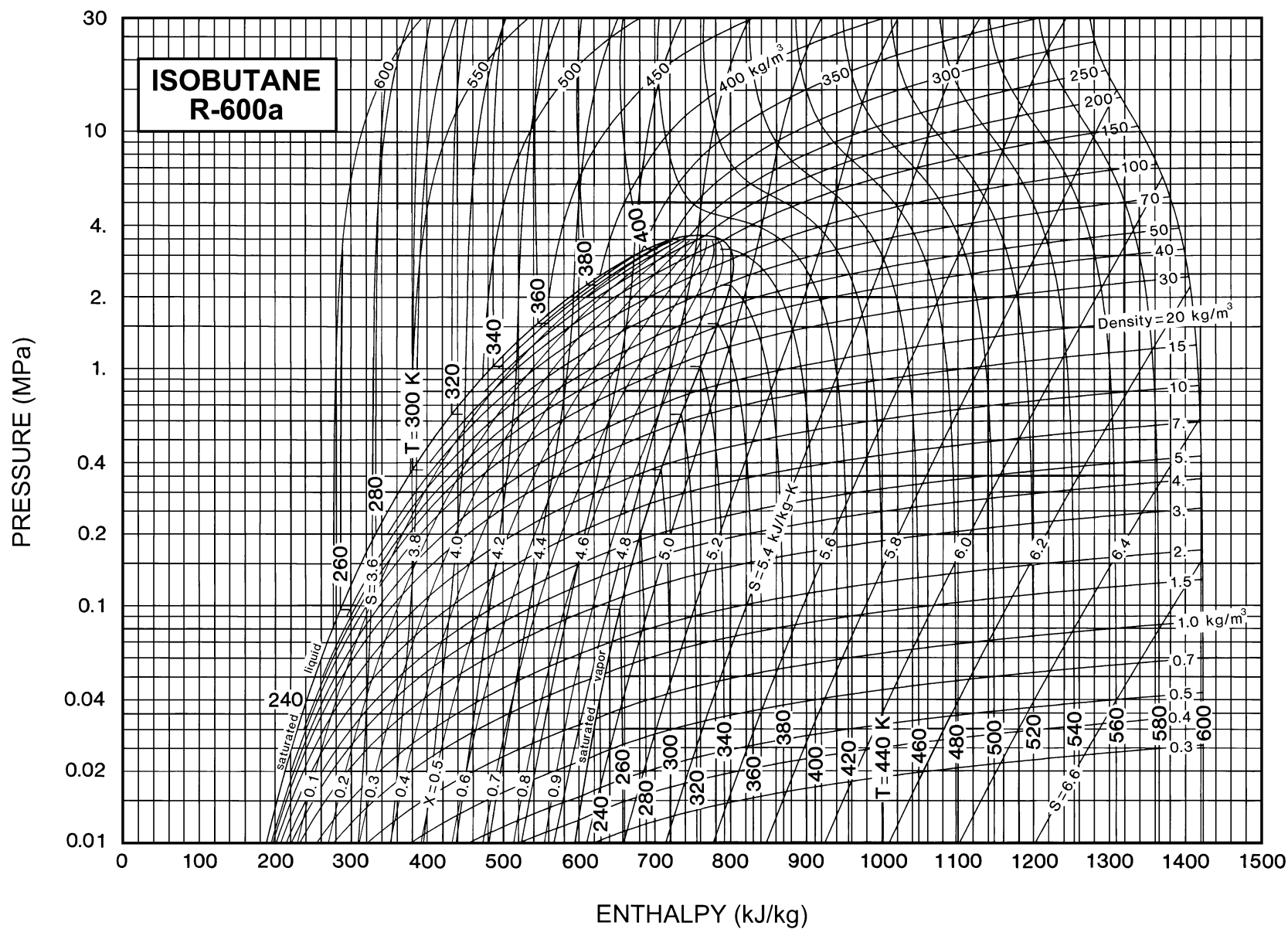


Fig. 19 Pressure-Enthalpy Diagram for Refrigerant 600a (Isobutane)

Note: The reference states for enthalpy and entropy differ from those in the table.

Refrigerant 600a (Isobutane) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, kg/m³	Volume, m³/kg	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p , kJ/(kg·K)			c_p/c_v	Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-100.00	0.00036	683.8	68.449	-7.88	430.08	0.0607	2.5902	1.881	1.131	1.145	1446.	168.3	932.0	4.49	138.3	6.03	25.53	-100.00	
-95.00	0.00059	679.0	42.929	1.57	435.75	0.1145	2.5518	1.898	1.152	1.143	1422.	170.5	833.4	4.60	138.3	6.31	24.88	-95.00	
-90.00	0.00094	674.1	27.744	11.11	441.50	0.1672	2.5174	1.916	1.172	1.140	1399.	172.6	749.8	4.71	138.0	6.61	24.24	-90.00	
-85.00	0.00146	669.2	18.429	20.73	447.34	0.2191	2.4866	1.934	1.192	1.138	1375.	174.7	678.4	4.83	137.5	6.91	23.60	-85.00	
-80.00	0.00220	664.3	12.552	30.44	453.25	0.2700	2.4592	1.952	1.213	1.136	1351.	176.7	616.8	4.94	136.7	7.22	22.96	-80.00	
-75.00	0.00323	659.4	8.7478	40.25	459.24	0.3202	2.4348	1.970	1.235	1.134	1328.	178.6	563.3	5.06	135.7	7.54	22.32	-75.00	
-70.00	0.00465	654.4	6.2265	50.15	465.30	0.3695	2.4132	1.989	1.256	1.132	1304.	180.6	516.5	5.18	134.6	7.87	21.69	-70.00	
-65.00	0.00655	649.5	4.5186	60.15	471.43	0.4181	2.3941	2.009	1.279	1.131	1279.	182.4	475.3	5.29	133.2	8.21	21.05	-65.00	
-60.00	0.00906	644.5	3.3382	70.25	477.62	0.4660	2.3773	2.028	1.302	1.130	1255.	184.2	438.8	5.41	131.7	8.56	20.42	-60.00	
-55.00	0.01233	639.4	2.5070	80.44	483.88	0.5133	2.3627	2.049	1.325	1.128	1230.	185.9	406.3	5.53	130.1	8.93	19.79	-55.00	
-50.00	0.01650	634.3	1.9115	90.74	490.19	0.5599	2.3501	2.069	1.349	1.128	1206.	187.5	377.3	5.65	128.3	9.30	19.16	-50.00	
-45.00	0.02176	629.2	1.4780	101.15	496.56	0.6060	2.3392	2.090	1.374	1.127	1181.	189.0	351.2	5.78	126.4	9.68	18.53	-45.00	
-40.00	0.02831	624.0	1.1577	111.66	502.98	0.6515	2.3300	2.112	1.400	1.126	1155.	190.4	327.6	5.90	124.4	10.08	17.91	-40.00	
-35.00	0.03636	618.8	0.91762	122.28	509.45	0.6966	2.3223	2.134	1.426	1.126	1130.	191.8	306.2	6.03	122.4	10.49	17.29	-35.00	
-30.00	0.04614	613.6	0.73542	133.02	515.96	0.7411	2.3161	2.156	1.453	1.126	1104.	193.0	286.7	6.15	120.3	10.91	16.67	-30.00	
-25.00	0.05791	608.2	0.59546	143.87	522.51	0.7852	2.3111	2.180	1.482	1.126	1079.	194.2	269.0	6.28	118.1	11.34	16.06	-25.00	
-20.00	0.07194	602.8	0.48671	154.84	529.09	0.8289	2.3073	2.204	1.511	1.127	1053.	195.2	252.7	6.42	115.9	11.79	15.45	-20.00	
-15.00	0.08850	597.4	0.40134	165.94	535.71	0.8722	2.3046	2.228	1.540	1.128	1026.	196.1	237.7	6.55	113.6	12.25	14.84	-15.00	
-11.61b	0.10132	593.7	0.35378	173.53	540.22	0.9013	2.3034	2.245	1.561	1.128	1008.	196.6	228.3	6.64	112.1	12.57	14.43	-11.61	
-10.00	0.10789	591.9	0.33363	177.16	542.36	0.9151	2.3029	2.253	1.571	1.129	1000.	196.9	223.9	6.69	111.3	12.73	14.23	-10.00	
-5.00	0.13042	586.3	0.27944	188.51	549.03	0.9577	2.3022	2.279	1.603	1.130	973.	197.5	211.2	6.83	109.1	13.22	13.63	-5.00	
0.00	0.15642	580.6	0.23569	200.00	555.73	1.0000	2.3023	2.306	1.636	1.132	947.	198.0	199.3	6.97	106.8	13.72	13.03	0.00	
2.00	0.16786	578.3	0.22057	204.63	558.41	1.0168	2.3026	2.317	1.649	1.133	936.	198.2	194.8	7.03	105.9	13.93	12.79	2.00	
4.00	0.17993	576.0	0.20663	209.29	561.09	1.0336	2.3030	2.328	1.663	1.133	925.	198.3	190.5	7.09	105.0	14.14	12.56	4.00	
6.00	0.19265	573.6	0.19376	213.97	563.78	1.0504	2.3035	2.340	1.677	1.134	914.	198.4	186.2	7.15	104.0	14.35	12.32	6.00	
8.00	0.20605	571.3	0.18186	218.67	566.47	1.0670	2.3041	2.351	1.691	1.135	903.	198.5	182.1	7.20	103.1	14.56	12.08	8.00	
10.00	0.22014	568.9	0.17085	223.39	569.16	1.0837	2.3048	2.363	1.705	1.136	893.	198.5	178.1	7.27	102.2	14.78	11.85	10.00	
12.00	0.23495	566.6	0.16065	228.14	571.85	1.1003	2.3057	2.374	1.719	1.137	882.	198.6	174.2	7.33	101.3	15.00	11.61	12.00	
14.00	0.25050	564.2	0.15118	232.91	574.54	1.1169	2.3066	2.386	1.734	1.139	871.	198.6	170.3	7.39	100.4	15.22	11.38	14.00	
16.00	0.26682	561.8	0.14239	237.71	577.23	1.1335	2.3076	2.398	1.748	1.140	860.	198.6	166.6	7.45	99.5	15.45	11.15	16.00	
18.00	0.28392	559.3	0.13422	242.53	579.92	1.1500	2.3088	2.411	1.763	1.141	849.	198.5	163.0	7.51	98.7	15.67	10.91	18.00	
20.00	0.30184	556.9	0.12661	247.38	582.61	1.1664	2.3100	2.423	1.779	1.143	838.	198.4	159.5	7.58	97.8	15.90	10.68	20.00	
22.00	0.32058	554.4	0.11952	252.25	585.30	1.1829	2.3113	2.436	1.794	1.144	827.	198.3	156.1	7.64	96.9	16.13	10.45	22.00	
24.00	0.34019	551.9	0.11292	257.15	587.99	1.1993	2.3127	2.449	1.810	1.146	816.	198.2	152.7	7.71	96.0	16.37	10.22	24.00	
26.00	0.36068	549.4	0.10675	262.07	590.67	1.2157	2.3141	2.462	1.826	1.148	805.	198.0	149.4	7.77	95.1	16.61	9.99	26.00	
28.00	0.38208	546.9	0.10099	267.02	593.35	1.2321	2.3156	2.475	1.842	1.149	794.	197.8	146.3	7.84	94.3	16.85	9.76	28.00	
30.00	0.40441	544.3	0.09560	272.00	596.03	1.2484	2.3173	2.489	1.859	1.151	783.	197.6	143.1	7.91	93.4	17.09	9.54	30.00	
32.00	0.42770	541.7	0.09055	277.00	598.71	1.2647	2.3189	2.502	1.875	1.153	772.	197.4	140.1	7.98	92.6	17.34	9.31	32.00	
34.00	0.45197	539.1	0.08583	282.03	601.38	1.2810	2.3207	2.517	1.892	1.156	761.	197.1	137.1	8.04	91.7	17.58	9.08	34.00	
36.00	0.47725	536.5	0.08139	287.09	604.04	1.2972	2.3225	2.531	1.910	1.158	749.	196.7	134.2	8.12	90.9	17.84	8.86	36.00	
38.00	0.50356	533.9	0.07723	292.18	606.70	1.3135	2.3243	2.546	1.928	1.160	738.	196.4	131.4	8.19	90.0	18.09	8.64	38.00	
40.00	0.53093	531.2	0.07332	297.30	609.36	1.3297	2.3262	2.560	1.946	1.163	727.	196.0	128.6	8.26	89.2	18.35	8.41	40.00	
42.00	0.55938	528.5	0.06965	302.44	612.00	1.3459	2.3282	2.576	1.964	1.166	716.	195.5	125.9	8.33	88.4	18.61	8.19	42.00	
44.00	0.58894	525.7	0.06619	307.62	614.64	1.3621	2.3302	2.591	1.983	1.168	705.	195.1	123.2	8.41	87.6	18.87	7.97	44.00	
46.00	0.61964	523.0	0.06293	312.83	617.27	1.3783	2.3322	2.607	2.003	1.172	694.	194.6	120.6	8.48	86.7	19.14	7.75	46.00	
48.00	0.65150	520.2	0.05986	318.07	619.89	1.3945	2.3343	2.624	2.023	1.175	682.	194.0	118.0	8.56	85.9	19.41	7.53	48.00	
50.00	0.68455	517.3	0.05696	323.34	622.50	1.4107	2.3364	2.640	2.043	1.178	671.	193.4	115.5	8.64	85.1	19.69	7.32	50.00	
55.00	0.77255	510.1	0.05041	336.66	628.97	1.4510	2.3418	2.684	2.096	1.188	643.	191.8	109.5	8.84	83.2	20.39	6.78	55.00	
60.00	0.86860	502.6	0.04470	350.20	635.34	1.4914	2.3473	2.731	2.154	1.200	614.	189.9	103.7	9.06	81.2	21.11	6.25	60.00	
65.00	0.97312	494.9	0.03972	363.96	641.61	1.5318	2.3528	2.782	2.										

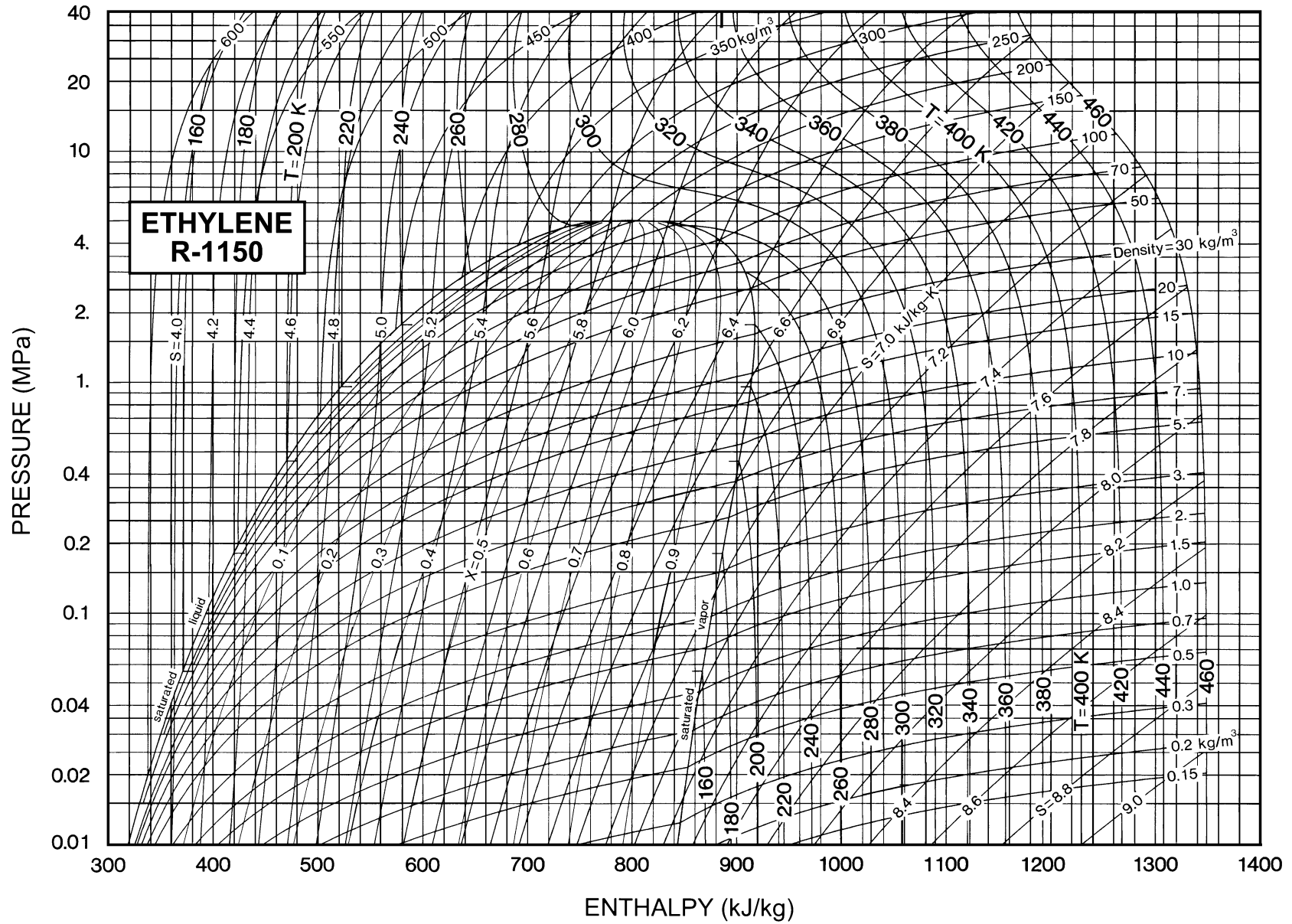


Fig. 20 Pressure-Enthalpy Diagram for Refrigerant 1150 (Ethylene)

Note: The reference states for enthalpy and entropy differ from those in the table.

Refrigerant 1150 (Ethylene) Properties of Saturated Liquid and Saturated Vapor

Temp.,* °C	Pres- sure, MPa	Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp., °C
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
-169.16a	0.00012	654.6	252.64	-158.09	409.42	-1.1789	4.2787	2.429	1.187	1.333	1767.	202.7	1246.	3.51	270.0	5.96	28.14	-169.16
-165.00	0.00025	649.3	129.69	-147.97	414.35	-1.0835	4.1160	2.432	1.188	1.333	1740.	206.7	598.1	1.64	264.9	6.62	27.31	-165.00
-160.00	0.00053	643.0	62.719	-135.81	420.24	-0.9736	3.9408	2.432	1.189	1.333	1707.	211.3	514.5	2.47	258.1	6.59	26.33	-160.00
-155.00	0.00107	636.6	32.557	-123.66	426.12	-0.8685	3.7848	2.429	1.191	1.334	1673.	215.9	448.6	3.13	251.3	6.71	25.35	-155.00
-150.00	0.00203	630.1	17.974	-111.52	431.97	-0.7679	3.6454	2.424	1.194	1.334	1639.	220.3	395.8	3.66	244.5	6.92	24.38	-150.00
-145.00	0.00362	623.6	10.472	-99.41	437.78	-0.6715	3.5204	2.419	1.198	1.335	1604.	224.5	352.7	4.09	237.9	7.18	23.42	-145.00
-140.00	0.00614	617.1	6.3951	-87.33	443.54	-0.5790	3.4080	2.414	1.203	1.336	1569.	228.6	317.2	4.44	231.2	7.47	22.47	-140.00
-135.00	0.01000	610.5	4.0710	-75.27	449.24	-0.4902	3.3065	2.409	1.210	1.337	1534.	232.5	287.5	4.74	224.7	7.78	21.53	-135.00
-130.00	0.01565	603.8	2.6880	-63.22	454.85	-0.4046	3.2145	2.406	1.218	1.339	1498.	236.3	262.3	5.00	218.3	8.09	20.59	-130.00
-125.00	0.02368	597.1	1.8331	-51.19	460.37	-0.3220	3.1310	2.404	1.228	1.341	1463.	239.8	240.7	5.23	212.0	8.39	19.66	-125.00
-120.00	0.03474	590.3	1.2865	-39.16	465.79	-0.2423	3.0548	2.404	1.240	1.344	1427.	243.2	222.0	5.44	205.8	8.70	18.74	-120.00
-115.00	0.04961	583.4	0.92612	-27.12	471.08	-0.1651	2.9850	2.406	1.254	1.348	1390.	246.3	205.7	5.63	199.7	9.00	17.83	-115.00
-110.00	0.06911	576.5	0.68196	-15.06	476.22	-0.0903	2.9210	2.409	1.271	1.353	1354.	249.2	191.3	5.81	193.7	9.30	16.93	-110.00
-105.00	0.09420	569.4	0.51239	-2.97	481.21	-0.0176	2.8619	2.416	1.290	1.358	1316.	251.8	178.5	5.99	187.9	9.61	16.04	-105.00
-103.77b	0.10133	567.7	0.47899	0.00	482.41	0.0000	2.8481	2.418	1.295	1.360	1307.	252.4	175.6	6.03	186.5	9.68	15.83	-103.77
-100.00	0.12585	562.2	0.39198	9.16	486.03	0.0532	2.8073	2.424	1.312	1.365	1279.	254.2	167.0	6.16	182.2	9.92	15.16	-100.00
-98.00	0.14059	559.3	0.35377	14.02	487.90	0.0810	2.7866	2.429	1.321	1.368	1264.	255.1	162.7	6.23	179.9	10.04	14.82	-98.00
-96.00	0.15662	556.4	0.32007	18.90	489.74	0.1085	2.7664	2.434	1.331	1.371	1249.	255.9	158.6	6.30	177.7	10.17	14.47	-96.00
-94.00	0.17402	553.5	0.29026	23.79	491.55	0.1358	2.7468	2.439	1.342	1.375	1233.	256.7	154.7	6.37	175.5	10.30	14.12	-94.00
-92.00	0.19285	550.5	0.26382	28.69	493.32	0.1628	2.7277	2.445	1.353	1.379	1218.	257.4	150.9	6.44	173.3	10.44	13.78	-92.00
-90.00	0.21320	547.5	0.24030	33.60	495.06	0.1896	2.7092	2.451	1.365	1.383	1203.	258.1	147.2	6.51	171.2	10.57	13.44	-90.00
-88.00	0.23514	544.5	0.21933	38.53	496.76	0.2161	2.6911	2.458	1.377	1.387	1187.	258.7	143.6	6.58	169.0	10.71	13.10	-88.00
-86.00	0.25874	541.4	0.20058	43.48	498.43	0.2425	2.6734	2.465	1.391	1.392	1172.	259.3	140.2	6.65	166.9	10.85	12.76	-86.00
-84.00	0.28409	538.4	0.18378	48.44	500.05	0.2686	2.6562	2.473	1.404	1.397	1156.	259.9	136.9	6.72	164.8	11.00	12.42	-84.00
-82.00	0.31127	535.3	0.16869	53.41	501.64	0.2945	2.6394	2.482	1.419	1.402	1140.	260.4	133.7	6.80	162.7	11.15	12.09	-82.00
-80.00	0.34034	532.2	0.15510	58.41	503.18	0.3202	2.6229	2.491	1.434	1.408	1125.	260.8	130.6	6.87	160.7	11.30	11.75	-80.00
-78.00	0.37141	529.0	0.14284	63.43	504.68	0.3457	2.6069	2.501	1.450	1.414	1109.	261.2	127.5	6.95	158.6	11.46	11.42	-78.00
-76.00	0.40454	525.8	0.13176	68.47	506.14	0.3711	2.5911	2.512	1.467	1.420	1093.	261.5	124.6	7.02	156.6	11.62	11.09	-76.00
-74.00	0.43982	522.6	0.12172	73.53	507.55	0.3963	2.5757	2.524	1.484	1.427	1077.	261.8	121.7	7.10	154.6	11.79	10.77	-74.00
-72.00	0.47733	519.3	0.11260	78.61	508.91	0.4214	2.5606	2.536	1.503	1.435	1061.	262.1	118.9	7.18	152.6	11.96	10.44	-72.00
-70.00	0.51716	516.1	0.10431	83.72	510.23	0.4463	2.5457	2.549	1.522	1.443	1044.	262.3	116.2	7.26	150.6	12.14	10.12	-70.00
-68.00	0.55939	512.7	0.09675	88.86	511.49	0.4710	2.5311	2.563	1.543	1.451	1028.	262.4	113.6	7.34	148.6	12.33	9.80	-68.00
-66.00	0.60411	509.4	0.08985	94.03	512.70	0.4957	2.5168	2.578	1.565	1.460	1012.	262.5	111.0	7.42	146.7	12.52	9.48	-66.00
-64.00	0.65141	506.0	0.08354	99.23	513.85	0.5202	2.5026	2.594	1.588	1.470	995.	262.5	108.5	7.51	144.7	12.72	9.16	-64.00
-62.00	0.70136	502.5	0.07776	104.46	514.95	0.5446	2.4887	2.611	1.612	1.480	978.	262.4	106.0	7.60	142.8	12.92	8.85	-62.00
-60.00	0.75406	499.0	0.07246	109.72	515.99	0.5689	2.4749	2.629	1.638	1.491	962.	262.3	103.6	7.68	140.9	13.14	8.53	-60.00
-58.00	0.80960	495.5	0.06758	115.02	516.97	0.5932	2.4614	2.648	1.665	1.503	945.	262.2	101.2	7.78	139.0	13.36	8.23	-58.00
-56.00	0.86807	491.9	0.06310	120.36	517.88	0.6173	2.4479	2.668	1.694	1.516	928.	262.0	98.9	7.87	137.1	13.59	7.92	-56.00
-54.00	0.92955	488.2	0.05896	125.74	518.73	0.6414	2.4346	2.690	1.725	1.529	911.	261.7	96.6	7.96	135.2	13.84	7.61	-54.00
-52.00	0.99414	484.5	0.05514	131.16	519.51	0.6654	2.4214	2.714	1.757	1.544	894.	261.3	94.4	8.06	133.4	14.09	7.31	-52.00
-50.00	1.0619	480.8	0.05161	136.62	520.21	0.6894	2.4083	2.739	1.792	1.560	876.	260.9	92.2	8.16	131.5	14.35	7.01	-50.00
-48.00	1.1330	476.9	0.04834	142.14	520.84	0.7133	2.3953	2.766	1.829	1.577	859.	260.5	90.1	8.27	129.7	14.63	6.71	-48.00
-46.00	1.2075	473.0	0.04530	147.70	521.39	0.7372	2.3824	2.795	1.869	1.596	841.	259.9	87.9	8.38	127.8	14.91	6.42	-46.00
-44.00	1.2854	469.1	0.04249	153.32	521.86	0.7611	2.3694	2.826	1.912	1.616	823.	259.3	85.8	8.49	126.0	15.22	6.13	-44.00
-42.00	1.3669	465.0	0.03987	158.99	522.24	0.7850	2.3565	2.859	1.958	1.638	806.	258.7	83.8	8.60	124.2	15.53	5.84	-42.00
-40.00	1.4521	460.9	0.03743	164.73	522.53	0.8089	2.3436	2.895	2.007	1.662	787.	257.9	81.8	8.72	122.3	15.86	5.55	-40.00
-38.00	1.5410	456.7	0.03515	170.52	522.72	0.8328	2.3306	2.934	2.061	1.688	769.	257.1	79.7	8.84	120.5	16.21	5.27	-38.00
-36.00	1.6339	452.4	0.03303	176.39	522.81	0.8568	2.3176	2.976	2.119	1.717	751.	256.3	77.8	8.97	118.7	16.58	4.99	-36.00
-34.00	1.7307	448.0	0.03105	182.33	522.79	0.8809	2.3045	3.022	2.182	1.749	732.	255.3	75.8	9.10	116.8	16.97	4.71	-34.00
-32.00	1.8315	443.5	0.02919	188.35	522.65	0												

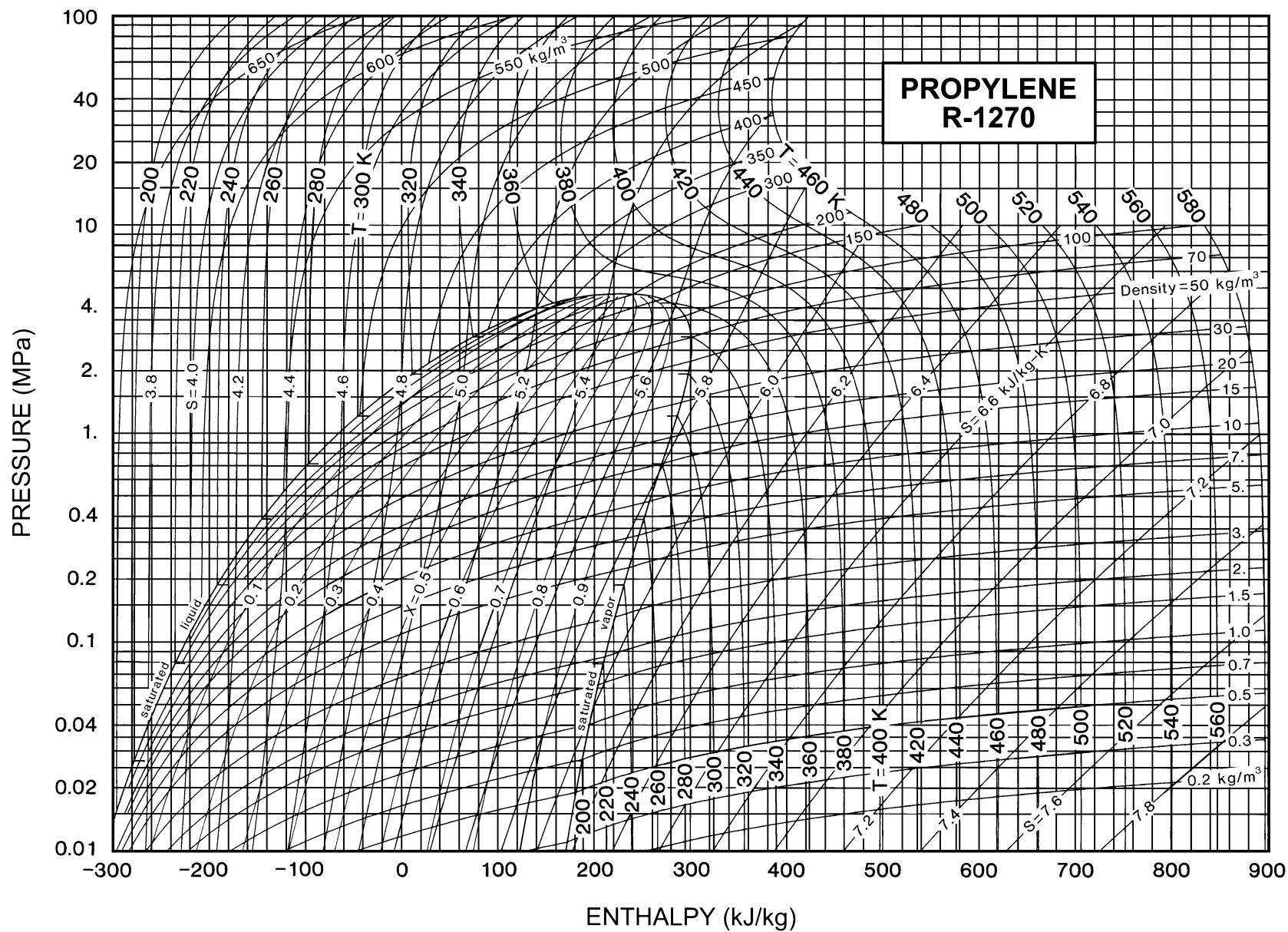


Fig. 21 Pressure-Enthalpy Diagram for Refrigerant 1270 (Propylene)

Note: The reference states for enthalpy and entropy differ from those in the table.

Refrigerant 1270 (Propylene) Properties of Saturated Liquid and Saturated Vapor

Temp., °C	Pres- sure, MPa	Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p , kJ/(kg·K)		c_p/c_v	Velocity of Sound, m/s		Surface Tension, mN/m	Temp., °C
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		Liquid	Vapor		
-140.00	0.00005	716.4	584.26	-98.40	429.52	-0.5068	3.4585	1.893	1.015	1.242	1754.	180.7	31.76	-140.00
-130.00	0.00018	704.9	156.30	-79.22	439.77	-0.3679	3.2579	1.939	1.039	1.235	1683.	186.9	30.05	-130.00
-120.00	0.00059	693.6	50.921	-59.65	450.23	-0.2357	3.0938	1.974	1.064	1.229	1617.	192.7	28.36	-120.00
-110.00	0.00166	682.2	19.445	-39.76	460.89	-0.1100	2.9589	2.002	1.090	1.223	1554.	198.3	26.69	-110.00
-100.00	0.00403	670.8	8.4527	-19.61	471.72	0.0099	2.8477	2.026	1.118	1.218	1493.	203.5	25.04	-100.00
-90.00	0.00881	659.4	4.0858	0.78	482.67	0.1243	2.7556	2.050	1.149	1.214	1432.	208.4	23.41	-90.00
-80.00	0.01753	647.8	2.1562	21.41	493.71	0.2339	2.6793	2.075	1.183	1.211	1371.	212.9	21.80	-80.00
-70.00	0.03230	636.1	1.2238	42.32	504.78	0.3393	2.6159	2.103	1.220	1.209	1309.	216.9	20.22	-70.00
-60.00	0.05575	624.1	0.73807	63.53	515.82	0.4411	2.5632	2.135	1.262	1.209	1247.	220.4	18.67	-60.00
-50.00	0.09107	611.9	0.46834	85.09	526.78	0.5397	2.5191	2.171	1.309	1.211	1184.	223.4	17.14	-50.00
-48.00	0.09987	609.5	0.42991	89.45	528.95	0.5591	2.5112	2.179	1.319	1.211	1171.	223.9	16.83	-48.00
-47.69b	0.10129	609.1	0.42431	90.12	529.29	0.5621	2.5100	2.180	1.321	1.211	1169.	224.0	16.79	-47.69
-46.00	0.10931	607.0	0.39528	93.82	531.12	0.5783	2.5036	2.187	1.330	1.212	1158.	224.4	16.53	-46.00
-44.00	0.11944	604.5	0.36402	98.21	533.28	0.5975	2.4962	2.195	1.340	1.213	1145.	224.8	16.23	-44.00
-42.00	0.13029	601.9	0.33575	102.62	535.44	0.6166	2.4891	2.203	1.351	1.214	1133.	225.3	15.93	-42.00
-40.00	0.14187	599.4	0.31014	107.05	537.58	0.6356	2.4822	2.212	1.362	1.215	1120.	225.7	15.63	-40.00
-38.00	0.15424	596.9	0.28688	111.49	539.72	0.6545	2.4756	2.221	1.373	1.216	1107.	226.1	15.34	-38.00
-36.00	0.16743	594.3	0.26574	115.95	541.85	0.6733	2.4692	2.230	1.385	1.217	1094.	226.4	15.04	-36.00
-34.00	0.18147	591.7	0.24648	120.43	543.96	0.6920	2.4630	2.239	1.396	1.218	1081.	226.7	14.75	-34.00
-32.00	0.19639	589.1	0.22892	124.94	546.07	0.7106	2.4570	2.249	1.408	1.220	1068.	227.0	14.45	-32.00
-30.00	0.21223	586.5	0.21286	129.46	548.17	0.7292	2.4512	2.259	1.421	1.221	1056.	227.3	14.16	-30.00
-28.00	0.22903	583.9	0.19818	134.00	550.25	0.7477	2.4457	2.269	1.433	1.223	1043.	227.5	13.87	-28.00
-26.00	0.24682	581.2	0.18472	138.56	552.32	0.7661	2.4402	2.279	1.446	1.225	1030.	227.7	13.58	-26.00
-24.00	0.26564	578.5	0.17237	143.14	554.38	0.7844	2.4350	2.289	1.459	1.227	1017.	227.9	13.29	-24.00
-22.00	0.28553	575.8	0.16102	147.75	556.42	0.8027	2.4299	2.300	1.473	1.229	1004.	228.1	13.01	-22.00
-20.00	0.30653	573.1	0.15058	152.37	558.46	0.8209	2.4250	2.311	1.487	1.231	991.	228.2	12.72	-20.00
-18.00	0.32866	570.4	0.14095	157.02	560.47	0.8390	2.4203	2.323	1.501	1.234	978.	228.3	12.44	-18.00
-16.00	0.35198	567.6	0.13207	161.70	562.47	0.8571	2.4157	2.335	1.515	1.236	965.	228.3	12.15	-16.00
-14.00	0.37653	564.8	0.12386	166.39	564.46	0.8751	2.4112	2.347	1.530	1.239	952.	228.3	11.87	-14.00
-12.00	0.40233	562.0	0.11627	171.12	566.42	0.8931	2.4068	2.359	1.546	1.242	939.	228.3	11.59	-12.00
-10.00	0.42944	559.2	0.10924	175.86	568.37	0.9110	2.4026	2.372	1.562	1.245	926.	228.2	11.31	-10.00
-8.00	0.45788	556.3	0.10272	180.64	570.30	0.9289	2.3985	2.385	1.578	1.248	912.	228.1	11.03	-8.00
-6.00	0.48770	553.5	0.09667	185.44	572.21	0.9468	2.3946	2.398	1.594	1.252	899.	228.0	10.76	-6.00
-4.00	0.51895	550.6	0.09105	190.26	574.10	0.9645	2.3907	2.412	1.612	1.256	886.	227.8	10.48	-4.00
-2.00	0.55166	547.6	0.08582	195.12	575.97	0.9823	2.3869	2.426	1.629	1.260	873.	227.6	10.21	-2.00
0.00	0.58588	544.6	0.08094	200.00	577.82	1.0000	2.3832	2.441	1.648	1.264	860.	227.4	9.94	0.00
2.00	0.62163	541.6	0.07640	204.91	579.65	1.0177	2.3796	2.456	1.666	1.268	847.	227.1	9.67	2.00
4.00	0.65898	538.6	0.07216	209.85	581.45	1.0353	2.3761	2.471	1.686	1.273	834.	226.7	9.40	4.00
6.00	0.69795	535.5	0.06819	214.83	583.22	1.0529	2.3726	2.487	1.706	1.278	820.	226.4	9.13	6.00
8.00	0.73860	532.4	0.06449	219.83	584.97	1.0705	2.3693	2.504	1.726	1.284	807.	226.0	8.87	8.00
10.00	0.78096	529.3	0.06102	224.87	586.69	1.0881	2.3660	2.521	1.748	1.289	794.	225.5	8.60	10.00
12.00	0.82508	526.1	0.05777	229.94	588.39	1.1056	2.3627	2.538	1.770	1.296	781.	225.0	8.34	12.00
14.00	0.87100	522.9	0.05472	235.04	590.05	1.1232	2.3595	2.557	1.793	1.302	767.	224.5	8.08	14.00
16.00	0.91877	519.7	0.05185	240.18	591.68	1.1407	2.3563	2.575	1.817	1.309	754.	223.9	7.82	16.00
18.00	0.96843	516.4	0.04916	245.35	593.28	1.1582	2.3532	2.595	1.842	1.316	741.	223.3	7.56	18.00
20.00	1.0200	513.0	0.04663	250.57	594.85	1.1757	2.3501	2.615	1.868	1.324	727.	222.6	7.31	20.00
22.00	1.0736	509.6	0.04425	255.82	596.37	1.1932	2.3470	2.637	1.895	1.333	714.	221.9	7.05	22.00
24.00	1.1292	506.2	0.04201	261.11	597.86	1.2107	2.3439	2.659	1.923	1.342	701.	221.1	6.80	24.00
26.00	1.1869	502.7	0.03990	266.44	599.31	1.2282	2.3409	2.682	1.952	1.351	687.	220.3	6.55	26.00
28.00	1.2467	499.2	0.03790	271.81	600.72	1.2457	2.3378	2.706	1.983	1.362	674.	219.4	6.31	28.00
30.00	1.3086	495.6	0.03601	277.23	602.09	1.2632	2.3348	2.731	2.015	1.373	661.	218.5	6.06	30.00
32.00	1.3728	491.9	0.03423	282.69	603.40	1.2807	2.3317	2.757	2.049	1.385	647.	217.5	5.82	32.00
34.00	1.4392	488.2	0.03254	288.20	604.67	1.2983	2.3286	2.785	2.085	1.398	634.	216.5	5.57	34.00
36.00	1.5080	484.4	0.03095	293.76	605.89	1.3159	2.3255	2.815	2.123	1.412	620.	215.4	5.33	36.00
38.00	1.5791	480.6	0.02943	299.37	607.05	1.3335	2.3223	2.845	2.163	1.427	606.	214.3	5.10	38.00
40.00	1.6526	476.6	0.02800	305.04	608.15	1.3511	2.3191	2.878	2.206	1.443	593.	213.1	4.86	40.00
42.00	1.7287	472.6	0.02664	310.76	609.20	1.3688	2.3158	2.913	2.252	1.460	579.	211.8	4.63	42.00
44.00	1.8072	468.6	0.02534	316.53	610.17	1.3866	2.3124	2.950	2.300	1.480	565.	210.5	4.40	44.00
46.00	1.8883	464.4	0.02411	322.37	611.08	1.4044	2.3089	2.990	2.352	1.501	551.	209.1	4.17	46.00
48.00	1.9721	460.1	0.02294	328.28	611.91	1.4223	2.3054	3.032	2.409	1.524	538.	207.7	3.95	48.00
50.00	2.0585	455.8	0.02182	334.25	612.65	1.4402	2.3017	3.078	2.469	1.549	524.	206.2	3.72	50.00
55.00	2.2868	444.4	0.01925	349.51	614.13	1.4855	2.2919	3.211	2.645	1.624	488.	202.2	3.18	55.00
60.00	2.5333	432.1	0.01696	365.31	614.95	1.5316	2.2809	3.380	2.868	1.723	452.	197.7	2.65	60.00
65.00	2.7990	418.8	0.01489	381.77	614.94	1.5788	2.2683	3.604	3.164	1.859	415.	192.8	2.15	65.00
70.00	3.0853	404.1	0.01302	399.08	613.86	1.6275	2.2534	3.922	3.579	2.056	377.	187.3	1.67	70.00
75.00	3.3935	387.3	0.01129	417.54	611.31	1.6787	2.2352	4.419	4.216	2.365	336.	181.3	1.21	75.00
80.00	3.7253	367.4	0.00967	437.75	606.58	1.7338	2.2118	5.320	5.339	2.921	294.	174.6	0.79	80.00
85.00	4.0827	341.6	0.00808	461.14	598.00	1.7967	2.1788	7.524	7.941	4.231	247.	167.2	0.41	85.00
90.00	4.4687	298.5	0.00629	493.66	579.40	1.8835	2.1196	—	—	—	195.	159.2	0.10	90.00
92.42c	4.6646	223.4	0.00448	540.41	540.41	2.0097	2.0097	∞	∞	∞	0.	0.0	0.00	92.42

*Temperatures have been converted from the IPTS-68 scale of the original formulation to the ITS-90 scale

b = normal boiling point

c = critical point

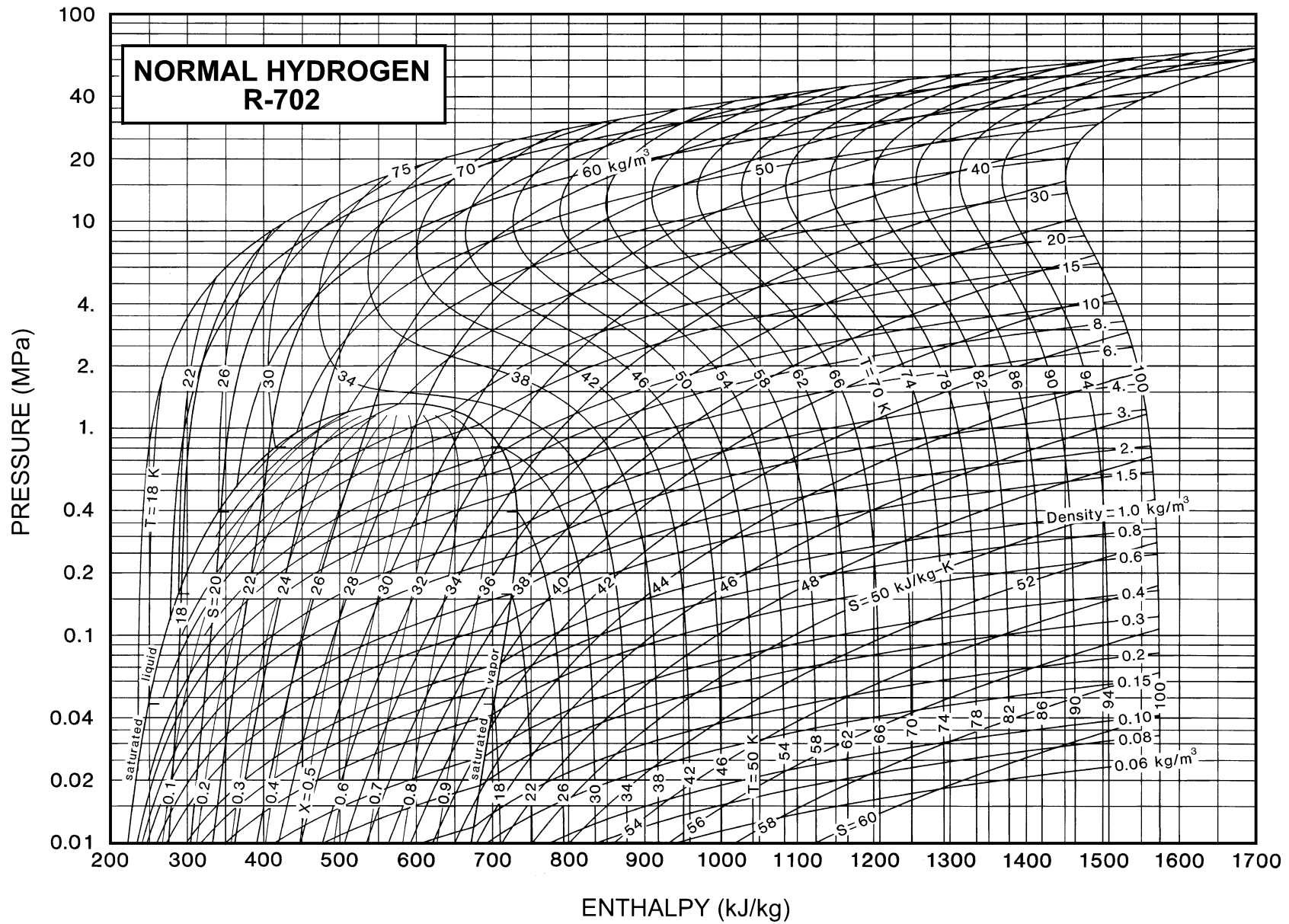


Fig. 22 Pressure-Enthalpy Diagram for Refrigerant 702 (Normal Hydrogen)

Refrigerant 702 (Normal Hydrogen) Properties of Saturated Liquid and Saturated Vapor

Temp.,* K	Absolute Pressure, MPa	Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p , kJ/(kg·K)		c_p/c_v Vapor	Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp.,* K
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
13.95a	0.00776	76.90	7.2871	218.1	667.4	14.082	46.224	7.78	10.90	1.669	1362.	304.5	25.5	0.66	76.2	10.37	3.181	13.95
14.00	0.00797	76.86	7.1136	218.6	667.8	14.108	46.147	7.71	10.89	1.672	1360.	305.1	25.3	0.67	76.7	10.43	3.171	14.00
15.00	0.01334	76.02	4.5226	226.3	676.9	14.610	44.697	7.15	10.86	1.701	1318.	316.2	22.2	0.74	84.1	11.62	2.970	15.00
16.00	0.02113	75.12	3.0172	233.4	685.6	15.075	43.411	7.30	11.00	1.719	1272.	325.2	19.8	0.81	90.1	12.68	2.771	16.00
17.00	0.03200	74.18	2.0940	240.9	693.7	15.530	42.260	7.72	11.19	1.739	1226.	333.2	17.8	0.87	94.8	13.68	2.575	17.00
18.00	0.04663	73.20	1.5017	249.0	701.3	15.984	41.220	8.26	11.43	1.764	1185.	340.6	16.2	0.94	98.4	14.67	2.381	18.00
19.00	0.06577	72.18	1.1068	257.8	708.3	16.441	40.270	8.85	11.71	1.795	1147.	347.3	14.8	1.00	101.1	15.68	2.191	19.00
20.00	0.09020	71.11	0.83478	267.3	714.6	16.904	39.393	9.49	12.04	1.833	1111.	353.3	13.6	1.06	103.0	16.72	2.003	20.00
20.39b	0.10132	70.67	0.75195	271.2	716.8	17.086	39.068	9.74	12.20	1.851	1097.	355.4	13.2	1.08	103.6	17.13	1.931	20.39
21.00	0.12072	69.96	0.64193	277.4	720.1	17.374	38.576	10.15	12.46	1.881	1075.	358.6	12.6	1.12	104.2	17.81	1.819	21.00
22.00	0.15816	68.73	0.50178	288.3	724.8	17.852	37.806	10.88	12.96	1.940	1039.	363.2	11.6	1.18	104.9	18.96	1.638	22.00
23.00	0.20336	67.41	0.39766	299.9	728.4	18.340	37.074	11.68	13.58	2.013	1001.	367.2	10.8	1.25	105.0	20.18	1.460	23.00
24.00	0.25717	65.98	0.31878	312.3	731.0	18.840	36.369	12.58	14.35	2.106	960.	370.6	10.1	1.32	104.6	21.50	1.287	24.00
25.00	0.32045	64.43	0.25795	325.8	732.3	19.351	35.683	13.65	15.34	2.224	918.	373.3	9.4	1.39	103.8	22.92	1.117	25.00
26.00	0.39404	62.75	0.21028	340.3	732.2	19.877	35.007	14.94	16.63	2.378	872.	375.4	8.7	1.46	102.5	24.48	0.953	26.00
27.00	0.47879	60.91	0.17233	356.1	730.4	20.421	34.331	16.56	18.36	2.586	824.	376.9	8.1	1.54	100.8	26.23	0.793	27.00
28.00	0.57555	58.87	0.14165	373.5	726.5	20.989	33.642	18.72	20.79	2.877	772.	377.8	7.5	1.63	98.7	28.22	0.639	28.00
29.00	0.68516	56.55	0.11647	392.7	720.2	21.596	32.925	21.85	24.41	3.310	715.	378.2	6.9	1.74	96.0	30.56	0.492	29.00
30.00	0.80844	53.76	0.09540	414.7	710.5	22.267	32.157	27.13	30.32	4.013	650.	378.1	6.4	1.86	92.6	33.46	0.352	30.00
31.00	0.94620	50.17	0.07735	441.4	696.2	23.059	31.298	38.73	41.37	5.321	573.	377.7	5.8	2.04	88.3	37.32	0.222	31.00
32.00	1.0993	44.89	0.06132	477.9	674.4	24.112	30.271	84.77	67.41	8.383	482.	377.6	5.1	2.35	82.3	43.40	0.105	32.00
33.00	1.2684	34.38	0.04665	547.5	640.5	26.097	28.951	—	—	—	—	—	—	—	—	—	0.011	33.00
33.19c	1.3152	30.11	0.03321	577.2	577.2	26.962	26.962	∞	∞	∞	0.	0.0	—	—	∞	∞	0.000	33.19

*Temperatures are on the IPTS-68 scale

a = triple point

b = normal boiling point

c = critical point

Refrigerant 702 (Normal Hydrogen) Properties of Gas at 0.101 325 MPa (one standard atmosphere)

Temp., °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	c_p , kJ/ (kg·K)	c_p/c_v	Vel. Sound, m/s	Viscosity, μPa·s	Thermal Cond., mW/(m·K)	Temp., °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	c_p , kJ/ (kg·K)	c_p/c_v	Vel. Sound, m/s	Viscosity, μPa·s	Thermal Cond., mW/(m·K)
-252.8a	1.3299	716.8	39.068	12.20	1.851	355.4	1.08	17.10	0.0	0.0899	3843.3	69.168	14.20	1.410	1261.1	8.40	172.58
-250.0	1.1366	749.3	40.564	11.45	1.793	385.4	1.22	19.29	5.0	0.0883	3914.4	69.425	14.22	1.409	1272.1	8.50	175.07
-245.0	0.9089	805.0	42.744	10.91	1.744	431.8	1.47	23.26	10.0	0.0867	3985.5	69.679	14.24	1.408	1283.0	8.61	177.56
-240.0	0.7609	859.0	44.508	10.69	1.720	472.2	1.72	27.06	15.0	0.0852	4056.8	69.928	14.27	1.407	1293.9	8.71	180.05
-235.0	0.6557	912.1	46.001	10.58	1.706	508.7	1.95	30.62	20.0	0.0838	4128.2	70.174	14.29	1.406	1304.7	8.81	182.48
-230.0	0.5767	964.8	47.300	10.52	1.696	542.3	2.18	34.00	25.0	0.0824	4199.7	70.416	14.31	1.405	1315.4	8.92	184.88
-225.0	0.5150	1017.4	48.452	10.49	1.688	573.6	2.40	37.23	30.0	0.0810	4271.3	70.654	14.32	1.405	1326.0	9.02	187.28
-220.0	0.4655	1069.7	49.487	10.47	1.682	603.0	2.60	40.37	35.0	0.0797	4342.9	70.888	14.34	1.404	1336.6	9.12	189.67
-215.0	0.4247	1122.1	50.429	10.48	1.676	630.6	2.80	43.47	40.0	0.0784	4414.7	71.119	14.36	1.403	1347.1	9.22	192.01
-210.0	0.3906	1174.6	51.294	10.51	1.668	656.6	2.98	46.55	45.0	0.0772	4486.5	71.347	14.37	1.403	1357.5	9.32	194.32
-200.0	0.3366	1280.1	52.845	10.62	1.650	704.1	3.34	52.56	50.0	0.0760	4558.3	71.571	14.38	1.402	1367.9	9.42	196.78
-190.0	0.2958	1387.2	54.217	10.81	1.629	746.5	3.67	58.30	55.0	0.0748	4630.3	71.792	14.39	1.402	1378.2	9.52	199.33
-180.0	0.2639	1496.4	55.457	11.05	1.604	784.7	3.98	64.12	60.0	0.0737	4702.3	72.010	14.40	1.401	1388.4	9.62	201.86
-170.0	0.2382	1608.2	56.597	11.32	1.580	819.7	4.28	70.43	65.0	0.0726	4774.3	72.224	14.41	1.401	1398.6	9.72	204.37
-160.0	0.2171	1722.8	57.657	11.61	1.556	852.3	4.57	77.02	70.0	0.0716	4846.4	72.436	14.42	1.401	1408.7	9.81	206.88
-150.0	0.1994	1840.3	58.652	11.89	1.534	883.2	4.85	83.56	75.0	0.0705	4918.5	72.644	14.43	1.400	1418.8	9.91	209.39
-140.0	0.1844	1960.7	59.592	12.17	1.515	912.7	5.12	90.15	80.0	0.0695	4990.7	72.850	14.44	1.400	1428.8	10.01	211.88
-130.0	0.1715	2083.7	60.483	12.44	1.499	941.2	5.38	96.62	85.0	0.0686	5062.9	73.053	14.44	1.400	1438.7	10.10	214.34
-120.0	0.1603	2209.3	61.331	12.68	1.484	968.8	5.64	103.03	90.0	0.0676	5135.1	73.254	14.45	1.400	1448.6	10.20	216.72
-110.0	0.1505	2337.3	62.140	12.90	1.471	995.7	5.89	109.55	95.0	0.0667	5207.4	73.451	14.45	1.399	1458.4	10.29	219.04
-100.0	0.1418	2467.3	62.913	13.10	1.461	1022.1	6.14	115.95	100.0	0.0658	5279.7	73.646	14.46	1.399	1468.2	10.39	221.42
-90.0	0.1340	2599.2	63.654	13.28	1.452	1047.9	6.38	122.20	110.0	0.0641	5424.3	74.029	14.47	1.399	1487.5	10.58	226.21
-80.0	0.1271	2732.8	64.364	13.44	1.444	1073.2	6.62	128.33	120.0	0.0625	5569.0	74.401	14.47	1.399	1506.7	10.77	230.86
-70.0	0.1208	2867.9	65.046	13.58	1.437	1098.0	6.85	134.30	130.0	0.0609	5713.8	74.765	14.48	1.398	1525.6	—	—
-60.0	0.1152	3004.4	65.702	13.71	1.431	1122.5	7.08	140.15	140.0	0.0594	5858.6	75.120	14.48	1.398	1544.3	—	—
-50.0	0.1100	3142.0	66.333	13.82	1.426	1146.5	7.31	145.84	150.0	0.0580	6003.4	75.466	14.49	1.398	1562.8	—	—
-40.0	0.1053	3280.7	66.941	13.91	1.422	1170.1	7.53	151.44	160.0	0.0567	6148.3	75.805	14.49	1.398	1581.0	—	—
-30.0	0.1010	3420.2	67.527	14.00	1.418	1193.4	7.75	156.92	170.0	0.0554	6293.2	76.135	14.49	1.398	1599.1	—	—
-20.0	0.0970	3560.6	68.093	14.07	1.415	1216.3	7.97	162.24	180.0	0.0542	6438.1	76.459	14.50	1.398	1616.9	—	—
-10.0	0.0933	3701.7	68.639	14.14	1.412	1238.8	8.19	167.47	190.0	0.0530	6583.1	76.775	14.50	1.398	1634.6	—	—
									200.0	0.0519	6728.1	77.085	14.50	1.397	1652.0	—	—

a = saturated vapor at normal boiling point

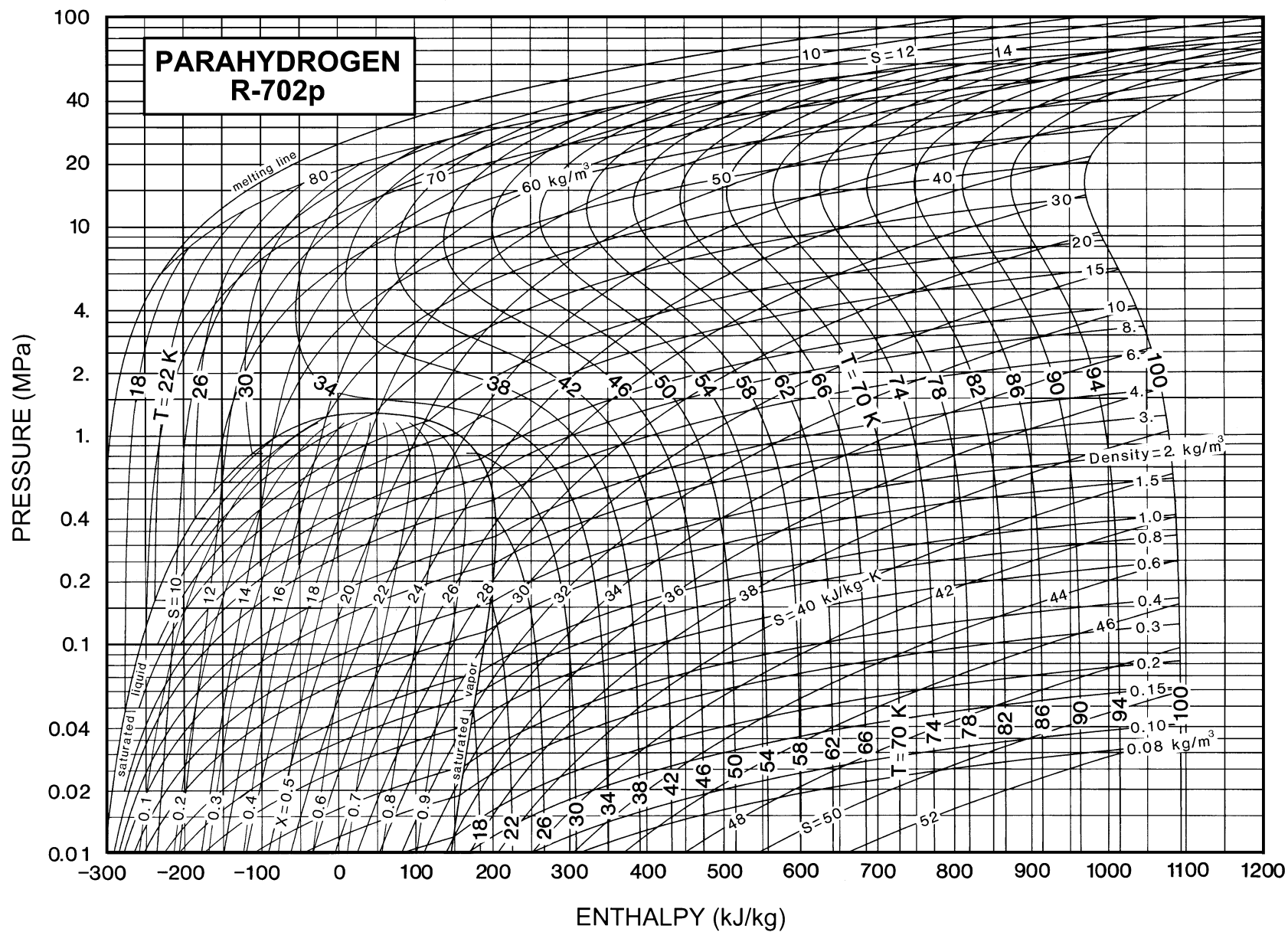


Fig. 23 Pressure-Enthalpy Diagram for Refrigerant 702p (Parahydrogen)

Refrigerant 702p (Parahydrogen) Properties of Saturated Liquid and Saturated Vapor

Temp.,* K	Absolute Pressure, MPa	Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp.,* K
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	c_p/c_v	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
13.80a	0.00705	77.04	7.8437	-307.2	140.1	4.980	37.428	7.72	10.68	1.690	1373.	305.0	26.0	0.65	75.3	10.46	3.124	13.80
14.00	0.00790	76.87	7.1198	-305.7	141.9	5.088	37.115	7.53	10.70	1.692	1364.	307.0	25.3	0.67	76.9	10.65	3.086	14.00
15.00	0.01343	76.01	4.4920	-298.3	150.9	5.588	35.628	7.13	10.84	1.704	1316.	316.4	22.2	0.74	84.1	11.62	2.894	15.00
16.00	0.02152	75.12	2.9640	-291.1	159.5	6.051	34.295	7.30	11.01	1.720	1269.	325.1	19.8	0.81	90.0	12.60	2.705	16.00
17.00	0.03284	74.19	2.0392	-283.5	167.5	6.504	33.107	7.72	11.22	1.741	1224.	333.0	17.8	0.87	94.7	13.59	2.516	17.00
18.00	0.04807	73.22	1.4541	-275.4	175.0	6.958	32.042	8.26	11.46	1.767	1183.	340.3	16.2	0.94	98.3	14.60	2.330	18.00
19.00	0.06796	72.19	1.0683	-266.6	181.8	7.416	31.077	8.85	11.76	1.800	1145.	346.8	14.8	1.00	101.1	15.64	2.146	19.00
20.00	0.09326	71.11	0.80448	-257.2	188.0	7.880	30.193	9.48	12.12	1.840	1109.	352.6	13.6	1.06	103.0	16.71	1.963	20.00
20.28b	0.10132	70.80	0.74656	-254.4	189.5	8.009	29.960	9.66	12.23	1.853	1099.	354.1	13.3	1.07	103.4	17.01	1.913	20.28
20.50	0.10818	70.54	0.70371	-252.2	190.8	8.114	29.776	9.81	12.33	1.864	1091.	355.3	13.1	1.09	103.7	17.25	1.873	20.50
21.00	0.12474	69.96	0.61847	-247.1	193.3	8.350	29.373	10.15	12.56	1.890	1073.	357.8	12.6	1.12	104.2	17.82	1.783	21.00
21.50	0.14305	69.35	0.54589	-241.7	195.7	8.589	28.983	10.51	12.81	1.920	1055.	360.2	12.1	1.15	104.7	18.39	1.693	21.50
22.00	0.16320	68.73	0.48372	-236.2	197.8	8.829	28.604	10.87	13.09	1.952	1036.	362.3	11.6	1.18	104.9	18.98	1.605	22.00
22.50	0.18529	68.08	0.43016	-230.5	199.7	9.071	28.235	11.26	13.39	1.989	1018.	364.3	11.2	1.21	105.0	19.59	1.517	22.50
23.00	0.20942	67.42	0.38378	-224.6	201.3	9.315	27.875	11.67	13.74	2.030	999.	366.2	10.8	1.25	105.0	20.21	1.429	23.00
23.50	0.23570	66.72	0.34340	-218.5	202.6	9.562	27.521	12.10	14.12	2.075	979.	367.9	10.4	1.28	104.9	20.86	1.342	23.50
24.00	0.26423	66.00	0.30808	-212.1	203.6	9.811	27.174	12.56	14.56	2.127	959.	369.4	10.1	1.32	104.7	21.53	1.256	24.00
24.50	0.29511	65.25	0.27705	-205.5	204.4	10.064	26.832	13.06	15.04	2.185	939.	370.8	9.7	1.35	104.3	22.23	1.171	24.50
25.00	0.32845	64.47	0.24966	-198.7	204.7	10.320	26.492	13.61	15.60	2.251	918.	372.1	9.4	1.39	103.8	22.95	1.086	25.00
26.00	0.40291	62.80	0.20378	-184.2	204.4	10.843	25.820	14.87	16.96	2.414	873.	374.1	8.7	1.46	102.6	24.51	0.920	26.00
27.00	0.48849	60.97	0.16716	-168.4	202.3	11.385	25.145	16.47	18.81	2.635	825.	375.5	8.1	1.54	100.9	26.25	0.757	27.00
28.00	0.58610	58.93	0.13744	-151.2	198.1	11.954	24.454	18.61	21.44	2.948	773.	376.3	7.5	1.63	98.7	28.23	0.599	28.00
29.00	0.69673	56.60	0.11286	-132.0	191.3	12.560	23.727	21.70	25.45	3.426	716.	376.4	6.9	1.74	96.0	30.57	0.445	29.00
30.00	0.82143	53.86	0.09208	-110.2	180.6	13.223	22.933	26.73	32.31	4.238	653.	375.9	6.4	1.86	92.6	33.45	0.299	30.00
31.00	0.96149	50.48	0.07387	-84.4	164.1	13.981	22.011	36.68	46.58	5.916	582.	374.8	5.8	2.04	88.3	37.31	0.161	31.00
32.00	1.1185	45.81	0.05667	-51.0	135.8	14.938	20.788	66.67	93.30	11.357	501.	373.2	5.1	2.35	82.3	43.38	0.038	32.00
32.94c	1.2838	31.36	0.03189	40.3	40.3	17.615	17.615	∞	∞	∞	0.	0.0	—	—	∞	∞	0.000	32.94

*Temperatures are on the IPTS-68 scale

a = triple point

b = normal boiling point

c = critical point

Refrigerant 702p (Parahydrogen) Properties of Gas at 0.101 325 MPa (one standard atmosphere)

Temp., °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	c_p , kJ/ (kg·K)	c_p/c_v	Vel. Sound, m/s	Viscosity, μPa·s	Thermal Cond., mW/(m·K)	Temp., °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	c_p , kJ/ (kg·K)	c_p/c_v	Vel. Sound, m/s	Viscosity, μPa·s	Thermal Cond., mW/(m·K)
-252.9a	1.3395	189.5	29.960	12.23	1.853	354.1	1.07	17.01	-50.0	0.1100	3030.3	60.270	15.71	1.356	1118.1	7.31	164.51
-250.0	1.1364	223.4	31.524	11.45	1.793	385.5	1.22	19.33	-40.0	0.1053	3186.7	60.955	15.56	1.361	1144.9	7.53	168.14
-245.0	0.9088	279.1	33.703	10.91	1.744	431.8	1.47	23.27	-30.0	0.1010	3341.5	61.605	15.41	1.366	1171.1	7.75	171.75
-240.0	0.7608	333.0	35.467	10.69	1.720	472.2	1.72	27.03	-20.0	0.0970	3495.0	62.224	15.28	1.370	1196.8	7.97	175.31
-235.0	0.6557	386.2	36.960	10.58	1.706	508.7	1.95	30.58	-10.0	0.0933	3647.2	62.814	15.16	1.374	1221.9	8.19	178.87
-230.0	0.5767	438.9	38.260	10.54	1.694	542.0	2.18	33.99	0.0	0.0899	3798.3	63.377	15.06	1.377	1246.5	8.40	182.44
-225.0	0.5150	491.6	39.415	10.53	1.683	572.8	2.40	37.34	5.0	0.0883	3873.5	63.650	15.01	1.379	1258.6	8.50	184.23
-220.0	0.4655	544.3	40.456	10.57	1.672	601.2	2.60	40.72	10.0	0.0867	3948.5	63.917	14.97	1.381	1270.5	8.61	186.05
-215.0	0.4247	597.3	41.410	10.66	1.656	627.0	2.80	44.21	15.0	0.0852	4023.2	64.179	14.93	1.382	1282.3	8.71	187.89
-210.0	0.3906	651.0	42.295	10.81	1.637	650.4	2.98	47.87	20.0	0.0838	4097.8	64.436	14.89	1.383	1294.0	8.81	189.73
-200.0	0.3366	761.4	43.918	11.31	1.587	690.5	3.34	55.69	25.0	0.0824	4172.1	64.687	14.86	1.384	1305.6	8.92	191.58
-190.0	0.2958	877.9	45.409	12.01	1.532	723.9	3.67	64.19	30.0	0.0810	4246.4	64.934	14.83	1.386	1317.0	9.02	193.46
-180.0	0.2639	1002.1	46.819	12.84	1.479	753.5	3.98	73.55	35.0	0.0797	4320.4	65.176	14.80	1.387	1328.3	9.12	195.36
-170.0	0.2382	1134.8	48.171	13.69	1.435	781.3	4.28	83.79	40.0	0.0784	4394.3	65.414	14.77	1.388	1339.5	9.22	197.29
-160.0	0.2171	1275.8	49.475	14.50	1.401	808.7	4.57	94.32	45.0	0.0772	4468.1	65.648	14.75	1.388	1350.5	9.32	199.25
-150.0	0.1994	1424.3	50.732	15.17	1.376	836.2	4.85	104.41	50.0	0.0760	4541.8	65.878	14.72	1.389	1361.5	9.42	201.20
-140.0	0.1844	1578.7	51.938	15.69	1.358	864.2	5.12	113.74	55.0	0.0748	4615.4	66.104	14.70	1.390	1372.3	9.52	203.16
-130.0	0.1715	1737.6	53.088	16.05	1.347	892.4	5.38	122.26	60.0	0.0737	4688.9	66.326	14.69	1.391	1383.1	9.62	205.18
-120.0	0.1603	1899.3	54.180	16.27	1.341	920.9	5.64	129.99	65.0	0.0726	4762.2	66.545	14.67	1.391	1393.7	9.72	207.24
-110.0	0.1505	2062.6	55.213	16.37	1.338	949.5	5.89	136.76	70.0	0.0716	4835.6	66.760	14.65	1.392	1404.3	9.81	209.33
-100.0	0.1418	2226.3	56.187	16.36	1.338	978.1	6.14	142.70	75.0	0.0705	4908.8	66.972	14.64	1.392	1414.7	9.91	211.44
-90.0	0.1340	2389.6	57.104	16.29	1.340	1006.7	6.38	147.96	80.0	0.0695	4981.9	67.180	14.63	1.393	1425.1	10.01	213.53
-80.0	0.1271	2551.9	57.967	16.17	1.343	1035.1	6.62	152.62	85.0	0.0686	5055.1	67.386	14.62	1.393	1435.3	10.10	215.59
-70.0	0.1208	2712.9	58.779	16.03	1.347	1063.2	6.85	156.90	90.0	0.0676	5128.1	67.588	14.60	1.394	1445.5	10.20	217.63
-60.0	0.1152	2872.4	59.546	15.87	1.352	1090.8	7.08	160.82	95.0	0.0667	5201.1	67.788	14.60	1.394	1455.6	10.29	219.65
									100.0	0.0658	5274.1	67.985	14.59	1.394	1465.6	10.39	221.73

a = saturated vapor at normal boiling point

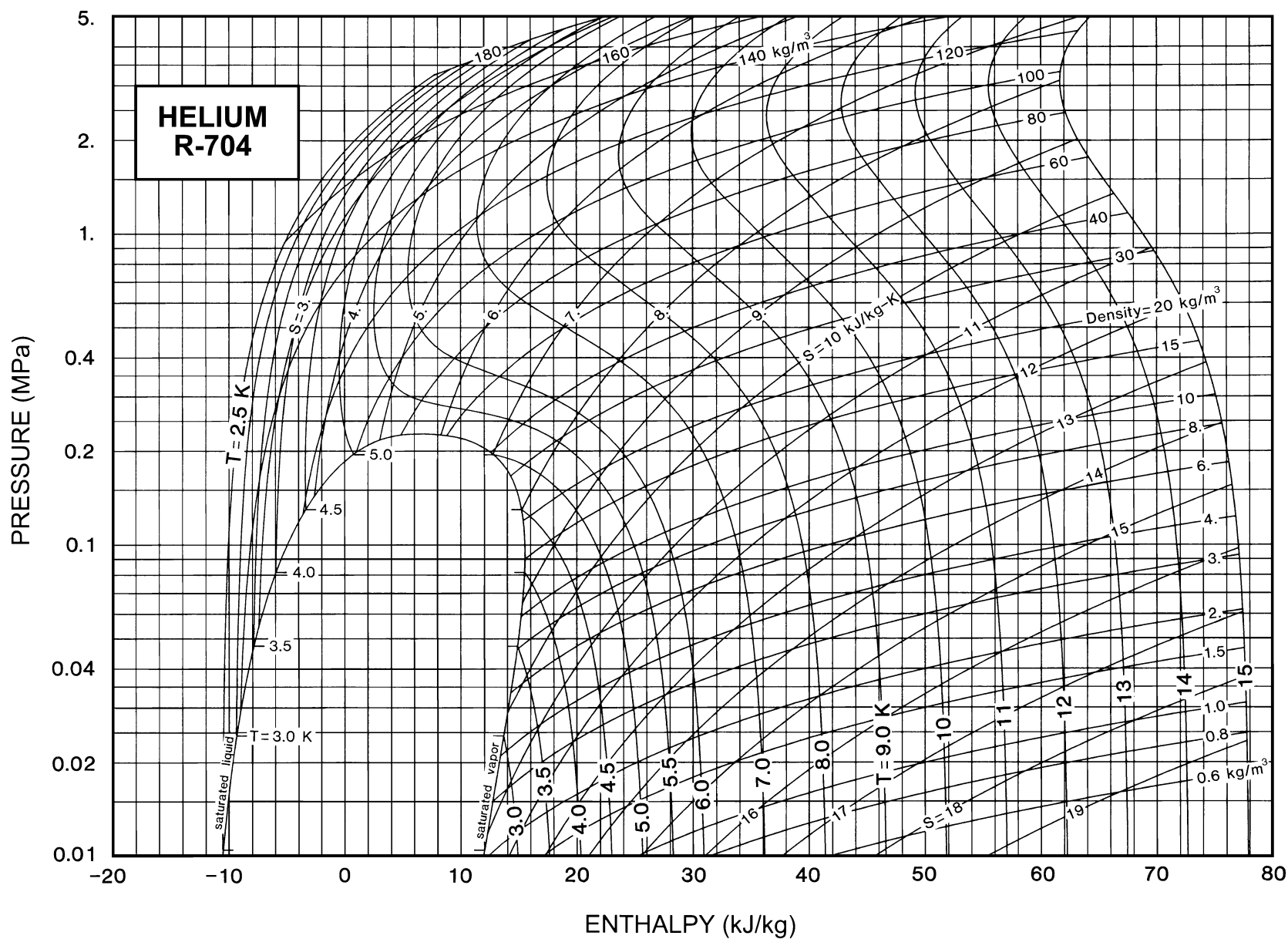


Fig. 24 Pressure-Enthalpy Diagram for Refrigerant 704 (Helium)

Note: The reference states for enthalpy and entropy differ from those in the table.

Refrigerant 704 (Helium) Properties of Saturated Liquid and Saturated Vapor

Temp.,* K	Absolute Pressure, MPa	Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p , kJ/(kg·K)		c_p/c_v Vapor	Velocity of Sound, m/s		Viscosity, μ Pa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp.,* K
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
2.18a	0.00486	146.24	0.87297	2.34	25.56	1.4040	12.0746	6.318	6.061	1.747	217.	83.2	—	—	—	—	0.388	2.18
2.20	0.00515	146.19	0.83068	2.48	25.66	1.4682	12.0035	5.800	6.076	1.750	217.	83.6	—	—	—	—	0.385	2.20
2.30	0.00653	145.87	0.67831	2.98	26.05	1.6865	11.7174	4.164	6.139	1.763	216.	85.0	—	—	—	—	0.371	2.30
2.40	0.00814	145.46	0.56257	3.35	26.44	1.8414	11.4586	3.217	6.199	1.778	216.	86.3	—	—	—	—	0.356	2.40
2.50	0.01000	144.96	0.47252	3.66	26.81	1.9607	11.2211	2.700	6.258	1.795	216.	87.6	—	—	—	—	0.342	2.50
2.60	0.01213	144.38	0.40113	3.93	27.17	2.0604	11.0011	2.453	6.318	1.813	217.	88.8	—	—	—	—	0.328	2.60
2.70	0.01454	143.72	0.34364	4.18	27.52	2.1502	10.7956	2.372	6.380	1.834	217.	90.0	—	—	—	—	0.314	2.70
2.80	0.01727	143.00	0.29674	4.44	27.86	2.2356	10.6024	2.394	6.446	1.857	217.	91.1	—	—	—	—	0.300	2.80
2.90	0.02032	142.21	0.25805	4.70	28.19	2.3196	10.4198	2.477	6.516	1.882	216.	92.1	—	—	—	—	0.286	2.90
3.00	0.02373	141.34	0.22582	4.97	28.50	2.4039	10.2464	2.598	6.592	1.910	214.	93.0	—	—	—	—	0.272	3.00
3.10	0.02750	140.42	0.19871	5.26	28.79	2.4894	10.0808	2.740	6.676	1.941	213.	93.9	—	—	—	—	0.258	3.10
3.20	0.03166	139.43	0.17574	5.56	29.07	2.5765	9.9222	2.897	6.768	1.976	210.	94.8	—	—	—	—	0.244	3.20
3.30	0.03622	138.38	0.15612	5.88	29.33	2.6653	9.7694	3.062	6.872	2.015	208.	95.5	—	—	—	—	0.231	3.30
3.40	0.04121	137.25	0.13925	6.22	29.57	2.7559	9.6216	3.234	6.989	2.059	205.	96.3	—	—	—	—	0.217	3.40
3.50	0.04664	136.06	0.12466	6.58	29.79	2.8482	9.4781	3.414	7.122	2.108	202.	96.9	—	—	—	—	0.203	3.50
3.60	0.05252	134.80	0.11195	6.96	29.98	2.9422	9.3381	3.603	7.274	2.165	199.	97.5	3.5	1.00	17.9	7.31	0.190	3.60
3.70	0.05888	133.45	0.10081	7.35	30.16	3.0380	9.2007	3.803	7.449	2.229	196.	98.1	3.4	1.04	18.1	7.56	0.177	3.70
3.80	0.06573	132.03	0.09101	7.77	30.31	3.1355	9.0653	4.020	7.654	2.303	193.	98.6	3.4	1.07	18.2	7.82	0.164	3.80
3.90	0.07310	130.51	0.08232	8.21	30.43	3.2351	8.9312	4.257	7.894	2.389	189.	99.1	3.3	1.11	18.4	8.09	0.150	3.90
4.00	0.08100	128.90	0.07459	8.67	30.52	3.3367	8.7975	4.523	8.179	2.491	186.	99.5	3.3	1.15	18.5	8.36	0.138	4.00
4.10	0.08945	127.17	0.06767	9.16	30.57	3.4407	8.6633	4.826	8.521	2.611	182.	99.8	3.2	1.19	18.6	8.66	0.125	4.10
4.20	0.09847	125.32	0.06144	9.68	30.59	3.5475	8.5277	5.179	8.938	2.756	178.	100.1	3.2	1.24	18.6	8.97	0.112	4.20
4.23b	0.10132	124.73	0.05967	9.84	30.59	3.5806	8.4861	5.299	9.083	2.806	176.	100.2	3.2	1.25	18.7	9.06	0.108	4.23
4.30	0.10809	123.33	0.05581	10.22	30.57	3.6577	8.3896	5.600	9.455	2.934	173.	100.4	3.1	1.28	18.7	9.30	0.099	4.30
4.40	0.11832	121.17	0.05067	10.80	30.50	3.7719	8.2476	6.118	10.110	3.158	169.	100.6	3.1	1.33	18.8	9.66	0.087	4.40
4.50	0.12920	118.81	0.04596	11.42	30.36	3.8912	8.0999	6.776	10.964	3.448	164.	100.8	3.0	1.38	18.8	10.07	0.075	4.50
4.60	0.14075	116.20	0.04161	12.09	30.16	4.0171	7.9440	7.646	12.117	3.838	159.	100.9	3.0	1.43	18.8	10.54	0.063	4.60
4.70	0.15301	113.27	0.03753	12.83	29.87	4.1517	7.7767	8.863	13.754	4.388	153.	101.0	2.9	1.48	18.9	11.08	0.051	4.70
4.80	0.16602	109.90	0.03367	13.64	29.45	4.2986	7.5924	10.700	16.244	5.224	147.	101.1	2.8	1.55	19.0	11.76	0.040	4.80
4.90	0.17983	105.89	0.02993	14.57	28.87	4.4641	7.3821	13.813	20.464	6.637	140.	101.3	2.7	1.62	19.1	12.63	0.029	4.90
5.00	0.19453	100.83	0.02617	15.69	28.02	4.6615	7.1273	20.240	29.094	9.531	133.	101.6	2.6	1.70	19.3	13.86	0.018	5.00
5.10	0.21023	93.53	0.02206	17.20	26.63	4.9283	6.7774	40.770	55.866	18.545	124.	102.5	2.5	1.80	19.9	15.77	0.008	5.10
5.20c	0.22746	69.64	0.01436	21.71	21.71	5.7639	5.7639	∞	∞	∞	0.	0.0	—	—	∞	∞	0.000	5.20

*Temperatures are on the EPT-76 scale

a = lower lambda point

b = normal boiling point

c = critical point

Refrigerant 704 (Helium) Properties of Gas at 0.101 325 MPa (one standard atmosphere)

Temp., °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	c_p , kJ/ (kg·K)	c_p/c_v	Vel. Sound, m/s	Viscosity, μ Pa·s	Thermal Cond., mW/(m·K)	Temp., °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	c_p , kJ/ (kg·K)	c_p/c_v	Vel. Sound, m/s	Viscosity, μ Pa·s	Thermal Cond., mW/(m·K)
−268.9a	16.758	30.59	8.4861	9.083	2.806	100.2	1.25	9.05	100.0	0.1307	1953.16	32.7129	5.193	1.667	1137.0	23.15	181.41
−260.0	3.7508	82.19	15.2748	5.327	1.708	213.6	2.72	20.17	120.0	0.1240	2057.02	32.9840	5.193	1.667	1167.0	24.00	188.10
−250.0	2.1049	134.88	18.2572	5.236	1.678	284.4	3.93	28.69	140.0	0.1180	2160.88	33.2417	5.193	1.667	1196.3	24.84	194.69
−240.0	1.4677	187.10	20.1325	5.213	1.671	340.1	4.93	35.90	160.0	0.1126	2264.74	33.4872	5.193	1.667	1224.9	25.67	201.19
−220.0	0.9155	291.20	22.5899	5.200	1.668	430.1	6.60	48.56	180.0	0.1076	2368.60	33.7216	5.193	1.667	1252.9	26.49	207.60
−200.0	0.6655	395.16	24.2500	5.196	1.667	504.3	8.04	59.86	200.0	0.1031	2472.46	33.9459	5.193	1.667	1280.2	27.29	213.93
−180.0	0.5228	499.06	25.5057	5.195	1.667	568.8	9.35	70.30	220.0	0.0989	2576.32	34.1609	5.193	1.667	1307.0	28.09	220.18
−160.0	0.4305	602.95	26.5160	5.194	1.667	626.7	10.39	80.09	240.0	0.0950	2680.18	34.3673	5.193	1.667	1333.2	28.88	226.35
−140.0	0.3659	706.82	27.3614	5.194	1.667	679.7	11.56	89.41	260.0	0.0915	2784.04	34.5659	5.193	1.667	1358.9	29.66	232.46
−120.0	0.3182	810.69	28.0882	5.193	1.666	728.8	12.68	98.32	280.0	0.0882	2887.90	34.7571	5.193	1.667	1384.1	30.43	238.50
−100.0	0.2815	914.56	28.7256	5.193	1.666	774.9	13.75	106.90	300.0	0.0851	2991.76	34.9416	5.193	1.667	1408.9	31.20	244.47
−80.0	0.2524	1018.42	29.2932	5.193	1.667	818.3	14.79	115.20	320.0	0.0822	3095.62	35.1197	5.193	1.667	1433.3	31.96	250.39
−60.0	0.2287	1122.28	29.8049	5.193	1.667	859.6	15.80	123.25	340.0	0.0795	3199.48	35.2919	5.193	1.667	1457.2	32.71	256.24
−40.0	0.2091	1226.14	30.2707	5.193	1.667	898.9	16.79	131.09	360.0	0.0770	3303.34	35.4586	5.193	1.667	1480.8	33.45	262.04
−20.0	0.1926	1330.00	30.6980	5.193	1.667	936.7	17.75	138.73	380.0	0.0747	3407.20	35.6201	5.193	1.667	1504.0	34.19	267.79
0.0	0.1785	1433.87	31.0929	5.193	1.667	972.9	18.70	146.20	400.0	0.0725	3511.06	35.7767	5.193	1.667	1526.8	34.92	273.48
20.0	0.1663	1537.73	31.4599	5.193	1.667	1007.9	19.62	153.50	420.0	0.0704	3614.92	35.9288	5.193	1.667	1549.3	35.65	279.13
40.0	0.1557	1641.58	31.8026	5.193	1.667	1041.6	20.52	160.67	440.0	0.0684	3718.78	36.0765	5.193	1.667	1571.5	36.37	284.73
60.0	0.1464	1745.44	32.1241	5.193	1.667	1074.4	21.41	167.70	460.0	0.0665	3822.64	36.2201	5.193	1.667	1593.4	37.08	290.28
80.0	0.1381	1849.30	32.4269	5.193	1.667	1106.1	22.29	174.61	480.0	0.0648	3926.50	36.3599	5.193	1.667	1615.0	37.79	295.78
									500.0	0.0631	4030.36	36.4960	5.193	1.667	1636.3	38.49	301.25

a = saturated vapor at normal boiling point

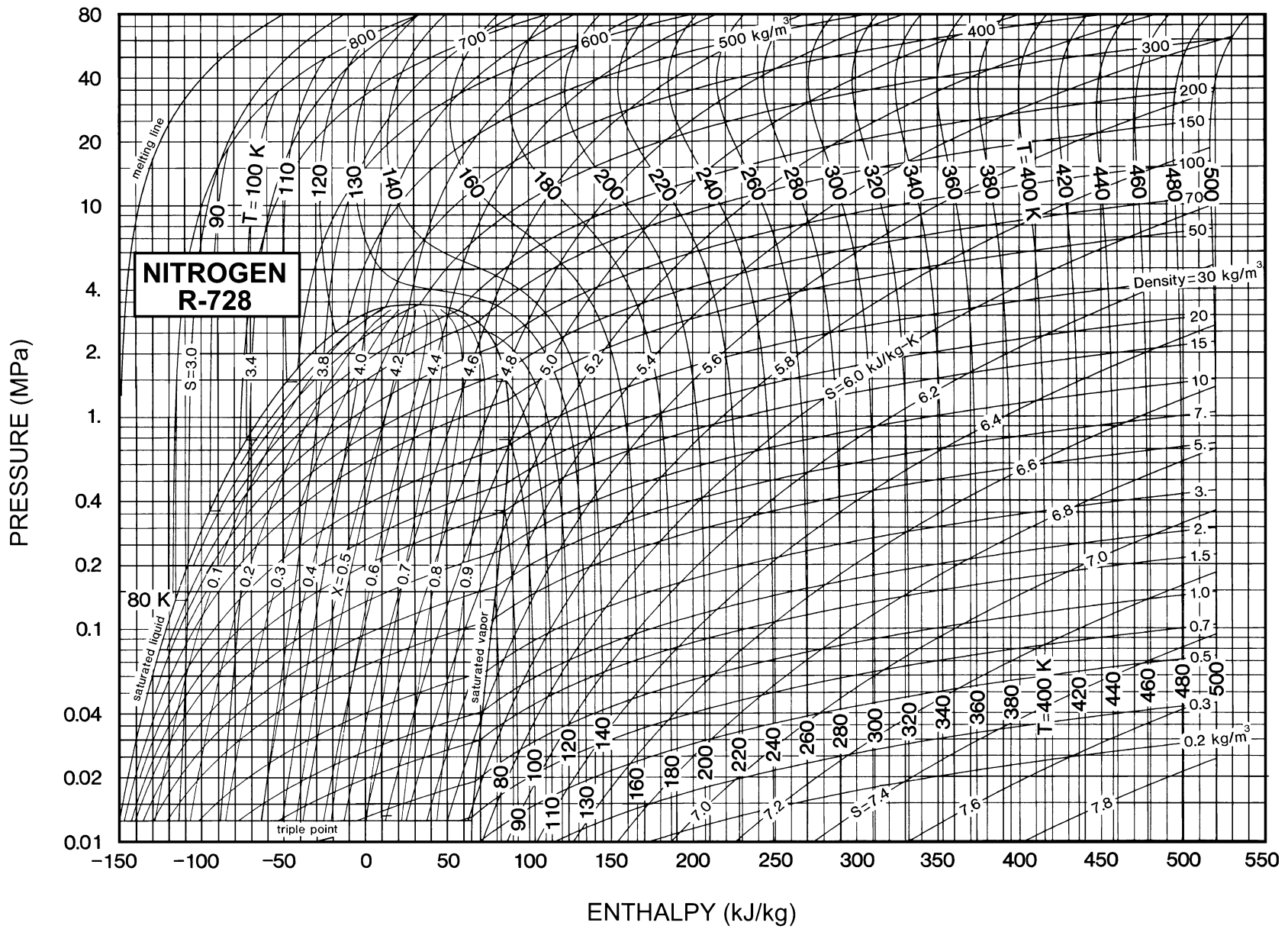


Fig. 25 Pressure-Enthalpy Diagram for Refrigerant 728 (Nitrogen)

Refrigerant 728 (Nitrogen) Properties of Saturated Liquid and Saturated Vapor

Temp.,* K	Absolute Pressure, MPa	Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp.,* K
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
63.15a	0.01252	869.7	1.4819	−150.87	64.52	2.4194	5.8303	2.019	1.187	1.390	1022.	159.5	285.9	4.17	174.6	5.38	12.24	63.15
64.00	0.01461	866.0	1.2853	−149.15	65.32	2.4464	5.7975	2.017	1.196	1.390	1010.	160.4	272.8	4.23	172.6	5.47	12.03	64.00
66.00	0.02063	857.4	0.93539	−145.12	67.17	2.5084	5.7248	2.013	1.218	1.393	983.	162.4	245.7	4.37	168.1	5.68	11.55	66.00
68.00	0.02850	848.6	0.69509	−141.09	68.98	2.5684	5.6576	2.013	1.240	1.396	958.	164.4	222.9	4.51	163.6	5.90	11.07	68.00
70.00	0.03857	839.8	0.52632	−137.05	70.74	2.6267	5.5952	2.016	1.262	1.401	933.	166.2	203.4	4.65	159.3	6.12	10.59	70.00
72.00	0.05124	830.9	0.40532	−133.01	72.45	2.6835	5.5370	2.020	1.284	1.407	910.	168.0	186.6	4.79	155.0	6.35	10.12	72.00
74.00	0.06696	822.0	0.31694	−128.95	74.10	2.7388	5.4827	2.027	1.306	1.414	887.	169.6	172.0	4.94	150.7	6.58	9.65	74.00
76.00	0.08616	812.8	0.25127	−124.87	75.69	2.7929	5.4319	2.036	1.327	1.423	864.	171.2	159.1	5.08	146.5	6.82	9.19	76.00
77.35b	0.10132	806.6	0.21639	−122.11	76.73	2.8286	5.3993	2.042	1.341	1.430	850.	172.2	151.2	5.19	143.7	6.99	8.88	77.35
78.00	0.10934	803.6	0.20170	−120.78	77.21	2.8457	5.3841	2.046	1.348	1.433	842.	172.7	147.7	5.23	142.4	7.07	8.73	78.00
80.00	0.13698	794.2	0.16375	−116.65	78.67	2.8975	5.3389	2.058	1.368	1.446	821.	174.0	137.5	5.39	138.3	7.33	8.27	80.00
82.00	0.16961	784.7	0.13431	−112.50	80.04	2.9482	5.2962	2.072	1.389	1.460	799.	175.3	128.3	5.54	134.3	7.59	7.83	82.00
84.00	0.20776	775.0	0.11118	−108.32	81.32	2.9980	5.2557	2.088	1.411	1.476	778.	176.4	120.0	5.70	130.3	7.86	7.38	84.00
86.00	0.25198	765.1	0.09281	−104.10	82.52	3.0469	5.2169	2.105	1.434	1.494	756.	177.4	112.4	5.86	126.3	8.14	6.94	86.00
88.00	0.30281	755.0	0.07806	−99.84	83.61	3.0951	5.1798	2.126	1.458	1.515	735.	178.2	105.5	6.02	122.4	8.44	6.51	88.00
90.00	0.36083	744.6	0.06611	−95.54	84.59	3.1426	5.1441	2.148	1.485	1.540	713.	179.0	99.1	6.19	118.5	8.75	6.09	90.00
92.00	0.42661	734.0	0.05633	−91.19	85.45	3.1894	5.1095	2.174	1.516	1.568	692.	179.6	93.2	6.37	114.7	9.07	5.67	92.00
94.00	0.50074	723.2	0.04827	−86.78	86.19	3.2357	5.0759	2.204	1.551	1.600	670.	180.1	87.7	6.54	110.8	9.40	5.25	94.00
96.00	0.58381	712.0	0.04156	−82.32	86.79	3.2816	5.0431	2.238	1.591	1.637	647.	180.4	82.6	6.73	107.0	9.76	4.84	96.00
98.00	0.67641	700.6	0.03594	−77.78	87.24	3.3270	5.0108	2.277	1.639	1.680	624.	180.6	77.7	6.92	103.2	10.14	4.44	98.00
100.00	0.77917	688.7	0.03120	−73.16	87.52	3.3721	4.9789	2.323	1.695	1.731	601.	180.6	73.2	7.12	99.5	10.54	4.05	100.00
105.00	1.0846	657.0	0.02218	−61.20	87.38	3.4844	4.8995	2.481	1.892	1.903	540.	180.0	62.8	7.66	90.0	11.67	3.10	105.00
110.00	1.4676	621.1	0.01595	−48.41	85.74	3.5978	4.8173	2.745	2.230	2.186	473.	178.4	53.5	8.29	80.5	13.09	2.21	110.00
115.00	1.9393	578.5	0.01144	−34.27	81.92	3.7164	4.7268	3.260	2.898	2.728	397.	175.5	44.6	9.09	70.5	15.07	1.39	115.00
120.00	2.5130	522.3	0.00799	−17.57	74.33	3.8496	4.6155	4.601	4.691	4.134	309.	171.0	35.7	10.23	60.2	18.80	0.66	120.00
125.00	3.2080	424.7	0.00490	6.76	55.64	4.0359	4.4270	—	—	—	—	—	—	—	—	—	0.08	125.00
126.19c	3.3978	313.1	0.00319	29.83	29.83	4.2154	4.2154	∞	∞	∞	0.	0.0	—	—	∞	∞	0.00	126.19

*temperatures are on the IPTS-68 scale

a = triple point

b = normal boiling point

c = critical point

Refrigerant 728 (Nitrogen) Properties of Gas at 0.101 325 MPa (one standard atmosphere)

Temp., °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	c_p , kJ/ (kg·K)	c_p/c_v	Vel. Sound, m/s	Viscosity, μPa·s	Thermal Cond., mW/(m·K)	Temp., °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	c_p , kJ/ (kg·K)	c_p/c_v	Vel. Sound, m/s	Viscosity, μPa·s	Thermal Cond., mW/(m·K)
−195.8a	4.6213	76.73	5.3993	1.341	1.430	172.2	5.19	6.99	150.0	0.8065	439.66	7.1966	1.047	1.397	419.0	22.80	33.72
−180.0	3.7557	94.62	5.6104	1.075	1.432	194.1	6.26	8.57	160.0	0.7879	450.13	7.2210	1.048	1.396	423.8	23.19	34.33
−160.0	3.0593	115.92	5.8177	1.059	1.419	215.3	7.59	10.58	170.0	0.7701	460.62	7.2450	1.049	1.396	428.6	23.56	34.93
−140.0	2.5860	137.03	5.9894	1.052	1.412	234.2	8.88	12.53	180.0	0.7531	471.11	7.2684	1.050	1.395	433.3	23.94	35.54
−120.0	2.2415	158.02	6.1363	1.048	1.409	251.6	10.12	14.35	190.0	0.7368	481.62	7.2913	1.051	1.394	438.0	24.31	36.14
−100.0	1.9789	178.95	6.2648	1.046	1.406	267.8	11.29	16.11	200.0	0.7213	492.13	7.3138	1.053	1.394	442.6	24.68	36.74
−90.0	1.8697	189.40	6.3235	1.045	1.405	275.6	11.86	16.97	210.0	0.7063	502.67	7.3358	1.054	1.393	447.1	25.04	37.34
−80.0	1.7719	199.85	6.3790	1.044	1.405	283.1	12.41	17.80	220.0	0.6920	513.21	7.3574	1.055	1.392	451.6	25.40	37.93
−70.0	1.6840	210.28	6.4316	1.043	1.404	290.4	12.95	18.62	230.0	0.6782	523.77	7.3786	1.057	1.391	456.0	25.75	38.53
−60.0	1.6044	220.72	6.4818	1.043	1.404	297.5	13.48	19.42	240.0	0.6650	534.35	7.3994	1.059	1.390	460.4	26.11	39.12
−50.0	1.5320	231.14	6.5296	1.042	1.403	304.4	14.00	20.21	250.0	0.6523	544.94	7.4199	1.060	1.389	464.7	26.45	39.71
−40.0	1.4660	241.56	6.5753	1.042	1.403	311.2	14.51	20.98	260.0	0.6401	555.55	7.4400	1.062	1.389	468.9	26.80	40.30
−30.0	1.4054	251.99	6.6190	1.042	1.403	317.9	15.01	21.73	270.0	0.6283	566.18	7.4597	1.064	1.388	473.2	27.14	40.89
−20.0	1.3496	262.40	6.6610	1.042	1.402	324.4	15.50	22.47	280.0	0.6169	576.83	7.4791	1.066	1.387	477.3	27.48	41.48
−10.0	1.2981	272.82	6.7014	1.042	1.402	330.7	15.98	23.20	290.0	0.6060	587.50	7.4983	1.068	1.386	481.4	27.82	42.07
0.0	1.2504	283.23	6.7402	1.041	1.402	337.0	16.46	23.92	300.0	0.5954	598.18	7.5171	1.070	1.385	485.5	28.15	42.66
10.0	1.2061	293.65	6.7777	1.041	1.402	343.1	16.92	24.63	310.0	0.5852	608.89	7.5356	1.072	1.384	489.6	28.48	43.25
20.0	1.1649	304.06	6.8138	1.041	1.401	349.1	17.38	25.32	320.0	0.5753	619.62	7.5538	1.074	1.383	493.6	28.81	43.83
30.0	1.1263	314.47	6.8487	1.041	1.401	355.0	17.83	26.01	330.0	0.5658	630.36	7.5718	1.076	1.381	497.5	29.14	44.42
40.0	1.0903	324.89	6.8825	1.041	1.401	360.8	18.28	26.69	340.0	0.5565	641.13	7.5895	1.078	1.380	501.4	29.46	45.00
50.0	1.0565	335.30	6.9153	1.042	1.401	366.5	18.72	27.36	350.0	0.5476	651.92	7.6070	1.080	1.379	505.3	29.79	45.59
60.0	1.0247	345.72	6.9470	1.042	1.400	372.1	19.15	28.02	360.0	0.5390	662.74	7.6242	1.082	1.378	509.1	30.11	46.17
70.0	0.9948	356.14	6.9778	1.042	1.400	377.7	19.58	28.68	370.0	0.5306	673.57	7.6412	1.085	1.377	512.9	30.42	46.76
80.0	0.9666	366.56	7.0077	1.042	1.400	383.1	20.00	29.33	380.0	0.5225	684.43	7.6579	1.087	1.376	516.7	30.74	47.34
90.0	0.9399	376.99	7.0369	1.043	1.400	388.5	20.42	29.97	390.0	0.5146	695.31	7.6745	1.089	1.375	520.4	31.05	47.93
100.0	0.9147	387.42	7.0652	1.043	1.399	393.7	20.83	30.61	400.0	0.5069	706.22	7.6908	1.092	1.374	524.1	31.36	48.51
110.0	0.8908	397.85	7.0928	1.044	1.399	398.9	21.23	31.24	420.0	0.4923	728.10	7.7228	1.096	1.371	531.4	31.98	49.68
120.0	0.8681	408.29	7.1197	1.044	1.398	404.0	21.63	31.86	440.0	0.4785	750.08	7.7541	1.101	1.369	538.6	32.58	50.84
130.0	0.8466	418.74	7.1459	1.045	1.398	409.1	22.03	32.48	460.0	0.4655	772.15	7.7846	1.106	1.367	545.6	33.19	52.00
140.0	0.8261	429.19	7.1716	1.046	1.397	414.1	22.42	33.10	480.0	0.4531	794.32	7.8144	1.111	1.365	552.6	33.78	53.16
									500.0	0.4414	816.59	7.8436	1.116	1.363	559.4	34.37	54.31

a = saturated vapor at normal boiling point

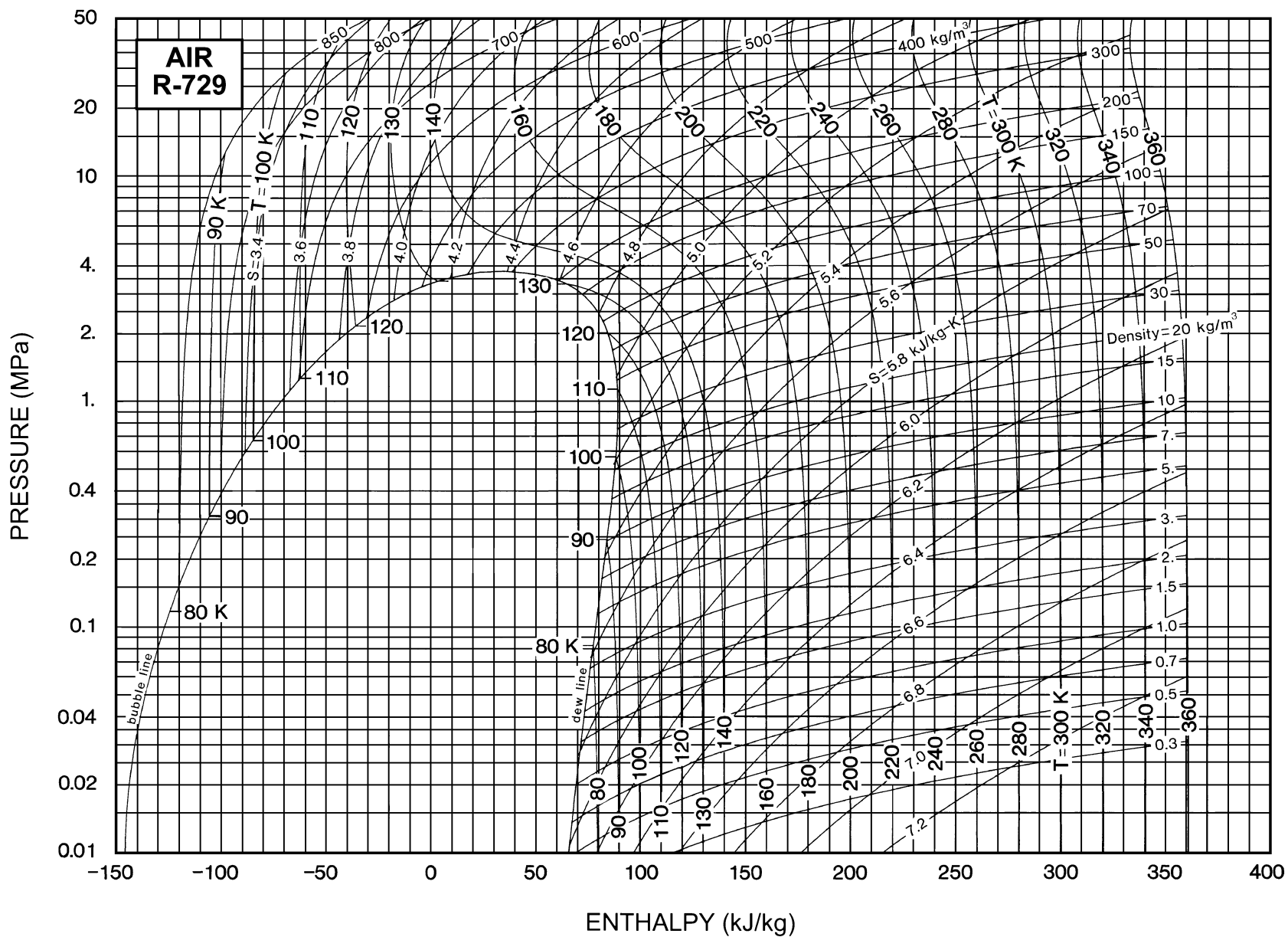


Fig. 26 Pressure-Enthalpy Diagram for Refrigerant 729 (Air)

Refrigerant 729 (Air) Properties of Liquid on the Bubble Line and Vapor on the Dew Line

Absolute Pressure, MPa	Temperature*, K		Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p , kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μ Pa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m
	Bubble	Dew			Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	
0.00625a	59.75	64.00	957.7	2.91977	-162.91	63.49	2.4486	6.1162	1.922	1.025	1.406	1013.	160.	440.3	4.40	174.7	5.62	14.12
0.00800	61.08	65.18	952.2	2.32465	-160.35	64.61	2.4909	6.0635	1.919	1.028	1.407	1004.	161.	399.8	4.49	172.1	5.75	13.80
0.01000	62.33	66.32	946.9	1.88989	-157.95	65.67	2.5298	6.0160	1.917	1.031	1.408	996.	162.	367.2	4.57	169.8	5.87	13.49
0.01500	64.72	68.51	936.8	1.29824	-153.38	67.69	2.6017	5.9306	1.914	1.038	1.410	979.	165.	316.2	4.73	165.3	6.10	12.91
0.02000	66.51	70.18	929.1	0.99507	-149.94	69.20	2.6540	5.8707	1.914	1.044	1.413	966.	167.	285.3	4.85	162.0	6.28	12.48
0.03000	69.20	72.70	917.6	0.68434	-144.79	71.44	2.7298	5.7872	1.915	1.054	1.418	945.	169.	248.0	5.04	157.2	6.55	11.84
0.04000	71.23	74.63	908.7	0.52481	-140.88	73.09	2.7853	5.7286	1.918	1.062	1.422	928.	171.	225.0	5.18	153.5	6.77	11.37
0.05000	72.89	76.20	901.4	0.42717	-137.69	74.41	2.8294	5.6834	1.921	1.070	1.427	914.	172.	208.9	5.30	150.6	6.95	10.98
0.06000	74.30	77.55	895.2	0.36102	-134.97	75.51	2.8662	5.6467	1.924	1.077	1.431	902.	174.	196.7	5.40	148.1	7.10	10.65
0.08000	76.65	79.78	884.7	0.27679	-130.44	77.28	2.9259	5.5891	1.930	1.089	1.439	882.	175.	179.0	5.57	144.1	7.36	10.11
0.10000	78.57	81.61	876.0	0.22518	-126.71	78.67	2.9737	5.5446	1.937	1.100	1.447	865.	177.	166.4	5.71	140.8	7.58	9.67
0.10132b	78.69	81.72	875.5	0.22245	-126.49	78.75	2.9766	5.5420	1.937	1.101	1.448	864.	177.	165.7	5.72	140.6	7.59	9.64
0.15000	82.32	85.20	858.6	0.15460	-119.38	81.22	3.0642	5.4641	1.954	1.126	1.466	830.	179.	145.7	6.00	134.4	8.02	8.82
0.20000	85.22	87.96	844.9	0.11825	-113.66	83.02	3.1317	5.4070	1.970	1.148	1.484	803.	181.	132.5	6.22	129.5	8.37	8.18
0.30000	89.68	92.23	823.0	0.08082	-104.76	85.46	3.2322	5.3262	2.003	1.190	1.520	760.	183.	115.4	6.57	122.2	8.95	7.21
0.40000	93.14	95.55	805.3	0.06152	-97.72	87.06	3.3078	5.2683	2.036	1.230	1.556	725.	184.	104.3	6.86	116.5	9.44	6.48
0.50000	96.01	98.32	790.0	0.04966	-91.78	88.15	3.3693	5.2227	2.070	1.270	1.593	695.	185.	96.1	7.11	111.8	9.87	5.88
0.60000	98.49	100.71	776.4	0.04161	-86.56	88.91	3.4216	5.1847	2.106	1.311	1.631	669.	185.	89.6	7.33	107.7	10.26	5.38
0.80000	102.67	104.74	752.2	0.03132	-77.57	89.74	3.5085	5.1228	2.180	1.398	1.712	623.	186.	79.8	7.72	100.9	10.98	4.55
1.00000	106.14	108.10	730.8	0.02498	-69.83	89.94	3.5800	5.0722	2.263	1.493	1.802	583.	186.	72.4	8.07	95.1	11.65	3.88
1.50000	113.06	114.76	683.2	0.01623	-53.52	88.62	3.7224	4.9703	2.518	1.796	2.088	499.	184.	59.2	8.87	83.5	13.31	2.62
2.00000	118.48	119.94	638.9	0.01163	-39.45	85.36	3.8373	4.8841	2.895	2.258	2.524	427.	182.	49.7	9.64	74.0	15.19	1.70
2.50000	123.02	124.25	593.8	0.00871	-26.22	80.29	3.9402	4.8013	3.533	3.068	3.278	362.	179.	42.0	10.50	65.7	17.82	1.01
3.00000	126.97	127.94	543.3	0.00661	-12.71	72.86	4.0412	4.7123	4.885	4.876	4.917	298.	177.	35.0	11.57	58.9	22.79	0.48
3.78502c	132.62	132.62	302.6	0.00331	38.10	38.10	4.4166	4.4166	—	—	—	—	—	—	—	—	—	0.00

*Temperatures are on the IPTS-68 scale

a = triple point

b = bubble and dew points at 0.101 325 MPa

c = critical point

Refrigerant 729 (Air) Properties of Gas at 0.101 325 MPa (one standard atmosphere)

Temp., °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	c_p , kJ/(kg·K)	c_p/c_v	Vel. Sound, m/s	Viscosity, μ Pa·s	Thermal Cond., mW/(m·K)	Temp., °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	c_p , kJ/(kg·K)	c_p/c_v	Vel. Sound, m/s	Viscosity, μ Pa·s	Thermal Cond., mW/(m·K)
-191.4a	4.4953	78.75	5.5420	1.101	1.448	176.9	5.72	7.59	150.0	0.8338	424.80	7.2170	1.017	1.394	411.7	23.75	34.30
-180.0	3.8899	91.02	5.6825	1.053	1.434	190.6	6.53	8.76	160.0	0.8145	434.98	7.2408	1.019	1.394	416.4	24.15	34.94
-160.0	3.1651	111.75	5.8842	1.026	1.421	211.7	7.92	10.80	170.0	0.7961	445.18	7.2640	1.020	1.393	421.1	24.55	35.57
-140.0	2.6745	132.15	6.0502	1.016	1.414	230.4	9.26	13.22	180.0	0.7786	455.39	7.2868	1.022	1.392	425.7	24.94	36.20
-120.0	2.3179	152.42	6.1921	1.012	1.410	247.6	10.54	14.62	190.0	0.7617	465.62	7.3091	1.024	1.391	430.2	25.32	36.82
-100.0	2.0463	172.63	6.3161	1.009	1.408	263.5	11.76	16.38	200.0	0.7456	475.86	7.3310	1.025	1.390	434.7	25.70	37.45
-90.0	1.9332	182.71	6.3727	1.008	1.407	271.1	12.35	17.23	210.0	0.7302	486.12	7.3525	1.027	1.389	439.1	26.08	38.07
-80.0	1.8321	192.79	6.4263	1.008	1.406	278.5	12.93	18.07	220.0	0.7154	496.40	7.3735	1.029	1.388	443.4	26.46	38.69
-70.0	1.7411	202.86	6.4771	1.007	1.406	285.7	13.49	18.90	230.0	0.7012	506.70	7.3942	1.031	1.387	447.8	26.83	39.31
-60.0	1.6588	212.93	6.5255	1.007	1.405	292.7	14.04	19.70	240.0	0.6875	517.01	7.4145	1.033	1.386	452.0	27.19	39.93
-50.0	1.5840	222.99	6.5717	1.006	1.405	299.5	14.58	20.49	250.0	0.6743	527.35	7.4345	1.035	1.385	456.2	27.56	40.55
-40.0	1.5156	233.06	6.6158	1.006	1.404	306.2	15.11	21.27	260.0	0.6617	537.71	7.4541	1.037	1.384	460.4	27.92	41.16
-30.0	1.4530	243.11	6.6580	1.006	1.404	312.7	15.63	22.03	270.0	0.6495	548.09	7.4734	1.039	1.383	464.5	28.28	41.78
-20.0	1.3953	253.17	6.6986	1.006	1.404	319.1	16.14	22.78	280.0	0.6378	558.49	7.4923	1.041	1.381	468.6	28.63	42.39
-10.0	1.3421	263.23	6.7375	1.006	1.403	325.4	16.65	23.52	290.0	0.6264	568.91	7.5110	1.043	1.380	472.6	28.98	43.00
0.0	1.2928	273.29	6.7750	1.006	1.403	331.5	17.14	24.23	300.0	0.6155	579.35	7.5294	1.045	1.379	476.6	29.33	43.61
10.0	1.2470	283.35	6.8112	1.006	1.402	337.5	17.63	24.95	310.0	0.6049	589.81	7.5475	1.048	1.378	480.5	29.67	44.22
20.0	1.2043	293.41	6.8461	1.006	1.402	343.4	18.10	25.66	320.0	0.5947	600.30	7.5653	1.050	1.377	484.4	30.02	44.83
30.0	1.1644	303.48	6.8799	1.007	1.402	349.2	18.58	26.36	330.0	0.5849	610.81	7.5829	1.052	1.376	488.3	30.36	45.44
40.0	1.1272	313.55	6.9126	1.007	1.401	354.9	19.04	27.06	340.0	0.5753	621.35	7.6002	1.055	1.375	492.1	30.69	46.05
50.0	1.0922	323.62	6.9443	1.008	1.401	360.5	19.50	27.74	350.0	0.5661	631.90	7.6173	1.057	1.373	495.9	31.03	46.66
60.0	1.0594	333.70	6.9750	1.008	1.400	365.9	19.95	28.42	360.0	0.5572	642.48	7.6341	1.059	1.372	499.6	31.36	47.26
70.0	1.0284	343.79	7.0048	1.009	1.400	371.3	20.39	29.10	370.0	0.5485	653.09	7.6508	1.062	1.371	503.4	31.69	47.87
80.0	0.9993	353.88	7.0338	1.010	1.399	376.7	20.83	29.76	380.0	0.5401	663.72	7.6672	1.064	1.370	507.1	32.02	48.47
90.0	0.9717	363.98	7.0620	1.011	1.399	381.9	21.27	30.42	390.0	0.5320	674.37	7.6833	1.066	1.369	510.7	32.35	49.07
100.0	0.9456	374.09	7.0895	1.011	1.398	387.0	21.69	31.08	400.0	0.5241	685.04	7.6993	1.069	1.368	514.3	32.67	49.67
110.0	0.9209	384.21	7.1162	1.012	1.397	392.1	22.12	31.73	420.0	0.5089	706.47	7.7307	1.074	1.365	521.5	33.31	50.87
120.0	0.8975	394.34	7.1423	1.014	1.397	397.1	22.53	32.38	440.0	0.4947	727.99	7.7613	1.078	1.363	528.5	33.95	52.07
130.0	0.8752	404.48	7.1678	1.015	1.396	402.0	22.95	33.02	460.0	0.4812	749.61	7.7912	1.083	1.361	535.4	34.57	53.26
140.0	0.8540	414.64	7.1927	1.016	1.395	406.9	23.35	33.66	480.0	0.4684	771.32	7.8204	1.088	1.359	542.3	35.19	54.45
									500.0	0.4563	793.12	7.8490	1.093	1.357	549.0	35.80	55.64

a = dew point temperature

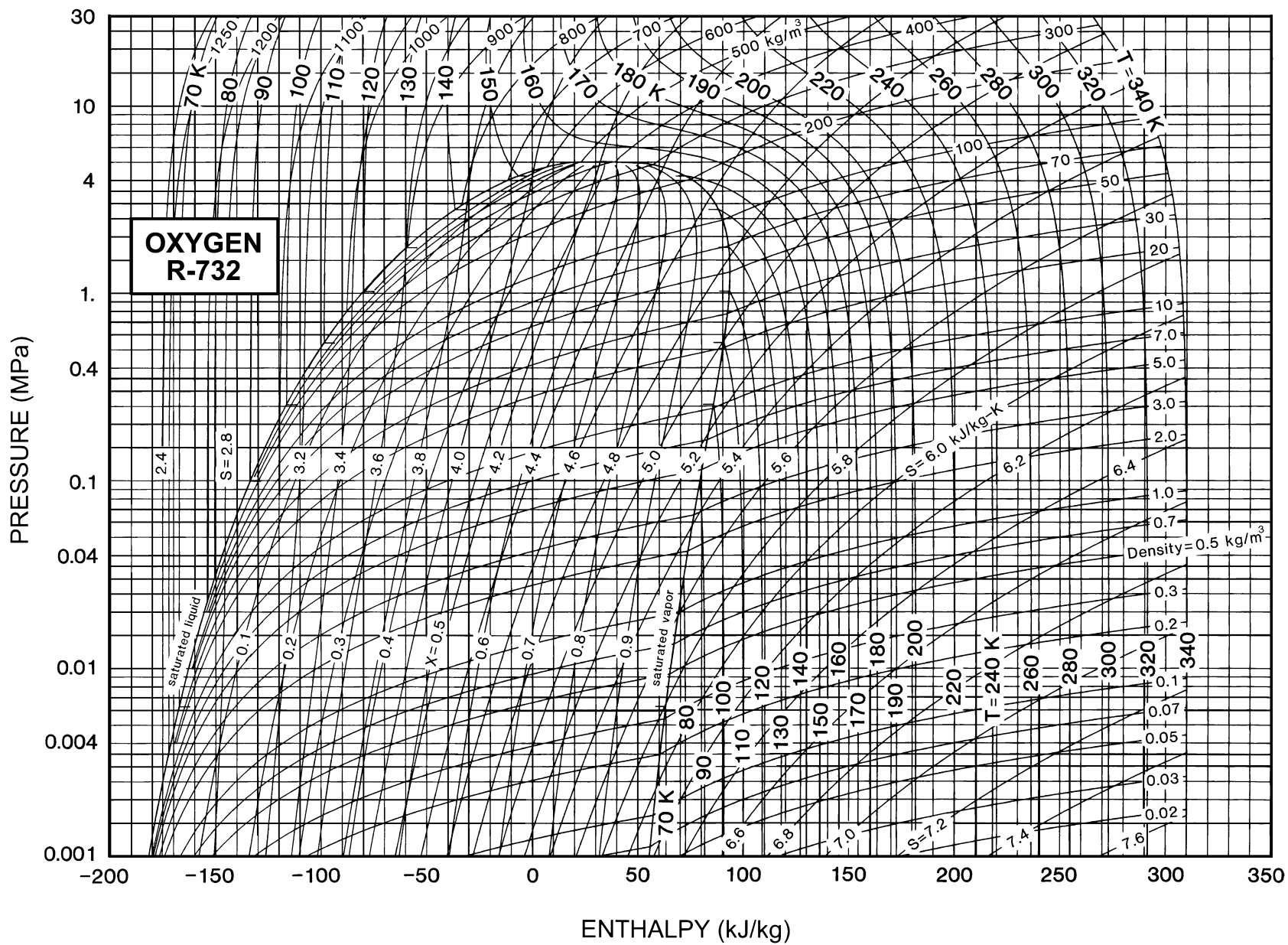


Fig. 27 Pressure-Enthalpy Diagram for Refrigerant 732 (Oxygen)

Refrigerant 732 (Oxygen) Properties of Saturated Liquid and Saturated Vapor

Temp.,* K	Absolute Pressure, MPa	Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p , kJ/(kg·K)		c_p/c_v	Velocity of Sound, m/s		Viscosity, μPa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp.,* K
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
54.36a	0.00015	1306.1	96.543	-193.61	49.11	2.0887	6.5537	1.673	0.926	1.395	1123.	140.3	982.0	4.01	202.9	5.04	22.68	54.36
55.00	0.00018	1303.5	79.987	-192.55	49.68	2.1083	6.5124	1.672	0.928	1.394	1127.	141.1	928.5	4.06	202.1	5.09	22.50	55.00
60.00	0.00073	1282.0	21.462	-184.19	54.19	2.2537	6.2266	1.673	0.948	1.390	1127.	147.0	630.3	4.42	195.2	5.54	21.12	60.00
65.00	0.00233	1259.7	7.2190	-175.81	58.66	2.3878	5.9950	1.677	0.967	1.387	1102.	152.6	462.0	4.78	188.1	6.00	19.76	65.00
70.00	0.00626	1237.0	2.8925	-167.42	63.09	2.5121	5.8051	1.678	0.978	1.387	1066.	158.1	358.8	5.15	180.9	6.46	18.41	70.00
75.00	0.01455	1213.9	1.3293	-159.02	67.45	2.6279	5.6476	1.679	0.979	1.392	1027.	163.3	290.6	5.53	173.8	6.94	17.09	75.00
80.00	0.03012	1190.5	0.6809	-150.61	71.69	2.7363	5.5151	1.682	0.974	1.402	987.	168.4	242.6	5.91	166.7	7.43	15.78	80.00
85.00	0.05683	1166.6	0.38047	-142.18	75.75	2.8383	5.4021	1.688	0.969	1.417	947.	173.1	207.1	6.30	159.6	7.93	14.49	85.00
90.00	0.09935	1142.1	0.22794	-133.69	79.55	2.9349	5.3042	1.699	0.970	1.436	906.	177.3	179.6	6.69	152.6	8.45	13.22	90.00
90.19b	0.10132	1141.2	0.22386	-133.37	79.69	2.9384	5.3008	1.699	0.971	1.437	904.	177.5	178.7	6.71	152.3	8.47	13.17	90.19
95.00	0.16308	1116.9	0.14450	-125.12	83.04	3.0269	5.2181	1.715	0.982	1.460	864.	181.0	157.7	7.09	145.5	9.00	11.98	95.00
100.00	0.25400	1090.9	0.09592	-116.45	86.16	3.1150	5.1411	1.738	1.006	1.491	822.	184.1	139.5	7.50	138.5	9.58	10.75	100.00
105.00	0.37853	1063.8	0.06612	-107.64	88.85	3.1999	5.0712	1.767	1.046	1.528	779.	186.4	124.2	7.92	131.4	10.19	9.56	105.00
110.00	0.54340	1035.5	0.04699	-98.64	91.05	3.2821	5.0066	1.807	1.101	1.576	735.	188.1	111.0	8.35	124.3	10.86	8.39	110.00
115.00	0.75559	1005.6	0.03424	-89.42	92.72	3.3623	4.9460	1.858	1.177	1.638	689.	189.1	99.4	8.79	117.1	11.60	7.25	115.00
120.00	1.0223	973.9	0.02544	-79.90	93.75	3.4409	4.8881	1.927	1.276	1.721	642.	189.4	89.0	9.26	109.9	12.44	6.14	120.00
125.00	1.3509	939.7	0.01919	-70.02	94.06	3.5188	4.8314	2.021	1.411	1.835	592.	189.0	79.5	9.76	102.5	13.42	5.07	125.00
130.00	1.7491	902.5	0.01463	-59.66	93.47	3.5967	4.7746	2.153	1.600	2.000	540.	187.8	70.8	10.31	95.1	14.63	4.04	130.00
135.00	2.2250	861.0	0.01120	-48.65	91.74	3.6757	4.7157	2.354	1.886	2.252	484.	185.7	62.5	10.94	87.5	16.21	3.05	135.00
140.00	2.7878	813.2	0.00856	-36.70	88.47	3.7577	4.6518	2.691	2.370	2.682	423.	182.8	54.6	11.68	79.8	18.49	2.13	140.00
145.00	3.4478	755.1	0.00646	-23.22	82.83	3.8464	4.5777	3.368	3.369	3.561	355.	178.8	46.5	12.64	72.3	22.28	1.27	145.00
150.00	4.2186	675.5	0.00465	-6.67	72.56	3.9512	4.4794	5.464	6.625	6.314	274.	172.8	37.8	14.15	66.2	30.28	0.51	150.00
154.58c	5.0430	436.1	0.00229	32.42	32.42	4.1974	4.1974	∞	∞	∞	0.	0.0	—	—	∞	∞	0.00	154.58

*Temperatures are on the IPTS-68 scale

a = triple point

b = normal boiling point

c = critical point

Refrigerant 732 (Oxygen) Properties of Gas at 0.101 325 MPa (one standard atmosphere)

Temp., °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	c_p , kJ/ (kg·K)	c_p/c_v	Vel. Sound, m/s	Viscosity, μPa·s	Thermal Cond., mW/(m·K)	Temp., °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	c_p , kJ/ (kg·K)	c_p/c_v	Vel. Sound, m/s	Viscosity, μPa·s	Thermal Cond., mW/(m·K)
-183.0a	4.4671	79.69	5.3008	0.971	1.437	177.5	6.71	8.47	150.0	0.9215	387.55	6.7299	0.948	1.379	389.3	27.00	34.83
-180.0	4.3120	82.52	5.3317	0.948	1.439	181.1	6.93	8.75	160.0	0.9002	397.05	6.7521	0.951	1.377	393.7	27.47	35.53
-160.0	3.5050	101.23	5.5137	0.931	1.422	201.0	8.46	10.64	170.0	0.8799	406.58	6.7738	0.954	1.375	398.0	27.94	36.23
-140.0	2.9596	119.78	5.6646	0.924	1.414	218.8	9.96	12.52	180.0	0.8605	416.13	6.7951	0.957	1.373	402.2	28.40	36.92
-120.0	2.5640	138.20	5.7936	0.919	1.409	235.2	11.43	14.38	190.0	0.8419	425.73	6.8161	0.961	1.372	406.4	28.86	37.61
-100.0	2.2630	156.56	5.9062	0.916	1.407	250.4	12.85	16.12	200.0	0.8241	435.35	6.8366	0.964	1.370	410.5	29.31	38.30
-90.0	2.1378	165.72	5.9577	0.916	1.406	257.6	13.54	16.98	210.0	0.8070	445.00	6.8568	0.967	1.368	414.5	29.76	38.99
-80.0	2.0258	174.87	6.0063	0.915	1.405	264.6	14.21	17.82	220.0	0.7906	454.68	6.8766	0.970	1.367	418.5	30.21	39.67
-70.0	1.9251	184.02	6.0525	0.915	1.404	271.5	14.88	18.65	230.0	0.7749	464.40	6.8962	0.973	1.365	422.5	30.65	40.35
-60.0	1.8340	193.16	6.0964	0.914	1.404	278.1	15.53	19.46	240.0	0.7598	474.14	6.9153	0.976	1.363	426.4	31.08	41.03
-50.0	1.7512	202.30	6.1383	0.914	1.403	284.6	16.16	20.26	250.0	0.7453	483.92	6.9342	0.980	1.362	430.3	31.52	41.71
-40.0	1.6756	211.45	6.1784	0.914	1.402	290.9	16.79	21.05	260.0	0.7313	493.74	6.9528	0.983	1.360	434.2	31.95	42.39
-30.0	1.6063	220.59	6.2168	0.915	1.401	297.1	17.40	21.83	270.0	0.7178	503.58	6.9711	0.986	1.359	438.0	32.37	43.06
-20.0	1.5425	229.74	6.2537	0.915	1.401	303.1	18.00	22.60	280.0	0.7048	513.45	6.9891	0.989	1.357	441.7	32.79	43.73
-10.0	1.4836	238.90	6.2892	0.916	1.400	309.0	18.60	23.35	290.0	0.6923	523.36	7.0068	0.992	1.355	445.4	33.21	44.40
0.0	1.4290	248.06	6.3233	0.917	1.399	314.8	19.18	24.10	300.0	0.6802	533.29	7.0243	0.995	1.354	449.1	33.62	45.06
10.0	1.3784	257.23	6.3563	0.918	1.398	320.5	19.75	24.84	310.0	0.6686	543.26	7.0416	0.998	1.352	452.8	34.03	45.72
20.0	1.3312	266.41	6.3882	0.919	1.397	326.0	20.32	25.58	320.0	0.6573	553.26	7.0586	1.001	1.351	456.4	34.44	46.38
30.0	1.2871	275.61	6.4190	0.920	1.396	331.4	20.87	26.30	330.0	0.6464	563.28	7.0753	1.004	1.350	460.0	34.84	47.03
40.0	1.2459	284.82	6.4489	0.922	1.395	336.7	21.42	27.03	340.0	0.6358	573.34	7.0919	1.007	1.348	463.6	35.24	47.68
50.0	1.2072	294.05	6.4779	0.924	1.394	341.9	21.96	27.75	350.0	0.6256	583.43	7.1082	1.010	1.347	467.1	35.64	48.33
60.0	1.1709	303.29	6.5061	0.926	1.392	347.1	22.49	28.47	360.0	0.6157	593.54	7.1243	1.013	1.345	470.6	36.03	48.98
70.0	1.1367	312.56	6.5335	0.928	1.391	352.1	23.02	29.19	370.0	0.6062	603.68	7.1402	1.016	1.344	474.1	36.42	49.62
80.0	1.1045	321.85	6.5602	0.930	1.390	357.0	23.54	29.90	380.0	0.5969	613.86	7.1559	1.019	1.343	477.5	36.81	50.26
90.0	1.0740	331.16	6.5862	0.932	1.388	361.9	24.05	30.61	390.0	0.5879	624.05	7.1714	1.021	1.342	480.9	37.20	50.89
100.0	1.0452	340.49	6.6116	0.935	1.387	366.6	24.56	31.32	400.0	0.5792	634.28	7.1867	1.024	1.340	484.3	37.58	51.53
110.0	1.0179	349.85	6.6363	0.937	1.385	371.3	25.06	32.02	420.0	0.5624	654.81	7.2167	1.029	1.338	491.0	38.34	52.78
120.0	0.9919	359.23	6.6605	0.940	1.384	375.9	25.55	32.73	440.0	0.5467	675.45	7.2461	1.034	1.336	497.6	39.09	54.02
130.0	0.9673	368.64	6.6841	0.943	1.382	380.5	26.04	33.43	460.0	0.5318	696.19	7.2748	1.039	1.334	504.2	39.82	55.25
140.0	0.9439	378.08	6.7072	0.945	1.380	384.9	26.52	34.13	480.0	0.5176	717.02	7.3028	1.044	1.332	510.6	40.55	56.47
									500.0	0.5042	737.95	7.3302	1.049	1.330	517.0	41.27	57.67

a = saturated vapor at normal boiling point

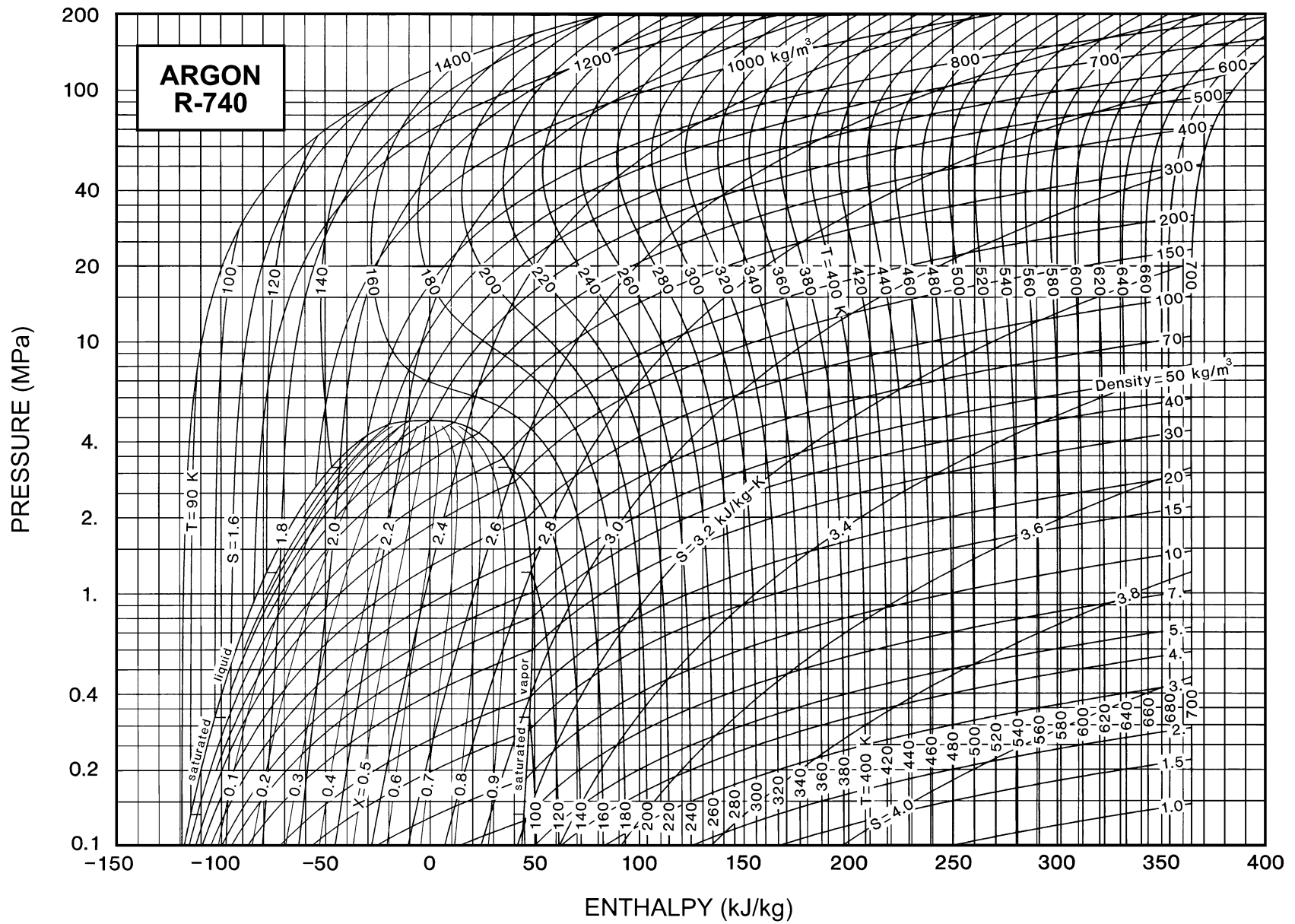


Fig. 28 Pressure-Enthalpy Diagram for Refrigerant 740 (Argon)

Refrigerant 740 (Argon) Properties of Saturated Liquid and Saturated Vapor

Temp.,* K	Absolute Pressure, MPa	Density, kg/m ³ Liquid	Volume, m ³ /kg Vapor	Enthalpy, kJ/kg		Entropy, kJ/(kg·K)		Specific Heat c_p kJ/(kg·K)			Velocity of Sound, m/s		Viscosity, μ Pa·s		Thermal Cond., mW/(m·K)		Surface Tension, mN/m	Temp.,* K
				Liquid	Vapor	Liquid	Vapor	Liquid	Vapor	c_p/c_v Vapor	Liquid	Vapor	Liquid	Vapor	Liquid	Vapor		
83.80a	0.06896	1417.2	0.24653	-121.05	42.59	1.3314	3.2841	1.067	—	—	853.	208.8	282.7	6.68	135.6	5.25	13.42	83.80
84.00	0.07053	1416.0	0.24148	-120.84	42.65	1.3339	3.2803	1.067	—	—	852.	207.4	281.0	6.69	135.3	5.27	13.37	84.00
86.00	0.08820	1404.1	0.19666	-118.70	43.29	1.3591	3.2426	1.074	—	—	839.	196.7	264.7	6.86	132.3	5.41	12.86	86.00
87.29b	0.10132	1396.3	0.17312	-117.30	43.69	1.3751	3.2193	1.078	—	—	830.	192.3	254.9	6.97	130.3	5.51	12.53	87.29
88.00	0.10910	1392.0	0.16174	-116.53	43.91	1.3838	3.2069	1.081	—	—	825.	190.4	249.7	7.04	129.3	5.56	12.35	88.00
90.00	0.13362	1379.7	0.13423	-114.35	44.50	1.4081	3.1730	1.089	—	—	812.	186.4	235.9	7.21	126.3	5.71	11.85	90.00
92.00	0.16212	1367.2	0.11233	-112.15	45.06	1.4320	3.1408	1.097	—	—	798.	183.8	223.2	7.39	123.4	5.86	11.35	92.00
94.00	0.19500	1354.5	0.09473	-109.94	45.59	1.4555	3.1100	1.106	—	—	784.	182.2	211.4	7.57	120.5	6.02	10.86	94.00
96.00	0.23266	1341.6	0.08045	-107.70	46.08	1.4788	3.0807	1.116	—	—	771.	181.2	200.4	7.75	117.6	6.19	10.37	96.00
98.00	0.27553	1328.4	0.06877	-105.44	46.55	1.5018	3.0526	1.127	—	—	757.	180.6	190.2	7.93	114.7	6.36	9.89	98.00
100.00	0.32400	1315.0	0.05914	-103.16	46.97	1.5245	3.0257	1.138	0.617	1.854	742.	180.3	180.7	8.12	111.8	6.53	9.41	100.00
102.00	0.37853	1301.3	0.05114	-100.85	47.35	1.5469	2.9998	1.151	0.644	1.856	728.	180.2	171.8	8.31	109.0	6.71	8.94	102.00
104.00	0.43952	1287.4	0.04445	-98.51	47.68	1.5691	2.9748	1.165	0.670	1.864	714.	180.3	163.4	8.51	106.2	6.90	8.47	104.00
106.00	0.50743	1273.1	0.03881	-96.15	47.96	1.5912	2.9507	1.179	0.695	1.879	699.	180.5	155.5	8.71	103.4	7.10	8.01	106.00
108.00	0.58268	1258.6	0.03403	-93.75	48.19	1.6130	2.9272	1.195	0.720	1.900	684.	180.8	148.0	8.92	100.6	7.31	7.56	108.00
110.00	0.66574	1243.7	0.02996	-91.32	48.35	1.6347	2.9044	1.213	0.746	1.926	669.	181.0	141.0	9.13	97.9	7.53	7.11	110.00
112.00	0.75704	1228.5	0.02646	-88.85	48.44	1.6562	2.8821	1.232	0.773	1.959	653.	181.3	134.3	9.35	95.2	7.76	6.66	112.00
114.00	0.85705	1212.9	0.02345	-86.35	48.46	1.6777	2.8602	1.253	0.801	1.997	637.	181.6	127.9	9.57	92.5	8.00	6.23	114.00
116.00	0.96622	1196.9	0.02085	-83.80	48.40	1.6990	2.8387	1.277	0.832	2.043	621.	181.9	121.9	9.80	89.8	8.25	5.80	116.00
118.00	1.0850	1180.4	0.01858	-81.21	48.25	1.7204	2.8174	1.303	0.867	2.096	604.	182.1	116.1	10.05	87.1	8.52	5.37	118.00
120.00	1.2139	1163.4	0.01659	-78.56	48.01	1.7417	2.7964	1.333	0.905	2.158	587.	182.3	110.6	10.30	84.4	8.81	4.95	120.00
125.00	1.5835	1118.4	0.01260	-71.69	46.92	1.7951	2.7440	1.429	1.026	2.363	541.	182.5	97.6	10.98	77.8	9.62	3.95	125.00
130.00	2.0270	1068.5	0.00964	-64.33	45.01	1.8496	2.6907	1.572	1.209	2.676	491.	182.3	85.7	11.77	71.1	10.64	2.99	130.00
135.00	2.5530	1011.5	0.00737	-56.29	41.97	1.9065	2.6344	1.809	1.515	3.195	434.	181.4	74.5	12.74	64.3	12.02	2.10	135.00
140.00	3.1710	942.4	0.00558	-47.15	37.26	1.9684	2.5713	2.277	2.120	4.201	369.	179.8	63.3	14.00	57.4	14.17	1.28	140.00
145.00	3.8929	849.1	0.00408	-35.87	29.57	2.0418	2.4931	3.577	3.807	6.895	290.	177.0	51.4	15.92	51.2	18.85	0.57	145.00
150.66c	4.8600	530.9	0.00188	-3.56	-3.56	2.2500	2.2500	∞	∞	∞	0.	0.0	—	—	∞	∞	0.00	150.66

*Temperatures are on the IPTS-68 scale

a = triple point

b = normal boiling point

c = critical point

Refrigerant 740 (Argon) Properties of Gas at 0.101 325 MPa (one standard atmosphere)

Temp., °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	c_p , kJ/ (kg·K)	c_p/c_v	Vel. Sound, m/s	Viscos- ity, μ Pa·s	Thermal Cond., mW/(m·K)	Temp., °C	Density, kg/m ³	Enthalpy, kJ/kg	Entropy, kJ/(kg·K)	c_p , kJ/ (kg·K)	c_p/c_v	Vel. Sound, m/s	Viscos- ity, μ Pa·s	Thermal Cond., mW/(m·K)
-185.86a	5.7764	43.69	3.2193	—	—	192.3	6.97	5.51	150.0	1.1505	220.08	4.0527	0.521	1.668	383.3	30.06	23.47
-180.0	5.3850	46.63	3.2518	0.554	1.729	177.6	7.45	5.87	160.0	1.1239	225.29	4.0648	0.521	1.668	387.8	30.61	23.90
-160.0	4.3729	57.75	3.3600	0.543	1.689	196.2	9.07	7.14	170.0	1.0985	230.49	4.0767	0.521	1.668	392.2	31.14	24.31
-140.0	3.6931	68.48	3.4474	0.532	1.685	213.9	10.71	8.45	180.0	1.0742	235.70	4.0884	0.521	1.668	396.6	31.67	24.73
-120.0	3.2000	79.06	3.5214	0.527	1.681	229.9	12.33	9.97	190.0	1.0510	240.91	4.0997	0.521	1.668	401.0	32.20	25.14
-100.0	2.8246	89.58	3.5860	0.525	1.677	244.7	13.92	10.93	200.0	1.0288	246.12	4.1109	0.521	1.668	405.3	32.72	25.54
-90.0	2.6684	94.83	3.6155	0.525	1.676	251.8	14.69	11.51	210.0	1.0075	251.32	4.1217	0.521	1.668	409.5	33.23	25.94
-80.0	2.5288	100.08	3.6433	0.524	1.675	258.6	15.46	12.09	220.0	0.9871	256.53	4.1324	0.521	1.667	413.8	33.74	26.34
-70.0	2.4031	105.31	3.6698	0.524	1.674	265.3	16.21	12.67	230.0	0.9674	261.74	4.1429	0.521	1.667	417.9	34.25	26.74
-60.0	2.2894	110.55	3.6949	0.523	1.673	271.8	16.95	13.25	240.0	0.9486	266.94	4.1531	0.521	1.667	422.1	34.75	27.13
-50.0	2.1861	115.78	3.7189	0.523	1.672	278.1	17.67	13.81	250.0	0.9304	272.15	4.1631	0.521	1.667	426.2	35.24	27.51
-40.0	2.0917	121.01	3.7418	0.523	1.672	284.3	18.38	14.37	260.0	0.9130	277.36	4.1730	0.521	1.667	430.2	35.74	27.90
-30.0	2.0052	126.23	3.7638	0.522	1.671	290.4	19.08	14.91	270.0	0.8962	282.56	4.1827	0.521	1.667	434.2	36.22	28.28
-20.0	1.9256	131.45	3.7848	0.522	1.671	296.3	19.77	15.45	280.0	0.8799	287.77	4.1922	0.521	1.667	438.2	36.71	28.66
-10.0	1.8521	136.67	3.8051	0.522	1.670	302.1	20.45	15.98	290.0	0.8643	292.98	4.2015	0.521	1.667	442.1	37.18	29.03
0.0	1.7840	141.89	3.8245	0.522	1.670	307.8	21.12	16.50	300.0	0.8492	298.18	4.2107	0.521	1.667	446.1	37.66	29.40
10.0	1.7207	147.11	3.8433	0.522	1.670	313.4	21.77	17.01	310.0	0.8347	303.39	4.2197	0.521	1.667	449.9	38.13	29.77
20.0	1.6619	152.33	3.8614	0.522	1.670	318.9	22.42	17.51	320.0	0.8206	308.59	4.2285	0.521	1.667	453.8	38.60	30.13
30.0	1.6069	157.54	3.8789	0.522	1.669	324.4	23.05	18.01	330.0	0.8070	313.80	4.2372	0.521	1.667	457.6	39.06	30.49
40.0	1.5554	162.76	3.8958	0.521	1.669	329.7	23.68	18.49	340.0	0.7938	319.00	4.2458	0.521	1.667	461.4	39.52	30.85
50.0	1.5072	167.97	3.9122	0.521	1.669	334.9	24.30	18.98	350.0	0.7811	324.21	4.2542	0.521	1.667	465.1	39.98	31.21
60.0	1.4618	173.19	3.9281	0.521	1.669	340.0	24.91	19.45	360.0	0.7687	329.41	4.2625	0.521	1.667	468.8	40.43	31.56
70.0	1.4191	178.40	3.9435	0.521	1.669	345.1	25.51	19.92	370.0	0.7568	334.62	4.2707	0.521	1.667	472.5	40.88	31.91
80.0	1.3789	183.61	3.9585	0.521	1.669	350.1	26.10	20.38	380.0	0.7452	339.82	4.2787	0.521	1.667	476.2	41.33	32.26
90.0	1.3408	188.82	3.9730	0.521	1.668	355.0	26.69	20.84	390.0	0.7340	345.03	4.2866	0.521	1.667	479.8	41.77	32.61
100.0	1.3048	194.03	3.9872	0.521	1.668	359.9	27.27	21.29	400.0	0.7231	350.24	4.2944	0.520	1.667	483.4	42.21	32.95
110.0	1.2707	199.24	4.0010	0.521	1.668	364.7	27.84	21.74	420.0	0.7022	360.64	4.3096	0.520	1.667	490.5	43.08	33.63
120.0	1.2384	204.45	4.0144	0.521	1.668	369.4	28.40	22.18	440.0	0.6825	371.05	4.3244	0.520	1.667	497.5	43.94	34.30
130.0	1.2076	209.66	4.0275	0.521	1.668	374.1	28.96	22.62	460.0	0.6639	381.46	4.3388	0.520	1.667	504.5	44.78	34.96
140.0	1.1784	214.87	4.0402	0.521	1.668	378.7	29.52	23.05	480.0	0.6462	391.87	4.3528	0.520	1.667	511.3	45.62	35.61
									500.0	0.6295	402.28	4.3665	0.520	1.667	518.0	46.45	36.25

a = saturated vapor at normal boiling point

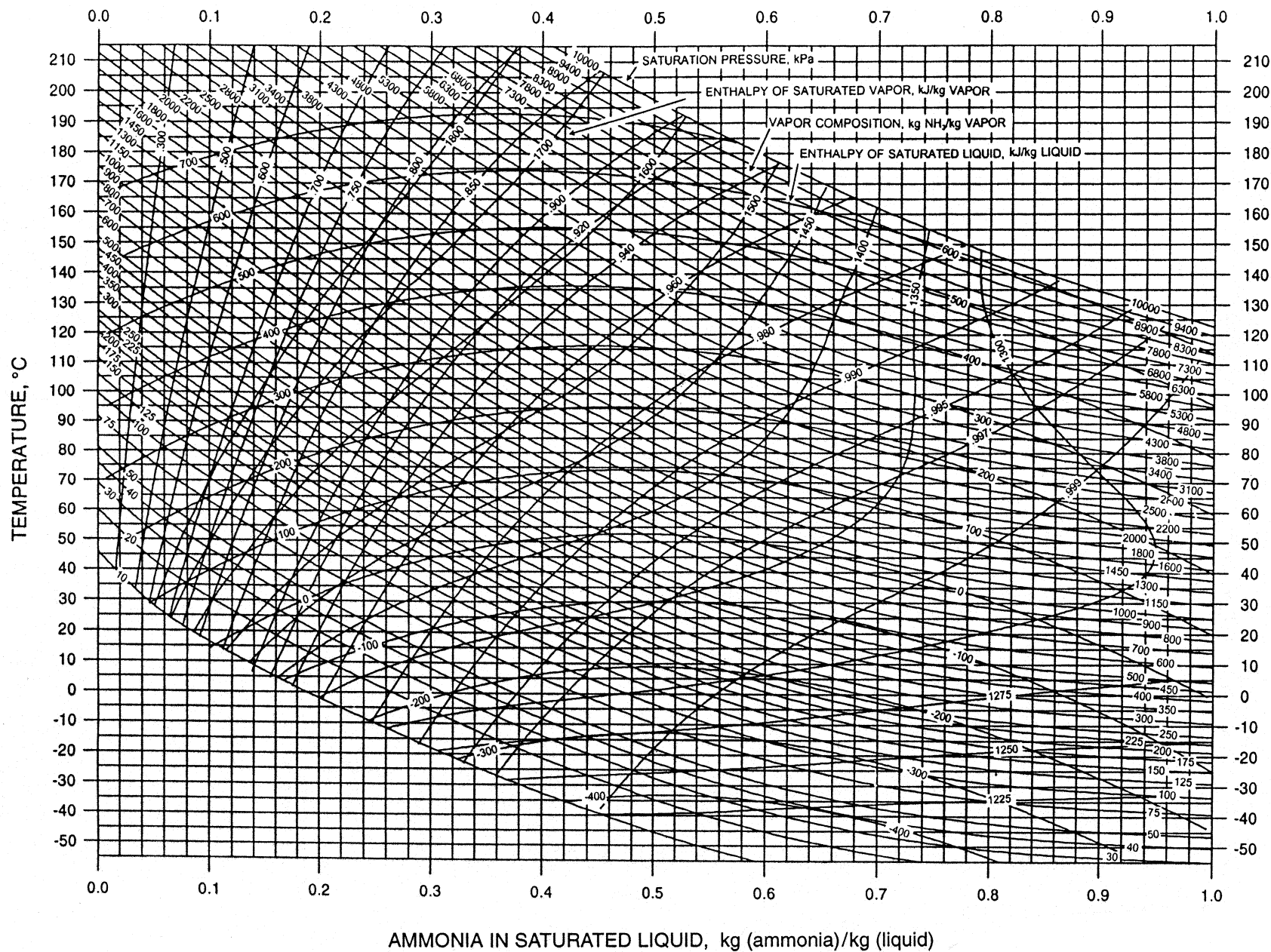


Fig. 29 Enthalpy-Concentration Diagram for Ammonia-Water Solutions

Prepared by: Kwang Kim and Keith Herold, Center for Environmental Energy Engineering, University of Maryland at College Park

Specific Volume of Saturated Ammonia Solutions, m³/kg

Temp., °C	Concentration, Ammonia (Mass basis)											Temp., °C
	0	10	20	30	40	50	60	70	80	90	100	
-10	0.00100	0.00103	0.00106	0.00109	0.00114	0.00118	0.00122	0.00128	0.00135	0.00142	0.00151	-10
0	0.00100	0.00103	0.00107	0.00110	0.00114	0.00119	0.00124	0.00130	0.00137	0.00146	0.00156	0
10	0.00100	0.00104	0.00107	0.00111	0.00115	0.00120	0.00125	0.00132	0.00139	0.00149	0.00160	10
20	0.00100	0.00104	0.00108	0.00112	0.00116	0.00121	0.00127	0.00133	0.00142	0.00152	0.00164	20
30	0.00100	0.00105	0.00108	0.00113	0.00117	0.00123	0.00128	0.00135	0.00145	0.00156	0.00168	30
40	0.00101	0.00105	0.00109	0.00114	0.00119	0.00124	0.00130	0.00138	0.00148	0.00159	0.00173	40
50	0.00101	0.00106	0.00110	0.00115	0.00120	0.00125	0.00132	0.00140	0.00151	0.00163	0.00177	50
60	0.00102	0.00106	0.00111	0.00116	0.00121	0.00127	0.00134	0.00143	0.00154	0.00167	0.00183	60
70	0.00102	0.00107	0.00112	0.00117	0.00122	0.00129	0.00136	0.00146	0.00158	0.00172	0.00190	70
80	0.00103	0.00108	0.00113	0.00118	0.00124	0.00130	0.00139	0.00149	0.00162	0.00178	0.00198	80
90	0.00104	0.00109	0.00114	0.00119	0.00125	0.00132	0.00141	0.00153	0.00167	0.00184	0.00208	90
100	0.00104	0.00110	0.00115	0.00121	0.00127	0.00135	0.00145	0.00157	0.00172	0.00191	0.00219	100

Prepared under Research Project No. 271-RP, sponsored by TC 8.3.

Data reference: B.H. Jennings, Ammonia water properties (paper presented at ASHRAE meeting, January 1965).

Refrigerant Temperature ($t' = ^\circ\text{C}$) and Enthalpy ($h = \text{kJ/kg}$) of Lithium Bromide Solutions

Temp., ($t = ^\circ\text{C}$)		Percent LiBr										
		0	10	20	30	40	45	50	55	60	65	70
20	t'	20	19.1	17.7	15.0	9.8	5.8	-0.4	-7.7	-15.8	-23.4#	-29.3#
	h	84.0	67.4	52.6	40.4	33.5	33.5	38.9	53.2	78.0	111.0#	145.0#
30	t'	30.0	29.0	27.5	24.6	19.2	15.0	8.6	1.0	-7.3	-15.2#	-21.6#
	h	125.8	103.3	84.0	68.6	58.3	56.8	60.5	73.5	96.8	128.4#	161.7#
40	t'	40.0	38.9	37.3	34.3	28.5	24.1	17.5	9.8	1.3	-7.0#	-14.0#
	h	167.6	139.5	115.8	96.0	82.5	79.7	82.2	93.5	115.4	146.0#	178.3#
50	t'	50.0	48.8	47.2	44.0	37.9	33.3	26.5	18.5	9.9	1.3	-6.3#
	h	209.3	175.2	147.0	123.4	106.7	102.6	103.8	114.0	134.5	163.5	195.0#
60	t'	60.0	58.8	57.0	53.6	47.3	42.5	35.5	27.3	18.4	9.5	1.4#
	h	251.1	211.7	179.1	151.4	131.7	125.8	125.8	134.7	153.7	181.4	211.9#
70	t'	70.0	68.7	66.8	63.3	56.6	51.6	44.4	36.1	27.0	17.7	9.0#
	h	293.0	247.7	210.5	178.8	155.7	148.9	148.0	155.6	173.2	199.4	228.8#
80	t'	80.0	78.6	76.7	73.0	66.0	60.8	53.4	44.8	35.6	26.0	16.7#
	h	334.9	287.8	243.6	207.3	181.0	172.8	170.0	176.2	192.6	217.2	245.7#
90	t'	90.0	88.6	86.5	82.6	75.4	70.0	62.3	53.6	44.1	34.2	24.3#
	h	376.9	321.1	275.6	235.4	206.1	195.8	192.3	197.1	212.2	235.6	262.9#
100	t'	100.0	98.5	96.3	92.3	84.7	79.1	71.3	62.4	52.7	42.4	32.0
	h	419.0	357.6	307.9	263.8	231.0	219.9	214.6	218.2	231.5	253.5	279.7
110	t'	110.0	108.4	106.2	101.9	94.1	88.3	80.2	71.1	61.3	50.6	39.7
	h	461.3	394.3	340.1	292.4	255.9	243.3	236.8	239.1	251.0	271.4	296.3
120	t'	120.0*	118.3*	116.0*	111.6	103.4	97.5	89.2	79.9	69.8	58.9	47.3
	h	503.7*	431.0*	372.5*	320.9	281.0	267.0	259.0	260.0	270.2	289.5	313.4
130	t'	130.0*	128.3*	125.8*	121.3*	112.8	106.7	92.8	88.7	78.4	67.1	55.0
	h	546.5*	468.4*	404.5*	349.6*	306.2	290.7	281.0	280.4	289.1	306.9	330.2
140	t'	140.0*	138.2*	135.7*	130.9*	122.2*	115.8	107.1	97.4	87.0	75.3	62.7
	h	589.1*	505.6*	437.8*	377.9*	331.3*	314.2	303.2	301.1	308.1	324.7	346.9
150	t'	150.0*	148.1*	145.5*	140.6*	131.5*	125.0*	116.1*	106.2	95.5	83.5	70.3
	h	632.2*	542.7*	470.5*	406.8*	356.6*	337.8*	325.5*	321.6	327.3	342.7	363.6
160	t'	160.0*	158.1*	155.3*	150.3*	140.9*	134.2*	125.0*	115.0	104.1	91.8	78.9
	h	675.6*	580.8*	503.1*	435.4*	381.9*	361.2*	347.7*	342.2	346.1	360.3	380.1
170	t'	170.0*	168.0*	165.2*	159.9*	150.3*	143.3*	134.0*	123.7	112.7	100.0	85.7
	h	719.2*	618.9*	536.1*	464.3*	406.8*	384.9*	369.9*	362.9	365.4	378.3	396.0
180	t'	180.0*	177.9*	175.0*	169.6*	159.6*	152.5*	142.9*	132.5*	121.2*	108.2	93.3
	h	763.2*	657.1*	569.4*	493.4*	432.1*	408.8*	392.1*	383.4*	384.3*	395.8	411.3

*Extensions of data above 115°C are well above the original data and should be used with care.

#Supersaturated solution.

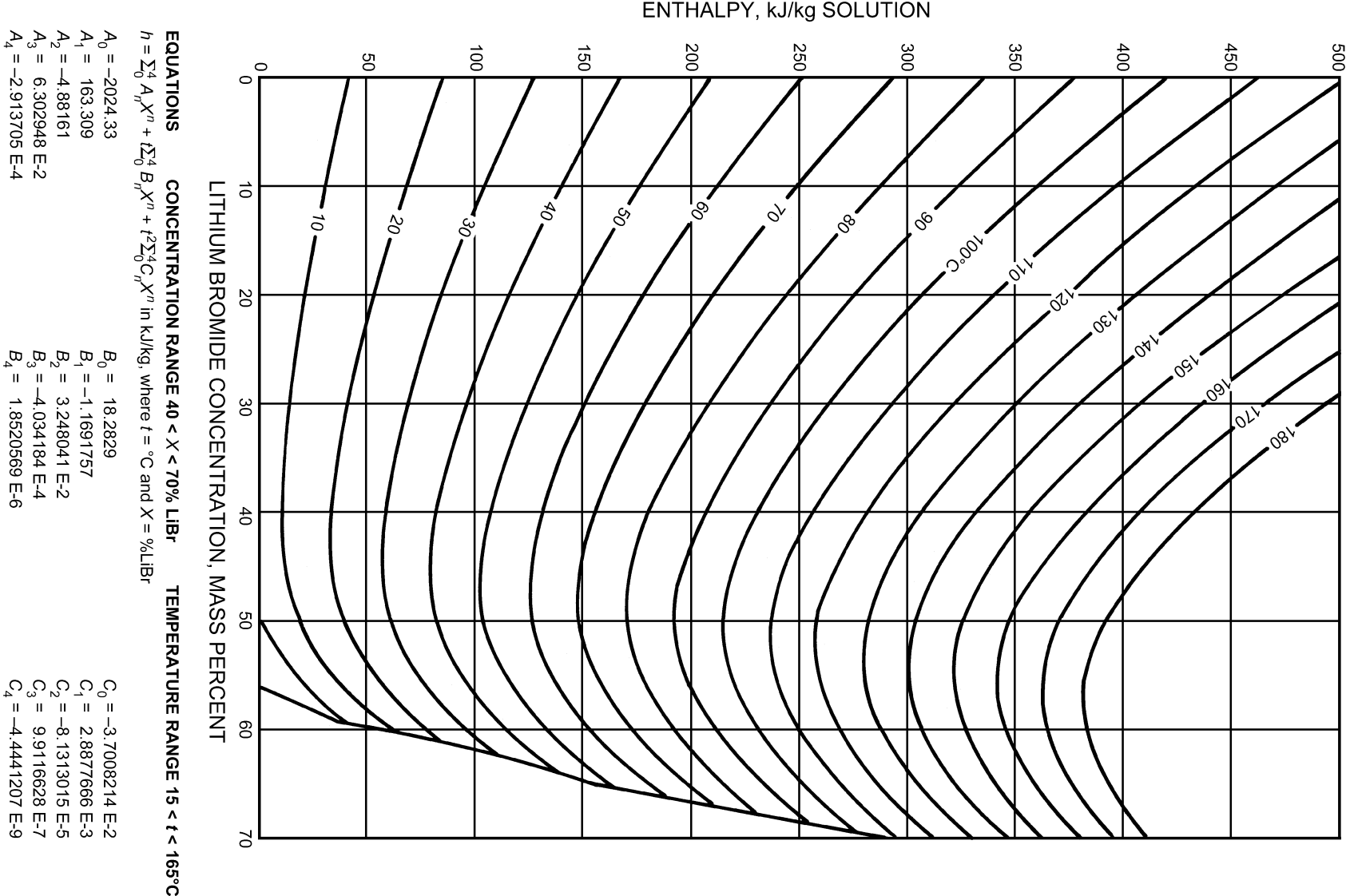


Fig. 30 Enthalpy-Concentration Diagram for Water-Lithium Bromide Solutions

EQUATIONS

$$1. t = \frac{\sum_0^3 B_n X^n + t' \sum_0^3 A_n X^n}{\sum_0^3 A_n X^n} \quad \text{Solution Temperature, } ^\circ\text{C}$$

$$2. t' = \frac{(t - \sum_0^3 B_n X^n) / \sum_0^3 A_n X^n}{\sum_0^3 A_n X^n} \quad \text{Refrigerant Temperature, } ^\circ\text{C}$$

$$3. \log P = C + D/T' + E/T'^2 \quad P = \text{kPa}; \quad T' = \text{K}$$

$$4. T' = \frac{-2E}{D + [D^2 - 4E(C - \log P)]^{0.5}}$$

$$A_0 = -2.007\,55$$

$$B_0 = 124.937$$

$$C = 7.05$$

$$A_1 = 0.169\,76$$

$$B_1 = -7.716\,49$$

$$D = -1596.49$$

$$A_2 = -3.133\,362\,E-03$$

$$B_2 = 0.152\,286$$

$$E = -104\,095.5$$

$$A_3 = 1.976\,68\,E-05$$

$$B_3 = -7.950\,90\,E-04$$

$$\text{RANGE: } -15 < t' < 110^\circ\text{C}$$

$$5 < t < 175^\circ\text{C}$$

$$45 < X < 70\% \text{ LiBr}$$

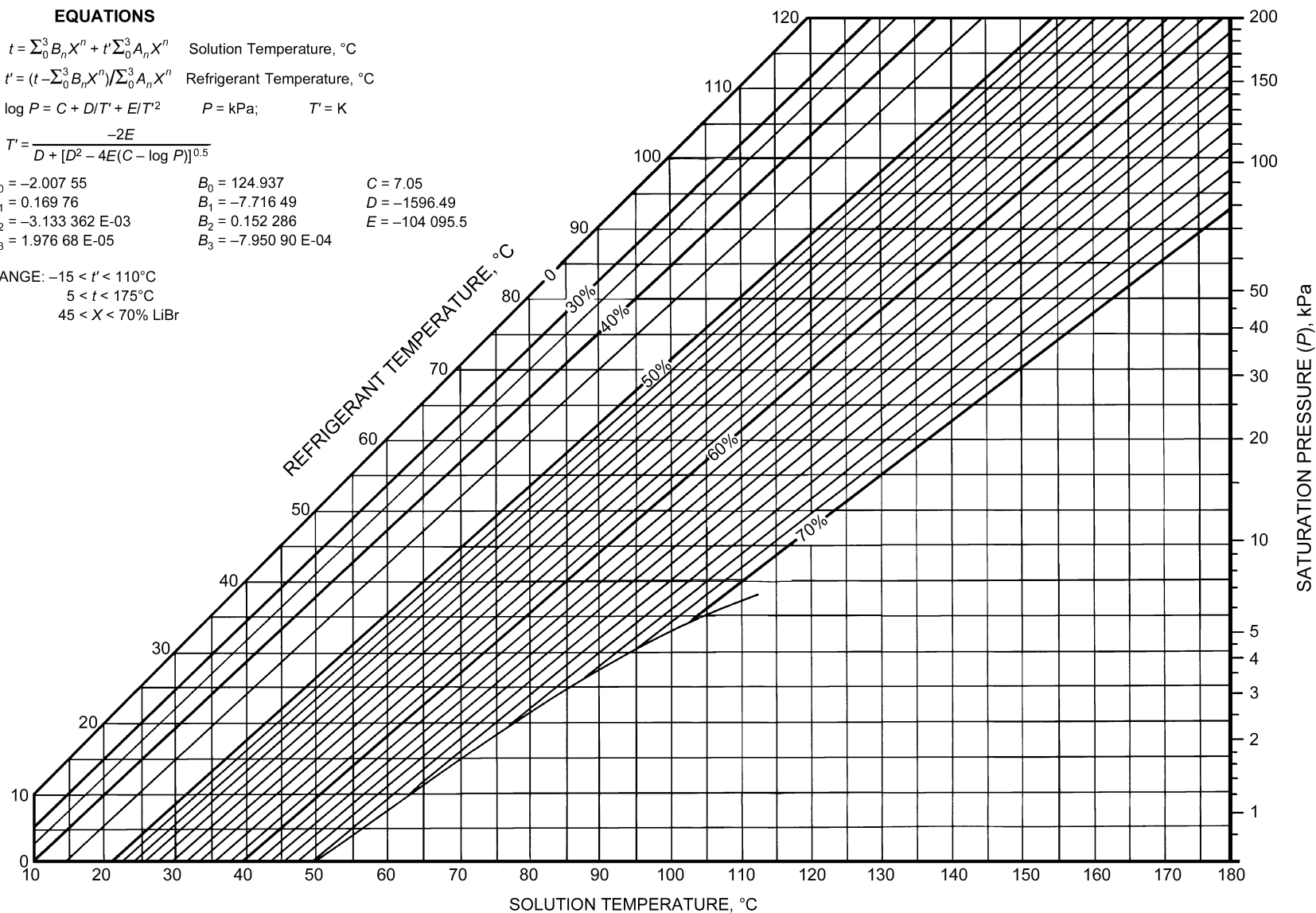


Fig. 31 Equilibrium Chart for Aqueous Lithium Bromide Solutions
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Except where noted below, tables for the halocarbon refrigerants and their blends have been calculated using:

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R-123*Equation of state*

Younglove, B.A. and M.O. McLinden. 1994. An international standard equation-of-state formulation of the thermodynamic properties of refrigerant 123 (2,2-dichloro-1,1,1-trifluoroethane). *Journal of Physical and Chemical Reference Data* 23(5):731-79.

Viscosity

Tanaka, Y. and T. Sotani. 1995. Chapter 2: Transport properties (thermal conductivity and viscosity), R-123. *Thermodynamic and Physical Properties*. International Institute of Refrigeration, Paris.

Thermal conductivity

Laesecke, A., R.A. Perkins, and J.B. Howley. 1996. An improved correlation for the thermal conductivity of HCFC-123 (2,2-dichloro-1,1,1-trifluoroethane). *International Journal of Refrigeration* 19:231-38.

Surface tension

Okada and Higashi. 1995. *op. cit.*

R-124*Equation of state*

de Vries, B., R. Tillner-Roth, and H.D. Baehr. 1995. Thermodynamic properties of HCFC-124. 19th International Congress of Refrigeration, International Institute of Refrigeration, IVa:582-89.

Viscosity

Klein et al. 1997. *op. cit.*

Thermal conductivity

McLinden et al. 2000b. *op. cit.*

Surface tension

Okada and Higashi. 1995. *op. cit.*

R-125*Equation of state*

Sunaga, H., R. Tillner-Roth, H. Sato, and K. Watanabe. 1998. A thermodynamic equation of state for pentafluoroethane (R-125). *International Journal of Thermophysics* 19:1623-35.

Viscosity

Klein et al. 1997. *op. cit.*

Thermal conductivity

McLinden et al. 2000b. *op. cit.*

Surface tension

Okada and Higashi. 1995. *op. cit.*

R-134a*Equation of state*

Tillner-Roth, R. and H.D. Baehr. 1994. An international standard formulation of the thermodynamic properties of 1,1,1,2-tetrafluoroethane (HFC-134a) covering temperatures from 170 K to 455 K at pressures up to 70 MPa. *Journal of Physical and Chemical Reference Data* 23:657-729.

Viscosity

Laesecke, A. 2000. Data reassessment and full surface correlation of the viscosity of HFC-134a (1,1,1,2-tetrafluoroethane). *Journal of Physical and Chemical Reference Data* (submitted).

Thermal conductivity

McLinden et al. 2000b. *op. cit.*

Surface tension

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R-143a*Equation of state*

Lemmon, E.W. and R.T. Jacobsen. 2001. An international standard formulation for the thermodynamic properties of 1,1,1-trifluoroethane (HFC-143a) for temperatures from 161 to 500 K and pressures to 60 MPa. *Journal of Physical and Chemical Reference Data* (in press).

Viscosity

Klein et al. 1997. *op. cit.*

Thermal conductivity

McLinden et al. 2000b. *op. cit.*

Surface tension

Schmidt, J.W., E. Carrillo-Nava, and M.R. Moldover. 1996. Partially halogenated hydrocarbons CHFCl-CF_3 , $\text{CF}_3\text{-CH}_3$, $\text{CF}_3\text{-CHF-CHF}_2$, $\text{CF}_3\text{-CH}_2\text{-CF}_3$, $\text{CHF}_2\text{-CF}_2\text{-CH}_2\text{F}$, $\text{CF}_3\text{-CH}_2\text{-CHF}_2$, $\text{CF}_3\text{-O-CHF}_2$: Critical temperature, refractive indices, surface tension and estimates of liquid, vapor and critical densities. *Fluid Phase Equilibria* 122:187-206.

R-152a*Equation of state*

Outcalt, S.L. and M.O. McLinden. 1996. A modified Benedict-Webb-Rubin equation of state for the thermodynamic properties of R152a (1,1-difluoroethane). *Journal of Physical and Chemical Reference Data* 25(2):605-36.

Viscosity and thermal conductivity

Krauss, R., V.C. Weiss, T.A. Edison, J.V. Sengers, and K. Stephan. 1996. Transport properties of 1,1-Difluoroethane (R-152a). *International Journal of Thermophysics* 17:731-57.

Surface tension

Okada and Higashi. 1995. *op. cit.*

R-245fa*Equation of state**Extended corresponding states model of:*

Huber, M.L. and J.F. Ely. 1994. A predictive extended corresponding states model for pure and mixed refrigerants including an equation of state for R-134a. *International Journal of Refrigeration* 17:18-31.

Fitted to the data of:

Defibaugh, D.R. and M.R. Moldover. 1997. Compressed and saturated liquid densities for 18 halogenated organic compounds. *Journal of Chemical and Engineering Data* 42:160-68.

Viscosity

Klein et al. 1997. *op. cit.*

Thermal conductivity

McLinden et al. 2000b. *op. cit.*

Surface tension

Schmidt et al. 1996. *op. cit.*

R-404A*Equation of state*

Lemmon, E.W. and R.T. Jacobsen. 1999. Thermodynamic properties of mixtures of R-32, R-125, R-134a, and R-152a. *International Journal of Thermophysics* 20:1629-38.

Viscosity

Klein et al. 1997. *op. cit.*

Thermal conductivity

McLinden et al. 2000b. *op. cit.*

Surface tension

Moldover, M.R. and J.C. Rainwater. 1988. Interfacial tension and vapor-liquid equilibria in the critical region of mixtures. *J. Chem. Phys.* 88: 7772-80.

R-407C*Equation of state*

Lemmon and Jacobsen. 1999. *op. cit.*

Viscosity

Klein et al. 1997. *op. cit.*

Thermal conductivity

McLinden et al. 2000b. *op. cit.*

Surface tension

Moldover and Rainwater. 1988. *op. cit.*

R-410A*Equation of state*

Lemmon and Jacobsen. 1999. *op. cit.*

Viscosity

Klein et al. 1997. *op. cit.*

Thermal conductivity

McLinden et al. 2000b. *op. cit.*

Surface tension

Moldover and Rainwater. 1988. *op. cit.*

R-507A*Equation of state*

Lemmon and Jacobsen. 1999. *op. cit.*

Viscosity

Klein et al. 1997. *op. cit.*

Thermal conductivity

McLinden et al. 2000b. *op. cit.*

Surface tension

Moldover and Rainwater. 1988. *op. cit.*

R-717 (Ammonia)*Equation of state*

Tillner-Roth, R., F. Harms-Watzenberg, and H.D. Baehr. 1993. Eine neue Fundamentalgleichung für Ammoniak. *DKV-Tagungsbericht* 20(II): 167-81.

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Fenghour, A., W.A. Wakeham, V. Vesovic, J.T.R. Watson, J. Millat, and E. Vogel. 1995. The viscosity of ammonia. *Journal of Physical and Chemical Reference Data* 24:1649-67.

Thermal conductivity

Tufeu, R., D.Y. Ivanov, Y. Garrabos, and B. Le Neindre. 1984. Thermal conductivity of ammonia in a large temperature and pressure range including the critical region. *Ber. Bunsen-Ges. Phys. Chem.* 88:422-27.

Surface tension

Stairs, R.A. and M.J. Sienko. 1956. Surface tension of ammonia and of solutions of alkali halides in ammonia. *J. Am. Chem. Soc.* 78: 920-923.

R-718 (Water/Steam)*Data computed using*

Harvey, A.H., S.A. Klein, and A.P. Peskin. 1999. NIST Standard Reference Database 10. NIST/ASME Steam properties database, Version 2.2. Standard Reference Data Program.

Equation of state

Wagner, W. and A. Pruß. 1999. New international formulation for the thermodynamic properties of ordinary water substance for general and scientific use. *Journal of Physical and Chemical Reference Data* (to be submitted).

Viscosity and thermal conductivity

Kestin, J., J.V. Sengers, B. Kamgar-Parsi, and J.M.H. Levelt Sengers. 1984. Thermophysical properties of fluid H_2O . *Journal of Physical and Chemical Reference Data* 13:175.

Surface tension

IAPWS. 1995. Physical chemistry of aqueous systems: Meeting the needs of industry. Proceedings 12th International Conference on the Properties of Water and Steam, Orlando. Begell House, Inc., A139-A142. International Association for the Properties of Steam.

R-744 (Carbon Dioxide)*Equation of state*

Span, R. and W. Wagner. 1996. A new equation of state for carbon dioxide covering the fluid region from the triple-point temperature to 1100 K at pressures up to 800 MPa. *Journal of Physical and Chemical Reference Data* 26:1509-96.

Viscosity

Fenghour et al. 1995. *op. cit.*

Thermal conductivity

Vesovic, V., W.A. Wakeham, G.A. Olchoway, J.V. Sengers, J.T.R. Watson, and J. Millat. 1990. The transport properties of carbon dioxide. *Journal of Physical and Chemical Reference Data* 19:763-808.

Surface tension

Rathjen, W. and J. Straub. 1977. Chapter 18, Temperature dependence of surface tension, coexistence curve, and vapor pressure of CO_2 , CClF_3 , CBrF_3 , and SF_6 . *Heat transfer in boiling*. Academic Press, New York.

R-50 (Methane)*Equation of state*

Setzmann, U. and W. Wagner. 1991. A new equation of state and tables of thermodynamic properties for methane covering the range from the melting line to 625 K at pressures to 1000 MPa. *Journal of Physical and Chemical Reference Data* 20:1061-1151.

Viscosity

Younglove, B.A. and J.F. Ely. 1987. Thermophysical properties of fluids. II. Methane, ethane, propane, isobutane and normal butane. *Journal of Physical and Chemical Reference Data* 16:577-798.

Thermal conductivity

Friend, D.G., J.F. Ely, and H. Ingham. 1989. Thermophysical properties of methane. *Journal of Physical and Chemical Reference Data* 18(2):583-638.

Surface tension

Somayajulu, G.R. 1988. A generalized equation for surface tension from the triple point to the critical point. *Int. J. of Thermophysics* 9:559-66.

R-170 (Ethane)*Equation of state, viscosity, and thermal conductivity*

Friend, D.G., H. Ingham, and J.F. Ely. 1991. Thermophysical properties of ethane. *Journal of Physical and Chemical Reference Data* 20(2):275-347.

Surface tension

Soares, V.A.M., B.d.J.V.S. Almeida, I.A. McLure, and R.A. Higgins. 1986. Surface tension of pure and mixed simple substances at low temperature. *Fluid Phase Equilibria* 32:9-16.

R-290 (Propane)*Equation of state and thermal conductivity*

Younglove and Ely. 1987. *op. cit.*

Viscosity

Vogel, E., C. Kuchenmeister, E. Bich, and A. Laesecke. 1998. Reference correlation of the viscosity of propane. *Journal of Physical and Chemical Reference Data* 27:947-70.

Thermal conductivity

Marsh, K., R. Perkins, and M.L.V. Ramires. 2001. Measurement and correlation of the thermal conductivity of propane from 86 to 600 K at pressures to 70 MPa. *Journal of Chemical and Engineering Data* (in press).

Surface tension:

Baidakov, V.G. and I.I. Sulla. 1985. Surface tension of propane and isobutane at near-critical temperatures. *Russian Journal of Physical Chemistry* 59:551-54.

R-600 (n-Butane)*Equation of state, viscosity, and thermal conductivity*

Younglove and Ely. 1987. *op. cit.*

Surface tension

Calado, J.C.G., I.A. McLure, and V.A.M. Soares. 1978. Surface tension for octafluorocyclobutane, n-butane and their mixtures from 233 K to 254 K, and vapour pressure, excess gibbs function and excess volume for the mixture at 233 K. *Fluid Phase Equilibria* 2:199-213.

Coffin, C.C. and O. Maass. 1928. The preparation and physical properties of a-, b- and g-butylene and normal and isobutane. *Journal of the American Chemical Society* 50:1427-37.

R-600a (Isobutane)*Equation of state, viscosity, and thermal conductivity*

Younglove and Ely. 1987. *op. cit.*

Surface tension

Baidakov and Sulla. 1985. *op. cit.*

R-1150 (Ethylene)*Equation of state*

Smukala, J., R. Span, and W. Wagner. 1999. A new fundamental equation for the fluid state of ethylene for temperatures from the melting line to 450 K and pressure to 300 MPa. *Fortschritt-Berichte VDI*, Duesseldorf, Series 3, Number 616.

Viscosity and thermal conductivity

Holland, P.M., Eaton, B.E. and Hanley, H.J.M. 1983. A correlation of the viscosity and thermal conductivity data of gaseous and liquid ethylene. *Journal of Physical and Chemical Reference Data* 12:917-32.

Surface tension

Soares, V.A.M., B.d.J.V.S. Almeida, I.A. McLure, and R.A. Higgins. 1986. Surface tension of pure and mixed simple substances at low temperature. *Fluid Phase Equilibria* 32:9-16.

R-1270 (Propylene)*Equation of state*

Angus, S., B. Armstrong, and K.M. de Reuck. 1980. International thermodynamic tables of the fluid state—7: Propylene. Pergamon Press, Oxford, England.

Surface tension

Maass, O. and C.H. Wright. 1921. Some physical properties of hydrocarbons containing two and three carbon atoms. *Journal of the American Chemical Society* 43:1098-1111.

†R-702 (Hydrogen)

Thermodynamic data computed using the ALLPROPS database, Version 4.0: Lemmon, E.W., R.T. Jacobsen, S.G. Penoncello, and S.W. Beyerlein. 1994. Computer programs for the calculation of thermodynamic properties of cryogenics and other fluids. *Advances in Cryogenic Engineering* 39:1891-97.

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Friend, D.G., R.D. McCarty, and V. Arp. 1992. NIST Thermophysical properties of pure fluids database, Version 3.0. Standard Reference Data Program.

†Indicates data reprinted from the 1997 ASHRAE Handbook.

Equation of state, viscosity, and thermal conductivity

McCarty, R.D. 1975. Hydrogen: Technology survey—Thermophysical properties. NASA SP-3089.

Surface tension

Liley, P.E. and P.D. Desai. 1993. *ASHRAE Thermophysical properties of refrigerants*.

†R-702p (Parahydrogen)

Thermodynamic data computed using the ALLPROPS database, Version 4.0: Lemmon et al. 1994. *op. cit.*

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Friend et al. 1992. *op. cit.*

Equation of state, viscosity, and thermal conductivity

Younglove, B.A. 1982. Thermophysical properties of fluids. I. Argon, ethylene, parahydrogen, nitrogen, nitrogen trifluoride, and oxygen. *Journal of Physical and Chemical Reference Data* 11(Supplement No. 1).

Surface tension

Liley and Desai. 1993. *op. cit.*

†R-704 (Helium)

Thermodynamic data computed using the ALLPROPS database, Version 4.0: Lemmon et al. 1994. *op. cit.*

Transport data computed using the NIST12 database, Version 3.0:

Friend et al. 1992. *op. cit.*

Equation of state, viscosity, and thermal conductivity

Arp, V.D., R.D. McCarty, and D.G. Friend. 1995. Thermophysical properties of helium-4 from 0.8 to 1500 K with pressures to 2000 MPa. NIST Technical Note 1334 (revised).

Surface tension

Liley and Desai. 1993. *op. cit.*

†R-728 (Nitrogen)

Thermodynamic data computed using the ALLPROPS database, Version 4.0: Lemmon et al. 1994. *op. cit.*

Equation of state

Jacobsen, R.T., R.B. Stewart, and M. Jahangiri. 1986. Thermodynamic properties of nitrogen from the freezing line to 2000 K at pressures to 1000 MPa. *Journal of Physical and Chemical Reference Data* 15(2):735-909.

Viscosity and thermal conductivity

Ely, J.F. 1997. Correlation contained in the AIRPROPS database, Version 1.0.

Surface tension

Lemmon, E.W. and S.G. Penoncello. 1994. The surface tension of air and air component mixtures. *Advances in Cryogenic Engineering* 39:1927-34.

†R-729 (Air)

Data computed using the AIRPROPS database, Version 1.0.

Lemmon, E.W. 1997. NIST thermophysical properties of air and air component mixtures, Version 1.0. Standard Reference Data Program.

Equation of state, viscosity, and thermal conductivity

Jacobsen, R.T., S.G. Penoncello, S.W. Beyerlein, D.G. Friend, J.F. Ely, J.C. Rainwater, and W.M. Haynes. 1995. Thermophysical properties of air. National Institute of Standards and Technology, Supplement to NASP Technical Memorandum 1005, NASA Langley Research Center.

Surface tension

Lemmon and Penoncello. 1994. *op. cit.*

†R-732 (Oxygen)

Thermodynamic data computed using the ALLPROPS database, Version 4.0: Lemmon et al. 1994. *op. cit.*

Equation of state

Schmidt, R. and W. Wagner. 1985. A new form of the equation of state for pure substances and its application to oxygen. *Fluid Phase Equilibria* 19:175-200.

Viscosity and thermal conductivity

Ely. 1997. *op. cit.*

Surface tension

Lemmon and Penoncello. 1994. *op. cit.*

†R-740 (Argon)

Thermodynamic data computed using the ALLPROPS database, Version 4.0: Lemmon et al. 1994. *op. cit.*

Equation of state

Stewart, R.B. and R.T. Jacobsen. 1989. Thermodynamic properties of argon from the triple point to 1200 K with pressures to 1000 MPa. *Journal of Physical and Chemical Reference Data* 18(2):639-798.

Viscosity and thermal conductivity

Ely. 1997. *op. cit.*

Surface tension

Lemmon and Penoncello. 1994. *op. cit.*