Designation: D4650 – 14

Standard Specification for Normal Butane Thermophysical Property Tables[1]

This standard is issued under the fixed designation D4650; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 The thermophysical property tables for normal butane are for use in the calculation of the pressure-volume-temperature (PVT), thermodynamic, and transport properties of normal butane for process design and operations. Two tables provide properties at the conditions of liquid-vapor equilibrium (saturation properties), one for liquid and one for vapor, at temperatures between 135 K and the critical point, 425.13 K. A third table provides properties at selected *T*, *p* points for the equilibrium phase at temperatures between 140 K and 560 K at pressures to 20 MPa. The tables were developed using the National Institute of Standards and Technology Standard Reference Database product REFPROP, version 9.1.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

2. Applicability

2.1 These tables apply directly only to pure normal butane. They may also be used in mathematical models and tables for the thermophysical properties of mixtures containing normal butane.

3. Tables

3.1 These tables were produced by equations from a computer package, "NIST Standard Reference Database 23; Reference Fluid Thermodynamic and Transport Properties Database (REFPROP): Version 9.1."[2] A wide selection of units (SI units, engineering units, chemical units) and additional properties are available with this program.

3.2 These thermophysical property tables are:

3.2.1 *Thermophysical Properties of Normal Butane Liquid at Vapor-Liquid Equilibrium, in SI units*. See Table 1.

3.2.2 *Thermophysical Properties of Normal Butane Vapor at Vapor-Liquid Equilibrium, in SI units*. See Table 2.

3.2.3 *Thermophysical Properties of Normal Butane Along Isobars, in SI units*. See Table 3.

3.3 The symbols are:

T, temperature (K)
ρ, molar density ($mol \cdot L_{-1}$)
H, molar enthalpy ($J \cdot mol_{-1}$)
S, molar entropy ($J \cdot K_{-1} \cdot mol_{-1}$)
Cv, constant volume molar heat capacity ($J \cdot K_{-1} \cdot mol_{-1}$)
Cp, constant pressure molar heat capacity ($J \cdot K_{-1} \cdot mol_{-1}$)
c, speed of sound ($m \cdot s_{-1}$)
η, viscosity (μPa·s)
λ, thermal conductivity ($mW \cdot m_{-1} \cdot K_{-1}$)

3.4 The tabulated thermophysical properties are:

ρ, molar density ($mol \cdot L_{-1}$)
H, molar enthalpy ($J \cdot mol_{-1}$)
S, molar entropy ($J \cdot K_{-1} \cdot mol_{-1}$)
Cv, constant volume molar heat capacity ($J \cdot K_{-1} \cdot mol_{-1}$)
Cp, constant pressure molar heat capacity ($J \cdot K_{-1} \cdot mol_{-1}$)
c, speed of sound ($m \cdot s_{-1}$)
η, viscosity (μPa·s)
λ, thermal conductivity ($mW \cdot m_{-1} \cdot K_{-1}$)

4. Additional Information

4.1 Reference state properties are required to calculate the thermodynamic properties enthalpy and entropy from an equation of state formulation. The reference state properties used are those specified by the International Institute of Refrigeration (IIR): enthalpy, *H*= 200 J/g, and entropy, *S*= 1 J/(g·K), for the saturated liquid at 273.15K (0°C).

4.2 The molar mass of normal butane is 58.122 g/mol.

5. Keywords

5.1 butane; N-butane; natural gas; normal butane gas tables; thermodynamic properties of normal butane; transport properties of normal butane

[1] This specification is under the jurisdiction of ASTM Committee D03 on Gaseous Fuels and is the direct responsibility of Subcommittee D03.08 on Thermophysical Properties.

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[2] Available from Standard Reference Data, National Institute of Standards and Technology (NIST), 100 Bureau Drive, Stop 3460, Gaithersburg, MD 20899.

TABLE 1 Thermophysical Properties of Normal Butane Liquid at Vapor-Liquid Equilibrium

T K	p MPa	ρ mol·l^{-1}	H J·mol^{-1}	S J·mol^{-1}·K^{-1}	C_v J·mol^{-1}·K^{-1}	C_p J·mol^{-1}·K^{-1}	c m·s^{-1}	η μPa·s	λ mW·m^{-1}·K^{-1}
135	6.7910E-07	12.643	-5208.7	-26.944	83.783	114.67	1826.10	2294.1	176.52
137	9.8726E-07	12.611	-4979.3	-25.257	83.793	114.77	1812.80	2114.2	175.86
139	1.4181E-06	12.579	-4749.6	-23.593	83.799	114.87	1799.60	1958.0	175.18
141	2.0137E-06	12.547	-4519.8	-21.951	83.805	114.97	1786.60	1821.1	174.49
143	2.8282E-06	12.515	-4289.8	-20.331	83.809	115.07	1773.70	1700.2	173.78
145	3.9306E-06	12.483	-4059.5	-18.732	83.814	115.17	1761.00	1592.7	173.06
147	5.4080E-06	12.451	-3829.1	-17.154	83.819	115.27	1748.50	1496.5	172.32
149	7.3695E-06	12.419	-3598.4	-15.596	83.827	115.38	1736.00	1409.9	171.57
151	9.9501E-06	12.387	-3367.6	-14.056	83.836	115.50	1723.70	1331.5	170.81
153	1.3316E-05	12.355	-3136.5	-12.536	83.848	115.61	1711.40	1260.3	170.03
155	1.7670E-05	12.323	-2905.1	-11.034	83.864	115.73	1699.30	1195.3	169.24
157	2.3258E-05	12.291	-2673.5	-9.5491	83.883	115.85	1687.20	1135.7	168.44
159	3.0374E-05	12.259	-2441.7	-8.0818	83.906	115.98	1675.20	1081.0	167.63
161	3.9370E-05	12.227	-2209.6	-6.6312	83.933	116.11	1663.20	1030.5	166.81
163	5.0664E-05	12.194	-1977.2	-5.1968	83.965	116.25	1651.30	983.74	165.98
165	6.4747E-05	12.162	-1744.6	-3.7782	84.002	116.39	1639.50	940.39	165.14
167	8.2193E-05	12.130	-1511.6	-2.3750	84.044	116.54	1627.70	900.09	164.29
169	0.00010367	12.098	-1278.4	-0.98666	84.092	116.69	1616.00	862.52	163.43
171	0.00012996	12.066	-1044.9	0.38715	84.145	116.85	1604.30	827.43	162.57
173	0.00016194	12.034	-810.99	1.7469	84.204	117.02	1592.60	794.58	161.69
175	0.00020064	12.002	-576.79	3.0928	84.269	117.19	1581.00	763.78	160.81
177	0.00024721	11.969	-342.24	4.4255	84.340	117.36	1569.40	734.84	159.93
179	0.00030297	11.937	-107.33	5.7452	84.418	117.54	1557.90	707.60	159.03
181	0.00036941	11.905	127.95	7.0523	84.501	117.73	1546.40	681.93	158.13
183	0.00044817	11.873	363.61	8.3471	84.592	117.93	1534.90	657.70	157.23
185	0.00054113	11.840	599.67	9.6300	84.688	118.13	1523.40	634.79	156.32
187	0.00065035	11.808	836.14	10.901	84.792	118.34	1512.00	613.11	155.40
189	0.00077813	11.775	1073.0	12.161	84.902	118.55	1500.60	592.57	154.48
191	0.0009270	11.743	1310.4	13.410	85.018	118.77	1489.20	573.07	153.56
193	0.0010997	11.710	1548.2	14.649	85.142	119.00	1477.80	554.55	152.63
195	0.0012994	11.678	1786.4	15.877	85.272	119.24	1466.50	536.94	151.70
197	0.0015293	11.645	2025.1	17.095	85.409	119.48	1455.20	520.18	150.76
199	0.0017931	11.612	2264.4	18.303	85.553	119.73	1443.90	504.21	149.83
201	0.0020948	11.580	2504.1	19.501	85.704	119.99	1432.60	488.97	148.89
203	0.0024385	11.547	2744.3	20.691	85.861	120.25	1421.30	474.43	147.94
205	0.0028290	11.514	2985.1	21.871	86.026	120.52	1410.10	460.54	147.00
207	0.0032710	11.481	3226.5	23.042	86.197	120.80	1398.80	447.25	146.05
209	0.0037700	11.448	3468.4	24.205	86.375	121.09	1387.60	434.54	145.11
211	0.0043316	11.415	3710.9	25.360	86.559	121.38	1376.40	422.36	144.16
213	0.0049618	11.382	3954.0	26.506	86.751	121.68	1365.20	410.69	143.21
215	0.0056671	11.349	4197.7	27.645	86.949	121.99	1354.10	399.50	142.26
217	0.0064543	11.316	4442.1	28.776	87.153	122.31	1342.90	388.76	141.31
219	0.0073306	11.282	4687.0	29.899	87.365	122.63	1331.80	378.45	140.36
221	0.0083037	11.249	4932.7	31.015	87.582	122.96	1320.60	368.54	139.40
223	0.0093815	11.215	5179.0	32.124	87.807	123.30	1309.50	359.01	138.45
225	0.010573	11.182	5426.1	33.227	88.037	123.65	1298.40	349.84	137.50
227	0.011886	11.148	5673.8	34.322	88.274	124.01	1287.40	341.01	136.55
229	0.013331	11.114	5922.2	35.411	88.517	124.37	1276.30	332.51	135.61
231	0.014917	11.080	6171.4	36.494	88.767	124.74	1265.20	324.32	134.66
233	0.016655	11.046	6421.4	37.571	89.022	125.12	1254.20	316.42	133.71
235	0.018554	11.012	6672.1	38.642	89.284	125.50	1243.20	308.79	132.77
237	0.020627	10.978	6923.6	39.707	89.551	125.90	1232.10	301.44	131.83
239	0.022885	10.943	7176.0	40.766	89.824	126.30	1221.10	294.33	130.89
241	0.025338	10.909	7429.1	41.820	90.104	126.71	1210.20	287.47	129.95
243	0.028001	10.874	7683.1	42.868	90.388	127.12	1199.20	280.83	129.02
245	0.030885	10.840	7937.9	43.912	90.679	127.55	1188.20	274.41	128.09
247	0.034005	10.805	8193.6	44.950	90.975	127.98	1177.30	268.20	127.16
249	0.037372	10.770	8450.2	45.983	91.276	128.42	1166.30	262.20	126.23
251	0.041002	10.735	8707.7	47.012	91.583	128.87	1155.40	256.38	125.31
253	0.044908	10.700	8966.1	48.036	91.894	129.32	1144.50	250.74	124.39
255	0.049106	10.664	9225.4	49.055	92.211	129.79	1133.60	245.27	123.47
257	0.053611	10.629	9485.7	50.070	92.534	130.26	1122.70	239.98	122.55
259	0.058438	10.593	9747.0	51.081	92.861	130.74	1111.80	234.84	121.64
261	0.063604	10.557	10009	52.088	93.193	131.23	1101.00	229.85	120.74
263	0.069124	10.521	10272	53.091	93.529	131.73	1090.10	225.01	119.83
265	0.075015	10.485	10537	54.090	93.871	132.23	1079.30	220.31	118.93
267	0.081295	10.449	10802	55.085	94.217	132.74	1068.40	215.74	118.04
269	0.087981	10.412	11068	56.076	94.567	133.26	1057.60	211.30	117.15
271	0.095090	10.375	11336	57.064	94.922	133.79	1046.80	206.99	116.26
273	0.10264	10.338	11604	58.049	95.281	134.33	1036.00	202.79	115.38
275	0.11065	10.301	11874	59.030	95.645	134.88	1025.20	198.71	114.50
277	0.11914	10.264	12145	60.007	96.012	135.43	1014.40	194.73	113.62
279	0.12813	10.227	12416	60.982	96.384	135.99	1003.60	190.87	112.75
281	0.13763	10.189	12689	61.954	96.760	136.57	992.87	187.10	111.89

TABLE 1 *Continued*

T K	p MPa	ρ $mol \cdot l^{-1}$	H $J \cdot mol^{-1}$	S $J \cdot mol^{-1} \cdot K^{-1}$	C_v $J \cdot mol^{-1} \cdot K^{-1}$	C_p $J \cdot mol^{-1} \cdot K^{-1}$	c $m \cdot s^{-1}$	η μPa·s	λ $mW \cdot m^{-1} \cdot K^{-1}$
283	0.14768	10.151	12964	62.923	97.139	137.15	982.11	183.43	111.03
285	0.15828	10.113	13239	63.889	97.522	137.74	971.36	179.85	110.18
287	0.16945	10.074	13516	64.852	97.909	138.34	960.61	176.36	109.33
289	0.18122	10.036	13793	65.812	98.300	138.95	949.87	172.95	108.48
291	0.19362	9.9968	14072	66.770	98.694	139.56	939.14	169.63	107.64
293	0.20665	9.9577	14353	67.726	99.092	140.19	928.41	166.39	106.81
295	0.22034	9.9183	14634	68.679	99.494	140.83	917.68	163.23	105.98
297	0.23471	9.8786	14917	69.630	99.898	141.48	906.96	160.14	105.16
299	0.24979	9.8387	15201	70.578	100.31	142.14	896.24	157.12	104.34
301	0.26559	9.7985	15487	71.525	100.72	142.81	885.52	154.17	103.53
303	0.28214	9.7579	15774	72.469	101.13	143.49	874.80	151.28	102.72
305	0.29946	9.7171	16062	73.412	101.55	144.18	864.09	148.46	101.92
307	0.31757	9.6760	16352	74.352	101.97	144.88	853.37	145.70	101.13
309	0.33650	9.6345	16643	75.291	102.39	145.59	842.65	143.00	100.34
311	0.35627	9.5927	16936	76.228	102.82	146.32	831.93	140.35	99.553
313	0.37690	9.5506	17230	77.164	103.25	147.06	821.21	137.76	98.776
315	0.39842	9.5081	17525	78.098	103.68	147.81	810.48	135.22	98.005
317	0.42084	9.4652	17822	79.030	104.12	148.58	799.74	132.73	97.239
319	0.44420	9.4220	18121	79.961	104.56	149.36	789.00	130.29	96.480
321	0.46852	9.3784	18421	80.891	105.00	150.16	778.25	127.90	95.727
323	0.49382	9.3343	18723	81.820	105.44	150.97	767.49	125.56	94.980
325	0.52012	9.2899	19026	82.747	105.89	151.79	756.71	123.25	94.239
327	0.54746	9.2450	19331	83.674	106.34	152.64	745.93	120.99	93.504
329	0.57585	9.1996	19638	84.599	106.79	153.50	735.13	118.77	92.775
331	0.60532	9.1538	19946	85.524	107.25	154.38	724.32	116.59	92.053
333	0.63590	9.1075	20256	86.448	107.70	155.28	713.48	114.45	91.337
335	0.66761	9.0607	20568	87.371	108.17	156.20	702.63	112.34	90.627
337	0.70048	9.0134	20882	88.294	108.63	157.14	691.75	110.27	89.923
339	0.73453	8.9656	21197	89.216	109.10	158.10	680.85	108.23	89.225
341	0.76979	8.9171	21514	90.138	109.57	159.09	669.93	106.22	88.534
343	0.80629	8.8681	21834	91.059	110.04	160.11	658.97	104.25	87.848
345	0.84406	8.8185	22155	91.981	110.52	161.15	647.99	102.30	87.169
347	0.88311	8.7683	22478	92.902	111.00	162.22	636.97	100.39	86.496
349	0.92348	8.7173	22803	93.823	111.49	163.32	625.91	98.495	85.829
351	0.96521	8.6657	23131	94.745	111.97	164.46	614.82	96.630	85.168
353	1.0083	8.6134	23460	95.667	112.47	165.63	603.68	94.791	84.513
355	1.0528	8.5603	23792	96.589	112.96	166.84	592.49	92.976	83.864
357	1.0987	8.5065	24126	97.512	113.46	168.09	581.26	91.184	83.221
359	1.1461	8.4517	24462	98.435	113.97	169.39	569.97	89.413	82.584
361	1.1950	8.3962	24800	99.359	114.48	170.74	558.63	87.663	81.952
363	1.2454	8.3397	25141	100.28	115.00	172.14	547.22	85.932	81.326
365	1.2974	8.2822	25485	101.21	115.52	173.60	535.75	84.220	80.706
367	1.3509	8.2237	25831	102.14	116.05	175.13	524.21	82.526	80.091
369	1.4061	8.1642	26180	103.07	116.58	176.72	512.59	80.848	79.482
371	1.4629	8.1035	26531	104.00	117.12	178.40	500.90	79.185	78.877
373	1.5214	8.0416	26886	104.93	117.67	180.16	489.12	77.536	78.278
375	1.5816	7.9783	27243	105.87	118.23	182.02	477.25	75.900	77.684
377	1.6436	7.9138	27603	106.81	118.79	184.00	465.28	74.276	77.095
379	1.7074	7.8477	27967	107.75	119.37	186.09	453.21	72.662	76.510
381	1.7730	7.7801	28334	108.69	119.95	188.33	441.03	71.058	75.929
383	1.8404	7.7108	28705	109.64	120.55	190.72	428.73	69.462	75.353
385	1.9098	7.6397	29080	110.59	121.16	193.31	416.32	67.872	74.781
387	1.9811	7.5666	29458	111.55	121.79	196.10	403.77	66.286	74.213
389	2.0544	7.4913	29841	112.51	122.42	199.15	391.08	64.705	73.649
391	2.1298	7.4137	30228	113.48	123.08	202.48	378.24	63.124	73.088
393	2.2072	7.3335	30621	114.45	123.75	206.17	365.25	61.543	72.530
395	2.2868	7.2504	31018	115.43	124.45	210.28	352.08	59.958	71.976
397	2.3686	7.1642	31421	116.42	125.16	214.89	338.74	58.368	71.424
399	2.4526	7.0743	31831	117.42	125.90	220.14	325.20	56.768	70.877
401	2.5389	6.9805	32248	118.43	126.67	226.18	311.45	55.156	70.333
403	2.6276	6.8820	32672	119.46	127.47	233.23	297.48	53.527	69.793
405	2.7187	6.7782	33105	120.49	128.31	241.60	283.26	51.875	69.260
407	2.8124	6.6682	33549	121.55	129.19	251.74	268.78	50.194	68.736
409	2.9087	6.5506	34004	122.63	130.12	264.33	254.01	48.474	68.226
411	3.0077	6.4239	34474	123.74	131.11	280.44	238.91	46.703	67.739
413	3.1095	6.2858	34962	124.89	132.18	301.89	223.46	44.866	67.293
415	3.2142	6.1328	35473	126.08	133.34	331.95	207.59	42.937	66.924
417	3.3219	5.9597	36014	127.34	134.63	377.22	191.25	40.879	66.710
419	3.4329	5.7569	36601	128.70	136.13	453.23	174.33	38.628	66.843
421	3.5474	5.5057	37261	130.22	137.97	607.03	156.63	36.054	67.908
423	3.6656	5.1554	38071	132.09	140.57	1074.8	137.67	32.817	72.282
425	3.7881	4.3042	39674	135.81	147.29	21816	114.85	26.322	139.47
425.12	3.7957	4.0037	40191	137.02	149.26	648340	112.67	24.391	519.09

TABLE 2 Thermophysical Properties of Normal Butane Vapor at Vapor-Liquid Equillibrium

T K	*p* MPa	ρ mol·l^{-1}	*H* J·mol^{-1}	*S* J·mol^{-1}·K^{-1}	C_v J·mol^{-1}·K^{-1}	C_p J·mol^{-1}·K^{-1}	*c* m·s^{-1}	η μPa·s	λ mW·m^{-1}·K^{-1}
135	6.7910E-07	6.0501E-07	23611	186.53	56.015	64.330	148.92	3.3235	4.8593
137	9.8726E-07	8.6672E-07	23740	184.37	56.434	64.748	149.95	3.3750	4.9511
139	1.4181E-06	1.2270E-06	23869	182.30	56.845	65.160	150.97	3.4265	5.0443
141	2.0137E-06	1.7177E-06	24000	180.32	57.250	65.565	151.98	3.4779	5.1387
143	2.8282E-06	2.3787E-06	24132	178.42	57.649	65.964	152.99	3.5293	5.2343
145	3.9306E-06	3.2603E-06	24264	176.60	58.042	66.357	153.99	3.5807	5.3313
147	5.4080E-06	4.4248E-06	24397	174.86	58.430	66.745	154.98	3.6321	5.4295
149	7.3695E-06	5.9487E-06	24531	173.19	58.813	67.129	155.97	3.6834	5.5291
151	9.9501E-06	7.9255E-06	24666	171.59	59.193	67.509	156.95	3.7347	5.6299
153	1.3316E-05	1.0468E-05	24801	170.06	59.568	67.885	157.93	3.7860	5.7319
155	1.7670E-05	1.3712E-05	24937	168.59	59.941	68.258	158.89	3.8372	5.8353
157	2.3258E-05	1.7818E-05	25074	167.19	60.310	68.628	159.85	3.8884	5.9400
159	3.0374E-05	2.2977E-05	25211	165.84	60.677	68.996	160.81	3.9396	6.0459
161	3.9370E-05	2.9414E-05	25350	164.54	61.042	69.361	161.76	3.9908	6.1531
163	5.0664E-05	3.7388E-05	25488	163.30	61.406	69.726	162.70	4.0419	6.2616
165	6.4747E-05	4.7203E-05	25628	162.12	61.768	70.089	163.63	4.0930	6.3713
167	8.2193E-05	5.9206E-05	25768	160.98	62.129	70.452	164.56	4.1440	6.4824
169	0.00010367	7.3797E-05	25909	159.89	62.489	70.814	165.48	4.1950	6.5947
171	0.00012996	9.1430E-05	26051	158.84	62.850	71.177	166.40	4.2460	6.7083
173	0.00016194	0.00011262	26193	157.84	63.210	71.540	167.31	4.2969	6.8231
175	0.00020064	0.00013795	26337	156.88	63.571	71.903	168.21	4.3478	6.9392
177	0.00024721	0.00016806	26480	155.96	63.933	72.268	169.10	4.3986	7.0566
179	0.00030297	0.00020368	26625	155.09	64.296	72.634	169.99	4.4494	7.1753
181	0.00036941	0.00024562	26770	154.24	64.660	73.002	170.87	4.5001	7.2952
183	0.00044817	0.00029476	26915	153.44	65.025	73.372	171.75	4.5508	7.4164
185	0.00054113	0.00035209	27062	152.67	65.393	73.744	172.61	4.6014	7.5389
187	0.00065035	0.00041869	27208	151.93	65.762	74.119	173.47	4.6520	7.6626
189	0.00077813	0.00049572	27356	151.22	66.134	74.497	174.32	4.7025	7.7876
191	0.00092700	0.00058446	27504	150.55	66.508	74.878	175.17	4.7530	7.9138
193	0.0010997	0.00068631	27653	149.91	66.885	75.263	176.01	4.8034	8.0413
195	0.0012994	0.00080276	27802	149.29	67.264	75.651	176.83	4.8537	8.1701
197	0.0015293	0.00093542	27952	148.71	67.647	76.044	177.66	4.9040	8.3000
199	0.0017931	0.0010860	28103	148.15	68.033	76.440	178.47	4.9542	8.4313
201	0.0020948	0.0012564	28254	147.61	68.423	76.841	179.27	5.0043	8.5638
203	0.0024385	0.0014486	28406	147.10	68.815	77.246	180.07	5.0544	8.6975
205	0.0028290	0.0016647	28558	146.62	69.212	77.657	180.85	5.1043	8.8324
207	0.0032710	0.0019069	28711	146.16	69.612	78.072	181.63	5.1543	8.9686
209	0.0037700	0.0021776	28865	145.72	70.017	78.492	182.40	5.2041	9.1061
211	0.0043316	0.0024792	29019	145.30	70.425	78.918	183.15	5.2539	9.2448
213	0.0049618	0.0028145	29173	144.91	70.838	79.349	183.90	5.3035	9.3847
215	0.0056671	0.0031862	29328	144.53	71.254	79.787	184.64	5.3531	9.5258
217	0.0064543	0.0035973	29484	144.18	71.675	80.229	185.37	5.4027	9.6682
219	0.0073306	0.0040506	29640	143.84	72.101	80.678	186.08	5.4521	9.8118
221	0.0083037	0.0045495	29797	143.52	72.530	81.134	186.79	5.5015	9.9567
223	0.0093815	0.0050973	29954	143.22	72.965	81.595	187.48	5.5507	10.103
225	0.010573	0.0056973	30111	142.94	73.403	82.063	188.16	5.5999	10.250
227	0.011886	0.0063533	30269	142.67	73.847	82.537	188.83	5.6490	10.399
229	0.013331	0.0070689	30428	142.42	74.295	83.018	189.49	5.6981	10.548
231	0.014917	0.0078481	30587	142.19	74.747	83.506	190.13	5.7470	10.699
233	0.016655	0.0086947	30746	141.97	75.205	84.001	190.77	5.7959	10.852
235	0.018554	0.0096130	30906	141.76	75.667	84.503	191.39	5.8447	11.005
237	0.020627	0.010607	31066	141.57	76.134	85.011	191.99	5.8934	11.160
239	0.022885	0.011682	31227	141.40	76.605	85.527	192.58	5.9421	11.316
241	0.025338	0.012841	31388	141.23	77.081	86.051	193.16	5.9907	11.473
243	0.028001	0.014090	31549	141.08	77.562	86.581	193.72	6.0393	11.632
245	0.030885	0.015434	31711	140.94	78.047	87.120	194.27	6.0877	11.792
247	0.034005	0.016877	31873	140.82	78.537	87.665	194.80	6.1362	11.953
249	0.037372	0.018424	32035	140.70	79.032	88.219	195.32	6.1846	12.116
251	0.041002	0.020081	32198	140.60	79.531	88.780	195.82	6.2329	12.280
253	0.044908	0.021853	32361	140.51	80.035	89.349	196.30	6.2812	12.445
255	0.049106	0.023746	32524	140.42	80.544	89.926	196.77	6.3295	12.611
257	0.053611	0.025765	32688	140.35	81.057	90.511	197.22	6.3778	12.779
259	0.058438	0.027915	32852	140.29	81.575	91.104	197.65	6.4261	12.949
261	0.063604	0.030204	33016	140.24	82.097	91.705	198.07	6.4743	13.119
263	0.069124	0.032636	33180	140.19	82.623	92.315	198.47	6.5226	13.292
265	0.075015	0.035219	33345	140.16	83.154	92.933	198.85	6.5709	13.465
267	0.081295	0.037958	33509	140.13	83.689	93.560	199.21	6.6193	13.640
269	0.087981	0.040860	33674	140.11	84.228	94.195	199.55	6.6677	13.817
271	0.095090	0.043931	33840	140.10	84.772	94.839	199.87	6.7161	13.995
273	0.10264	0.047179	34005	140.10	85.320	95.492	200.18	6.7646	14.175
275	0.11065	0.050611	34170	140.11	85.872	96.154	200.46	6.8133	14.357
277	0.11914	0.054232	34336	140.12	86.428	96.825	200.72	6.8620	14.540
279	0.12813	0.058052	34502	140.14	86.988	97.506	200.96	6.9108	14.725
281	0.13763	0.062077	34667	140.17	87.552	98.196	201.18	6.9598	14.912

TABLE 2 *Continued*

T K	p MPa	ρ mol·l^{-1}	H J·mol^{-1}	S J·mol^{-1}·K^{-1}	C_v J·mol^{-1}·K^{-1}	C_p J·mol^{-1}·K^{-1}	c m·s^{-1}	η µPa·s	λ mW·m^{-1}·K^{-1}
283	0.14768	0.066316	34833	140.20	88.120	98.896	201.38	7.0090	15.100
285	0.15828	0.070775	34999	140.24	88.692	99.605	201.56	7.0583	15.291
287	0.16945	0.075463	35165	140.29	89.267	100.33	201.71	7.1078	15.483
289	0.18122	0.080389	35331	140.34	89.847	101.06	201.85	7.1576	15.677
291	0.19362	0.085560	35497	140.40	90.430	101.80	201.96	7.2076	15.874
293	0.20665	0.090986	35663	140.46	91.017	102.55	202.04	7.2579	16.072
295	0.22034	0.096676	35829	140.53	91.607	103.31	202.10	7.3085	16.273
297	0.23471	0.10264	35995	140.60	92.201	104.08	202.14	7.3594	16.476
299	0.24979	0.10888	36161	140.68	92.798	104.87	202.15	7.4106	16.681
301	0.26559	0.11542	36326	140.76	93.399	105.67	202.14	7.4622	16.888
303	0.28214	0.12226	36492	140.85	94.004	106.48	202.10	7.5143	17.098
305	0.29946	0.12941	36657	140.94	94.611	107.30	202.04	7.5668	17.311
307	0.31757	0.13689	36823	141.03	95.222	108.14	201.95	7.6197	17.526
309	0.33650	0.14470	36988	141.13	95.837	108.99	201.83	7.6732	17.745
311	0.35627	0.15286	37152	141.23	96.454	109.85	201.69	7.7272	17.966
313	0.37690	0.16138	37317	141.34	97.075	110.73	201.52	7.7818	18.190
315	0.39842	0.17027	37481	141.45	97.699	111.63	201.32	7.8371	18.417
317	0.42084	0.17954	37645	141.56	98.327	112.54	201.09	7.8930	18.647
319	0.44420	0.18921	37809	141.68	98.957	113.47	200.83	7.9496	18.881
321	0.46852	0.19929	37972	141.80	99.591	114.41	200.54	8.0070	19.118
323	0.49382	0.20980	38135	141.92	100.23	115.38	200.22	8.0652	19.359
325	0.52012	0.22075	38297	142.04	100.87	116.36	199.87	8.1243	19.603
327	0.54746	0.23215	38459	142.17	101.51	117.36	199.48	8.1843	19.852
329	0.57585	0.24403	38620	142.30	102.16	118.39	199.07	8.2452	20.105
331	0.60532	0.25640	38781	142.43	102.81	119.44	198.62	8.3072	20.362
333	0.63590	0.26929	38941	142.56	103.46	120.51	198.14	8.3703	20.623
335	0.66761	0.28270	39100	142.69	104.12	121.61	197.62	8.4346	20.889
337	0.70048	0.29666	39259	142.83	104.78	122.73	197.06	8.5000	21.160
339	0.73453	0.31119	39417	142.96	105.44	123.89	196.47	8.5668	21.436
341	0.76979	0.32632	39574	143.10	106.10	125.07	195.85	8.6350	21.718
343	0.80629	0.34206	39730	143.24	106.76	126.28	195.18	8.7046	22.005
345	0.84406	0.35845	39886	143.37	107.43	127.53	194.48	8.7757	22.298
347	0.88311	0.37550	40040	143.51	108.10	128.81	193.73	8.8485	22.597
349	0.92348	0.39326	40193	143.65	108.76	130.13	192.95	8.9231	22.903
351	0.96521	0.41175	40346	143.79	109.43	131.49	192.12	8.9995	23.215
353	1.0083	0.43100	40496	143.93	110.10	132.90	191.25	9.0778	23.535
355	1.0528	0.45105	40646	144.07	110.77	134.35	190.34	9.1582	23.862
357	1.0987	0.47194	40794	144.20	111.45	135.86	189.38	9.2408	24.197
359	1.1461	0.49370	40941	144.34	112.12	137.44	188.37	9.3258	24.540
361	1.1950	0.51639	41086	144.47	112.80	139.08	187.32	9.4133	24.892
363	1.2454	0.54004	41229	144.60	113.48	140.79	186.22	9.5034	25.254
365	1.2974	0.56471	41370	144.73	114.17	142.59	185.07	9.5964	25.626
367	1.3509	0.59046	41509	144.86	114.86	144.49	183.86	9.6924	26.008
369	1.4061	0.61735	41646	144.98	115.56	146.49	182.61	9.7916	26.402
371	1.4629	0.64544	41781	145.10	116.27	148.61	181.29	9.8943	26.808
373	1.5214	0.67480	41913	145.22	116.99	150.87	179.93	10.001	27.227
375	1.5816	0.70553	42043	145.33	117.73	153.28	178.50	10.111	27.661
377	1.6436	0.73770	42169	145.44	118.47	155.85	177.01	10.226	28.109
379	1.7074	0.77141	42293	145.55	119.24	158.62	175.46	10.346	28.574
381	1.7730	0.80678	42413	145.64	120.01	161.61	173.84	10.470	29.057
383	1.8404	0.84392	42529	145.73	120.81	164.85	172.16	10.600	29.560
385	1.9098	0.88298	42641	145.82	121.62	168.37	170.41	10.736	30.084
387	1.9811	0.92411	42750	145.89	122.46	172.23	168.58	10.879	30.633
389	2.0544	0.96749	42853	145.96	123.31	176.46	166.69	11.029	31.208
391	2.1298	1.0133	42951	146.02	124.18	181.14	164.71	11.187	31.813
393	2.2072	1.0618	43044	146.06	125.08	186.36	162.65	11.354	32.452
395	2.2868	1.1133	43130	146.09	126.00	192.20	160.51	11.532	33.129
397	2.3686	1.1681	43209	146.11	126.95	198.82	158.28	11.720	33.851
399	2.4526	1.2266	43281	146.12	127.92	206.37	155.97	11.921	34.625
401	2.5389	1.2891	43344	146.10	128.93	215.09	153.55	12.138	35.459
403	2.6276	1.3564	43396	146.07	129.97	225.31	151.04	12.371	36.366
405	2.7187	1.4291	43437	146.01	131.06	237.46	148.41	12.624	37.361
407	2.8124	1.5080	43465	145.92	132.19	252.18	145.68	12.901	38.465
409	2.9087	1.5944	43476	145.79	133.38	270.43	142.83	13.207	39.708
411	3.0077	1.6898	43469	145.63	134.65	293.73	139.85	13.549	41.132
413	3.1095	1.7962	43438	145.41	136.00	324.58	136.74	13.936	42.802
415	3.2142	1.9169	43376	145.13	137.48	367.52	133.47	14.383	44.821
417	3.3219	2.0567	43275	144.75	139.12	431.61	130.02	14.912	47.372
419	3.4329	2.2240	43115	144.24	141.00	538.03	126.37	15.566	50.815
421	3.5474	2.4360	42861	143.52	143.26	750.33	122.47	16.428	56.019
423	3.6656	2.7399	42419	142.37	146.19	1383.4	118.16	17.738	66.079
425	3.7881	3.5364	41020	138.97	150.45	26744	112.63	21.677	152.56
425.12	3.7957	3.8414	40474	137.68	149.99	685360	112.3	23.411	540.52

TABLE 3 Thermophysical Properties of Normal Butane Along Isobars

T K	ρ mol·l^{-1}	H J·mol^{-1}	S J·mol^{-1}·K^{-1}	C_v J·mol^{-1}·K^{-1}	C_p J·mol^{-1}·K^{-1}	c m·s^{-1}	η μPa·s	λ mW·m^{-1}·K^{-1}
Pressure = 0.1 MPa								
140	12.564	-4628.2	-22.780	83.808	114.91	1793.4	1889.1	174.87
150	12.404	-3476.5	-14.834	83.837	115.44	1730.2	1370.9	171.22
160	12.243	-2319.2	-7.3651	83.924	116.04	1669.6	1056.1	167.26
170	12.083	-1155.3	-0.30897	84.123	116.77	1610.6	845.35	163.04
180	11.922	16.586	6.3890	84.464	117.63	1552.6	695.12	158.62
190	11.760	1197.9	12.776	84.964	118.65	1495.4	583.16	154.06
200	11.597	2390.2	18.891	85.632	119.85	1438.8	496.90	149.40
210	11.433	3595.4	24.771	86.471	121.22	1382.6	428.73	144.68
220	11.267	4815.3	30.446	87.477	122.79	1326.8	373.75	139.93
230	11.098	6051.8	35.942	88.646	124.54	1271.4	328.64	135.18
240	10.927	7306.7	41.283	89.967	126.49	1216.2	291.08	130.46
250	10.753	8582.2	46.489	91.432	128.63	1161.4	259.42	125.81
260	10.576	9880.0	51.579	93.028	130.97	1106.7	232.42	121.21
270	10.394	11202	56.569	94.744	133.52	1052.3	209.15	116.71
272.31	10.351	11512	57.711	95.158	134.15	1039.7	204.22	115.68
272.31	0.046045	33948	140.10	85.131	95.267	200.07	6.7480	14.113
280	0.044602	34686	142.77	86.833	96.765	203.31	6.9452	14.821
290	0.042873	35664	146.21	89.128	98.841	207.36	7.1997	15.768
300	0.041289	36663	149.59	91.498	101.03	211.28	7.4522	16.747
310	0.039830	37685	152.94	93.928	103.32	215.06	7.7029	17.758
320	0.038480	38730	156.26	96.404	105.67	218.74	7.9519	18.800
330	0.037225	39799	159.55	98.913	108.08	222.31	8.1995	19.873
340	0.036056	40892	162.81	101.45	110.52	225.80	8.4457	20.978
350	0.034963	42009	166.05	103.99	112.99	229.21	8.6907	22.115
360	0.033938	43152	169.27	106.54	115.48	232.55	8.9344	23.284
370	0.032975	44319	172.47	109.10	117.98	235.82	9.1771	24.484
380	0.032067	45511	175.65	111.64	120.48	239.03	9.4186	25.716
390	0.031211	46728	178.81	114.18	122.97	242.19	9.6592	26.980
400	0.030400	47970	181.95	116.69	125.45	245.29	9.8987	28.275
410	0.029633	49237	185.08	119.19	127.91	248.35	10.137	29.602
420	0.028904	50529	188.19	121.67	130.36	251.36	10.375	30.962
430	0.028211	51844	191.29	124.12	132.78	254.33	10.612	32.353
440	0.027552	53184	194.37	126.54	135.18	257.25	10.848	33.775
450	0.026924	54548	197.43	128.93	137.55	260.14	11.083	35.230
460	0.026324	55935	200.48	131.30	139.90	262.99	11.318	36.717
470	0.025751	57346	203.52	133.63	142.21	265.81	11.551	38.235
480	0.025203	58779	206.53	135.93	144.49	268.59	11.784	39.786
490	0.024679	60235	209.54	138.20	146.75	271.34	12.016	41.368
500	0.024176	61714	212.52	140.43	148.97	274.06	12.248	42.982
510	0.023694	63215	215.49	142.63	151.16	276.76	12.479	44.629
520	0.023230	64737	218.45	144.80	153.32	279.42	12.709	46.307
530	0.022785	66281	221.39	146.94	155.44	282.05	12.938	48.017
540	0.022357	67846	224.32	149.05	157.54	284.66	13.167	49.759
550	0.021945	69432	227.23	151.12	159.60	287.25	13.395	51.533
560	0.021548	71038	230.12	153.16	161.64	289.80	13.622	53.339
Pressure = 1 MPa								
140	12.570	-4569.4	-22.871	83.863	114.88	1796.8	1905.0	175.10
150	12.411	-3418.0	-14.927	83.887	115.40	1733.9	1381.3	171.48
160	12.251	-2261.1	-7.4611	83.972	116.00	1673.5	1063.7	167. 54
170	12.091	-1097.6	-0.40774	84.169	116.72	1614.8	851.34	163.35
180	11.931	73.712	6.2871	84.509	117.57	1557.2	700.06	159.96
190	11.770	1254.4	12.670	85.009	118.58	1500.3	587.36	154.43
200	11.608	2446.0	18.782	85.677	119.77	1443.9	500.58	149.79
210	11.444	3650.3	24.658	86.516	121.13	1388.1	432.01	145.10
220	11.279	4869.2	30.328	87.522	122.68	1332.7	376.72	140.37
230	11.112	6104.5	35.819	88.690	124.41	1277.6	331.37	135.65
240	10.942	7358.0	41.153	90.012	126.34	1222.9	293.62	130.96
250	10.770	8631.8	46.353	91.477	128.45	1168.5	261.81	126.34
260	10.594	9927.7	51.435	93.073	130.76	1114.4	234.69	121.78
270	10.413	11248	56.417	94.789	133.27	1060.6	211.32	117.30
280	10.229	12594	61.312	96.613	135.98	1006.9	190.99	112.93
290	10.038	13968	66.134	98.535	138.92	953.24	173.13	108.66
300	9.8412	15373	70.896	100.54	142.09	899.57	157.29	104.51
310	9.6362	16811	75.611	102.63	145.54	845.68	143.11	100.48
320	9.4218	18285	80.290	104.79	149.32	791.34	130.30	96.582
330	9.1956	19799	84.948	107.03	153.51	736.22	118.60	92.799
340	8.9549	21357	89.599	109.33	158.25	679.85	107.80	89.130
350	8.6953	22966	94.264	111.73	163.78	621.53	97.696	85.560
352.62	8.6234	23397	95.491	112.37	165.40	605.80	95.139	84.637
352.62	0.42728	40468	143.90	109.97	132.62	191.42	9.0627	23.473
360	0.40955	41443	146.64	111.18	131.74	197.12	9.2290	24.298
370	0.38891	42758	150.24	113.03	131.50	204.07	9.4581	25.464
380	0.37116	44075	153.76	115.04	131.97	210.36	9.6898	26.679

TABLE 3 *Continued*

T K	ρ mol·l^{-1}	*H* J·mol^{-1}	*S* J·mol^{-1}·K^{-1}	C_v J·mol^{-1}·K^{-1}	C_p J·mol^{-1}·K^{-1}	*c* m·s^{-1}	η μPa·s	λ mW·m^{-1}·K^{-1}
390	0.35562	45399	157.19	117.13	132.89	216.13	9.9228	27.935
400	0.34181	46734	160.57	119.28	134.10	221.49	10.156	29.230
410	0.32939	48082	163.90	121.46	135.54	226.52	10.390	30.562
420	0.31812	49445	167.19	123.67	137.13	231.27	10.624	31.930
430	0.30782	50825	170.43	125.90	138.84	235.79	10.857	33.331
440	0.29835	52223	173.65	128.13	140.64	240.10	11.090	34.767
450	0.28958	53638	176.83	130.36	142.50	244.24	11.323	36.235
460	0.28143	55073	179.98	132.59	144.41	248.23	11.554	37.737
470	0.27382	56526	183.11	134.80	146.34	252.08	11.786	39.271
480	0.26670	58000	186.21	136.99	148.29	255.80	12.016	40.838
490	0.26000	59492	189.29	139.16	150.25	259.42	12.246	42.436
500	0.25369	61005	192.34	141.32	152.21	262.94	12.475	44.067
510	0.24773	62536	195.37	143.45	154.16	266.37	12.704	45.730
520	0.24209	64088	198.39	145.55	156.11	269.71	12.932	47.425
530	0.23673	65659	201.38	147.63	158.05	272.98	13.159	49.152
540	0.23164	67249	204.35	149.68	159.98	276.17	13.385	50.911
550	0.22679	68858	207.30	151.71	161.89	279.30	13.611	52.702
560	0.22217	70487	210.24	153.71	163.79	282.37	13.837	54.524
				Pressure = 2 MPa				
140	12.578	-4504.0	-22.972	83.923	114.85	1800.5	1922.8	175.36
150	12.419	-3353.0	-15.031	83.943	115.36	1737.9	1392.9	171.77
160	12.260	-2196.5	-7.5672	84.025	115.95	1677.9	1072.2	167.86
170	12.100	-1033.5	-0.51688	84.220	116.66	1619.5	858.01	163.70
180	11.941	137.24	6.1746	84.559	117.51	1562.2	705.55	159.34
190	11.780	1317.2	12.554	85.059	118.51	1505.6	592.04	154.83
200	11.619	2508.0	18.662	85.727	119.68	1449.6	504.66	150.23
210	11.457	3711.4	24.533	86.565	121.03	1394.2	435.65	145.56
220	11.293	4929.2	30.198	87.572	122.56	1339.1	380.02	140.87
230	11.126	6163.2	35.683	88.740	124.27	1284.5	334.39	136.18
240	10.958	7415.3	41.011	90.062	126.17	1230.3	296.43	131.52
250	10.787	8687.3	46.204	91.526	128.26	1176.4	264.45	126.92
260	10.613	9981.1	51.278	93.122	130.54	1122.8	237.19	122.40
270	10.435	11299	56.250	94.838	133.00	1069.6	213.71	117.95
280	10.252	12642	61.134	96.662	135.66	1016.6	193.29	113.61
290	10.065	14012	65.944	98.582	138.52	963.76	175.37	109.39
300	9.8708	15413	70.692	100.59	141.61	911.00	159.49	105.28
310	9.6698	16845	75.389	102.67	144.94	858.18	145.30	101.30
320	9.4601	18313	80.047	104.83	148.56	805.11	132.49	97.445
330	9.2401	19818	84.678	107.05	152.54	751.55	120.82	93.721
340	9.0072	21365	89.296	109.34	156.96	697.16	110.08	90.122
350	8.7582	22959	93.917	111.70	161.99	641.45	100.08	86.637
360	8.4882	24608	98.561	114.16	167.92	583.69	90.650	83.249
370	8.1894	26322	103.26	116.75	175.32	522.68	81.596	79.928
380	7.8483	28123	108.06	119.56	185.44	456.34	72.691	76.616
387.52	7.5472	29557	111.80	121.95	196.87	400.48	65.875	74.066
387.52	0.93517	42777	145.91	122.68	173.29	168.10	10.917	30.780
390	0.91189	43201	147.00	122.87	169.18	171.75	10.917	30.898
400	0.83711	44836	151.14	123.85	159.11	184.18	10.976	31.659
410	0.78130	46401	155.00	125.15	154.28	194.26	11.092	32.672
420	0.73671	47930	158.69	126.72	151.92	202.90	11.240	33.827
430	0.69961	49443	162.25	128.47	150.93	210.53	11.408	35.078
440	0.66788	50951	165.72	130.34	150.78	217.41	11.588	36.402
450	0.64019	52461	169.11	132.28	151.16	223.72	11.778	37.785
460	0.61565	53976	172.44	134.27	151.92	229.57	11.975	39.221
470	0.59366	55500	175.72	136.29	152.93	235.03	12.177	40.704
480	0.57375	57035	178.95	138.32	154.13	240.18	12.382	42.229
490	0.55559	58583	182.14	140.35	155.47	245.06	12.591	43.796
500	0.53891	60145	185.30	142.39	156.91	249.70	12.801	45.401
510	0.52350	61722	188.42	144.42	158.43	254.14	13.013	47.044
520	0.50919	63314	191.51	146.43	160.00	258.40	13.226	48.724
530	0.49585	64922	194.57	148.44	161.62	262.50	13.440	50.438
540	0.48337	66546	197.61	150.42	163.26	266.46	13.655	52.188
550	0.47165	68187	200.62	152.39	164.92	270.29	13.871	53.973
560	0.46062	69845	203.61	154.34	166.60	274.00	14.086	55.791
				Pressure = 3 MPa				
140	12.585	-4438.6	-23.072	83.983	114.82	1804.1	1940.7	175.62
150	12.426	-3287.9	-15.134	83.998	115.32	1741.9	1404.6	172.06
160	12.268	-2131.8	-7.6727	84.077	115.91	1682.2	1080.7	168.18
170	12.109	-969.33	-0.62540	84.271	116.61	1624.1	864.7	164.04
180	11.951	200.83	6.0628	84.609	117.45	1567.1	711.05	159.71
190	11.791	1380.1	12.439	85.108	118.44	1510.9	596.71	155.24
200	11.631	2570.1	18.542	85.776	119.60	1455.3	508.74	150.66
210	11.469	3772.6	24.409	86.614	120.93	1400.2	439.29	146.02
220	11.306	4989.3	30.069	87.621	122.44	1345.5	383.31	141.36

TABLE 3 *Continued*

T K	ρ mol·l^{-1}	H J·mol^{-1}	S J·mol^{-1}·K^{-1}	C_v J·mol^{-1}·K^{-1}	C_p J·mol^{-1}·K^{-1}	c m·s^{-1}	η μPa·s	λ mW·m^{-1}·K^{-1}
230	11.141	6222.1	35.549	88.789	124.14	1291.3	337.41	136.70
240	10.974	7472.7	40.871	90.111	126.02	1237.5	299.24	132.07
250	10.804	8743.0	46.056	91.576	128.08	1184.1	267.08	127.50
260	10.632	10035	51.123	93.172	130.32	1131.1	239.68	123.01
270	10.456	11350	56.086	94.887	132.74	1078.5	216.09	118.60
280	10.275	12690	60.960	96.710	135.35	1026.1	195.58	114.29
290	10.090	14058	65.758	98.629	138.15	974.03	177.60	110.10
300	9.8996	15454	70.492	100.63	141.16	922.12	161.67	106.03
310	3.7022	16882	75.172	102.71	144.39	870.28	147.45	102.09
320	9.4970	18343	79.811	104.86	147.88	818.38	134.64	98.288
330	9.2825	19840	84.418	107.08	151.66	766.22	122.99	94.617
340	9.0566	21377	89.006	109.35	155.82	713.55	112.30	91.080
350	8.8168	22958	93.589	111.69	160.46	660.04	102.38	87.669
360	8.5593	24589	98.182	114.10	165.79	605.20	93.080	84.374
370	8.2787	26277	102.81	116.62	172.12	548.29	84.233	81.176
380	7.9662	28037	107.50	119.28	180.13	488.16	75.673	78.042
390	7.6058	29890	112.31	122.20	191.35	422.81	67.174	74.911
400	7.1622	31889	117.37	125.62	210.58	348.01	58.336	71.669
410	6.5128	34207	123.09	130.45	267.03	250.73	47.932	68.089
410.85	6.4340	34438	123.66	131.03	279.05	240.08	46.841	67.775
410.85	1.6821	43470	145.64	134.55	291.72	140.09	13.521	41.016
420	1.4245	45625	150.83	132.14	205.30	161.75	12.856	38.568
430	1.2754	47544	155.35	132.30	182.24	177.28	12.629	38.560
440	1.1738	49311	159.41	133.32	172.40	189.36	12.574	39.226
450	1.0967	51008	163.22	134.72	167.37	199.45	12.603	40.197
460	1.0348	52666	166.87	136.31	164.69	208.23	12.682	41.349
470	0.98303	54306	170.40	138.03	163.35	216.06	12.794	42.624
480	0.93874	55936	173.83	139.83	162.84	223.17	12.929	43.992
490	0.90009	57564	177.19	141.68	162.89	229.70	13.080	45.436
500	0.86587	59195	180.48	143.56	163.34	235.76	13.243	46.943
510	0.83521	60832	183.72	145.46	164.06	241.44	13.415	48.506
520	0.80748	62477	186.92	147.37	164.99	246.79	13.594	50.121
530	0.78220	64132	190.07	149.28	166.08	251.85	13.780	51.782
540	0.75899	65799	193.18	151.19	167.28	256.68	13.969	53.487
550	0.73757	67478	196.27	153.09	168.56	261.29	14.163	55.234
560	0.71770	69171	199.31	154.98	169.92	265.71	14.359	57.021
				Pressure = 4 MPa				
140	12.592	-4373.1	-23.172	84.042	114.79	1807.8	1958.8	175.87
150	12.434	-3222.8	-15.236	84.053	115.29	1745.9	1416.4	172.34
160	12.276	-2067.1	-7.7777	84.129	115.86	1686.5	1089.3	168.49
170	12.118	-905.12	-0.7333	84.322	116.56	1628.7	871.40	164.39
180	11.960	264.47	5.9517	84.659	117.39	1572.0	716.55	160.09
190	11.801	1443.1	12.324	85.157	118.37	1516.1	601.39	155.64
200	11.642	2632.4	18.424	85.824	119.51	1460.9	512.82	151.09
210	11.481	3834.0	24.286	86.663	120.83	1406.1	442.92	146.48
220	11.319	5049.7	29.941	87.670	122.33	1351.8	386.59	141.85
230	11.155	6281.2	35.416	88.838	124.01	1298.0	340.42	137.21
240	10.990	7530.4	40.732	90.160	125.87	1244.7	302.03	132.61
250	10.821	8799.1	45.911	91.625	127.90	1191.7	269.69	128.08
260	10.650	10089	50.969	93.221	130.11	1139.3	242.15	123.61
270	10.476	11402	55.924	94.936	132.50	1087.2	218.45	119.23
280	10.298	12740	60.788	96.758	135.06	1305.5	197.86	114.96
290	10.115	14104	65.575	98.676	137.81	984.07	179.80	110.81
300	9.9276	15496	70.296	100.68	140.74	932.96	163.83	106.77
310	9.7337	16919	74.961	102.76	143.88	882.04	149.58	102.87
320	9.5326	18375	79.582	104.90	147.24	831.19	136.76	99.113
330	9.3232	19865	84.168	107.11	150.87	780.29	125.12	95.490
340	9.1036	21393	88.729	109.37	154.81	729.15	114.46	92.007
350	8.8718	22962	93.278	111.69	159.14	677.52	104.61	88.662
360	8.6250	24578	97.828	114.07	163.99	625.09	95.402	85.445
370	8.3592	26245	102.40	116.53	169.58	571.39	86.711	82.347
380	8.0682	27973	107.00	119.10	176.27	515.76	78.392	79.346
390	7.7426	29776	111.69	121.83	184.82	457.18	70.289	76.409
400	7.3648	31681	116.51	124.82	196.97	393.91	62.193	73.478
410	6.8958	33744	121.60	128.32	218.06	322.56	53.723	70.448
420	6.2067	36154	127.41	133.14	277.88	234.19	43.770	67.169
430	2.9217	43123	143.74	144.40	766.95	124.15	18.532	60.318
440	2.0562	46782	152.17	138.12	252.66	153.39	15.083	46.189
450	1.7780	49038	157.24	137.99	207.41	171.01	14.308	44.746
460	1.6076	51015	161.59	138.84	190.18	184.52	13.974	44.798
470	1.4854	52869	165.57	140.08	181.49	195.71	13.827	45.432
480	1.3905	54657	169.34	141.54	176.63	205.38	13.783	46.377
490	1.3134	56409	172.95	143.13	173.85	213.96	13.802	47.521
500	1.2487	58139	176.44	144.82	172.31	221.71	13.865	48.805

TABLE 3 *Continued*

T K	ρ mol·l^{-1}	H J·mol^{-1}	S J·mol^{-1}·K^{-1}	C_v J·mol^{-1}·K^{-1}	C_p J·mol^{-1}·K^{-1}	c m·s^{-1}	η µPa·s	λ mW·m^{-1}·K^{-1}
510	1.1931	59858	179.85	146.56	171.59	228.80	13.958	50.196
520	1.1444	61572	183.18	148.34	171.43	235.37	14.073	51.674
530	1.1013	63287	186.45	150.15	171.66	241.49	14.205	53.225
540	1.0626	65006	189.66	151.96	172.18	247.24	14.351	54.840
550	1.0276	66732	192.82	153.79	172.92	252.67	14.507	56.512
560	0.99570	68465	195.95	155.61	173.82	257.82	14.671	58.236
Pressure = 5 MPa								
140	12.599	-4307.7	-23.272	84.101	114.76	1811.4	1977.0	176.13
150	12.442	-3157.7	-15.338	84.107	115.25	1749.9	1428.2	172.63
160	12.285	-2002.4	-7.8821	84.181	115.82	1690.8	1097.9	168.81
170	12.127	-840.87	-0.84058	84.372	116.51	1633.3	878.12	164.73
180	11.970	328.17	5.8413	84.708	117.33	1576.9	722.07	160.46
190	11.812	1506.2	12.210	85.206	118.30	1521.3	606.08	156.04
200	11.653	2694.7	18.306	85.873	119.43	1466.4	516.90	151.52
210	11.493	3895.4	24.164	86.711	120.74	1412.0	446.55	146.94
220	11.332	5110.1	29.815	87.718	122.22	1358.1	389.87	142.33
230	11.170	6340.5	35.284	88.887	123.88	1304.7	343.43	137.72
240	11.005	7588.4	40.594	90.209	125.72	1251.7	304.81	133.15
250	10.838	8855.5	45.767	91.674	127.73	1199.3	272.30	128.64
260	10.669	10144	50.818	93.270	129.91	1147.3	244.61	124.21
270	10.496	11454	55.765	94.985	132.26	1095.7	220.80	119.86
280	10.320	12789	60.620	96.807	134.78	1044.6	200.11	115.62
290	10.140	14150	65.396	98.724	137.48	993.90	181.99	111.50
300	9.9548	15539	70.104	100.72	140.34	943.54	165.96	107.50
310	9.7642	16958	74.756	102.80	143.40	893.47	151.68	103.64
320	9.5670	18408	79.359	104.94	146.66	843.60	138.84	99.920
330	9.3622	19892	83.925	107.14	150.15	793.83	127.20	96.342
340	9.1483	21412	88.463	109.39	153.90	744.04	116.57	92.909
350	8.9238	22971	92.982	111.70	157.98	694.05	106.76	89.620
360	8.6862	24573	97.494	114.06	162.47	643.65	97.636	86.471
370	8.4326	26222	102.01	116.48	167.50	592.54	89.063	83.455
380	8.1588	27925	106.55	118.98	173.30	540.35	80.920	80.559
390	7.8585	29692	111.14	121.58	180.28	486.52	73.087	77.763
400	7.5216	31537	115.81	124.35	189.21	430.26	65.426	75.035
410	7.1301	33488	120.63	127.38	201.87	370.32	57.576	72.325
420	6.6460	35603	125.73	130.86	223.30	304.64	49.761	69.546
430	5.9625	38045	131.47	135.28	274.20	230.03	40.693	66.605
440	4.6563	41524	139.46	141.61	450.47	155.71	28.474	63.927
450	3.1209	45861	149.21	142.34	350.80	147.05	19.322	55.862
460	2.5025	48772	155.61	141.80	250.79	162.44	16.755	51.247
470	2.1833	51080	160.58	142.35	215.75	176.65	15.724	49.910
480	1.9754	53146	164.93	143.37	199.26	188.80	15.202	49.805
490	1.8235	55089	168.94	144.66	190.20	199.38	14.920	50.298
500	1.7051	56962	172.72	146.11	184.83	208.77	14.775	51.142
510	1.6087	58793	176.34	147.68	181.58	217.24	14.717	52.216
520	1.5278	60598	179.85	149.32	179.63	224.97	14.717	53.454
530	1.4585	62388	183.26	151.01	178.55	232.10	14.759	54.820
540	1.3979	64171	186.59	152.73	178.08	238.73	14.831	56.286
550	1.3443	65951	189.86	154.48	178.04	244.93	14.928	57.838
560	1.2963	67733	193.07	156.24	178.32	250.78	15.042	59.463
Pressure = 7.5 MPa								
140	12.617	-4144.0	-23.519	84.246	114.69	1820.5	2023.3	176.76
150	12.461	-2994.8	-15.590	84.241	115.16	1759.7	1458.0	173.33
160	12.305	-1840.5	-8.1409	84.309	115.72	1701.4	1119.5	169.58
170	12.149	-680.07	-1.1062	84.495	116.38	1644.6	895.00	165.57
180	11.994	487.65	5.5681	84.829	117.18	1589.0	735.89	161.37
190	11.837	1664.1	11.929	85.326	118.13	1534.2	617.79	157.02
200	11.681	2850.9	18.016	85.993	119.24	1480.0	527.10	152.57
210	11.523	4049.5	23.864	86.832	120.52	1426.5	455.60	148.06
220	11.364	5261.8	29.503	87.839	121.97	1373.4	398.05	143.52
230	11.204	6489.5	34.960	89.008	123.59	1321.0	350.91	138.98
240	11.043	7734.2	40.257	90.331	125.38	1269.0	311.74	134.48
250	10.879	8997.6	45.414	91.796	127.33	1217.6	278.77	130.04
260	10.713	10281	50.449	93.392	129.45	1166.8	250.72	125.68
270	10.545	11587	55.376	95.106	131.72	1116.5	226.61	121.41
280	10.374	12916	60.210	96.927	134.15	1066.8	205.69	117.24
290	10.199	14270	64.962	98.843	136.72	1017.6	187.37	113.19
300	10.020	15651	69.643	100.84	139.45	968.94	171.20	109.28
310	9.8368	17060	74.262	102.91	142.34	920.76	156.82	105.50
320	9.6482	18498	78.829	105.04	145.38	873.03	143.92	101.87
330	9.4536	19968	83.351	107.23	148.59	825.70	132.26	98.388
340	9.2520	21471	87.837	109.47	151.99	778.73	121.65	95.062
350	9.0424	23009	92.294	111.75	155.60	732.04	111.91	91.891
360	8.8235	24584	96.731	114.06	159.45	685.58	102.91	88.876

TABLE 3 *Continued*

T K	ρ mol·l^{-1}	H J·mol^{-1}	S J·mol^{-1}·K^{-1}	C_v J·mol^{-1}·K^{-1}	C_p J·mol^{-1}·K^{-1}	c m·s^{-1}	η μPa·s	λ mW·m^{-1}·K^{-1}
370	8.5937	26199	101.16	116.42	163.58	639.25	94.527	86.016
380	8.3508	27857	105.58	118.82	168.08	592.97	86.661	83.306
390	8.0924	29562	110.01	121.28	173.05	546.64	79.223	80.741
400	7.8150	31320	114.46	123.79	178.64	500.14	72.134	78.311
410	7.5139	33138	118.94	126.37	185.12	453.38	65.320	76.003
420	7.1824	35026	123.50	129.06	192.92	406.27	58.710	73.800
430	6.8106	37003	128.15	131.87	202.77	358.86	52.233	71.678
440	6.3836	39093	132.95	134.82	215.85	311.63	45.817	69.611
450	5.8803	41335	137.99	137.89	233.36	266.47	39.428	67.570
460	5.2865	43767	143.33	140.91	252.63	228.45	33.223	65.528
470	4.6420	46351	148.89	143.48	261.18	204.59	27.798	63.453
480	4.0503	48933	154.33	145.41	253.10	195.26	23.783	61.512
490	3.5735	51391	159.39	146.96	238.18	194.95	21.129	60.043
500	3.2073	53700	164.06	148.38	224.13	199.23	19.424	59.194
510	2.9254	55884	168.39	149.79	213.21	205.57	18.317	58.923
520	2.7037	57974	172.44	151.26	205.30	212.67	17.584	59.117
530	2.5246	59998	176.30	152.77	199.72	219.91	17.092	59.668
540	2.3765	61974	179.99	154.33	195.82	227.03	16.764	60.492
550	2.2513	63918	183.56	155.94	193.14	233.89	16.549	61.592
560	2.1438	65840	187.02	157.57	191.36	240.47	16.416	62.734
				Pressure = 10 MPa				
140	12.635	-3980.2	-23.763	84.388	114.62	1829.4	2070.6	177.38
150	12.480	2831.7	-15.840	84.373	115.08	1769.4	1488.3	174.03
160	12.325	-1678.3	-8.3964	84.434	115.62	1711.8	1141.4	170.35
170	12.171	-519.02	-1.3682	84.617	116.27	1655.8	911.98	166.41
180	12.017	647.45	5.2989	84.949	117.05	1600.9	749.76	162.27
190	11.862	1822.5	11.652	85.445	117.98	1546.8	629.54	157.99
200	11.707	3007.5	17.730	86.111	119.06	1493.4	537.30	153.61
210	11.552	4204.3	23.569	86.950	120.31	1440.6	464.65	149.16
220	11.396	5414.4	29.198	87.957	121.73	1388.4	406.19	144.69
230	11.238	6639.5	34.643	89.127	123.31	1336.8	358.35	140.22
240	11.079	7881.2	39.928	90.450	125.06	1285.8	318.61	135.78
250	10.919	9141.2	45.071	91.916	126.97	1235.4	285.19	131.40
260	10.756	10421	50.091	93.512	129.02	1185.7	256.77	127.11
270	10.592	11722	55.001	95.227	131.23	1136.5	232.35	122.91
280	10.425	13046	59.816	97.047	133.58	1088.1	211.17	118.81
290	10.255	14394	64.546	98.961	136.06	1040.2	192.66	114.83
300	10.082	15768	69.202	100.96	138.68	993.02	176.33	110.99
310	9.9048	17168	73.794	103.02	141.43	946.46	161.83	107.29
320	9.7235	18597	78.329	105.15	144.30	900.52	148.84	103.73
330	9.5375	20055	82.815	107.33	147.31	855.19	137.14	100.33
340	9.3461	21543	87.259	109.56	150.46	810.46	126.51	97.095
350	9.1484	23064	91.668	111.82	153.74	766.31	116.79	94.017
360	8.9438	24619	96.047	114.11	157.19	722.73	107.84	91.103
370	8.7313	26209	100.40	116.44	160.80	679.71	99.559	88.354
380	8.5098	27836	104.74	118.79	164.61	637.27	91.838	85.769
390	8.2781	29502	109.07	121.17	168.63	595.40	84.602	83.346
400	8.0346	31209	113.39	123.57	172.93	554.16	77.782	81.081
410	7.7777	32961	117.72	126.01	177.54	513.58	71.322	78.970
420	7.5052	34761	122.05	128.48	182.54	473.76	65.177	77.005
430	7.2147	36614	126.41	130.98	188.04	434.83	59.311	75.180
440	6.9034	38524	130.80	133.51	194.14	397.04	53.698	73.483
450	6.5680	40499	135.24	136.06	200.93	360.83	48.326	71.907
460	6.2060	42545	139.74	138.61	208.29	326.99	43.210	70.445
470	5.8177	44664	144.30	141.11	215.59	296.89	38.406	69.095
480	5.4101	46851	148.90	143.52	221.41	272.28	34.025	67.868
490	5.0000	49082	153.50	145.76	224.14	254.52	30.214	66.790
500	4.6089	51323	158.03	147.84	223.43	243.50	27.075	65.910
510	4.2533	53543	162.42	149.75	220.36	237.86	24.602	65.283
520	3.9401	55726	166.66	151.55	216.25	236.05	22.707	64.944
530	3.6688	57867	170.74	153.28	212.01	236.83	21.273	64.898
540	3.4352	59968	174.67	154.96	208.15	239.33	20.195	65.130
550	3.2339	62032	178.46	156.62	204.86	242.94	19.386	65.615
560	3.0595	64067	182.12	158.28	202.21	247.22	18.780	66.323
				Pressure = 20 MPa				
140	12.703	-3324.1	-24.715	84.929	114.37	1864.1	2270.9	179.80
150	12.553	-2178.4	-16.811	84.876	114.78	1807.0	1614.0	176.72
160	12.404	-1028.3	-9.3879	84.914	115.27	1752.1	1231.0	173.31
170	12.255	127.28	-2.3828	85.084	115.86	1698.7	981.12	169.63
180	12.106	1289.4	4.2594	85.409	116.58	1646.4	805.88	165.76
190	11.958	2459.3	10.585	85.901	117.44	1595.0	676.78	161.73
200	11.810	3638.7	16.634	86.567	118.45	1544.3	578.16	157.60
210	11.662	4828.9	22.441	87.407	119.61	1494.3	500.72	153.40
220	11.513	6031.5	28.035	88.416	120.93	1445.0	438.58	149.17

TABLE 3 *Continued*

T K	ρ mol·l^{-1}	H J·mol^{-1}	S J·mol^{-1}·K^{-1}	C_v J·mol^{-1}·K^{-1}	C_p J·mol^{-1}·K^{-1}	c m·s^{-1}	η μPa·s	λ mW·m^{-1}·K^{-1}
230	11.365	7248.0	33.442	89.588	122.40	1396.5	387.82	144.94
240	11.215	8480.0	38.685	90.913	124.02	1348.7	345.74	140.75
250	11.065	9728.9	43.783	92.381	125.78	1301.6	310.40	136.60
260	10.914	10996	48.753	93.979	127.67	1255.4	280.40	132.53
270	10.763	12283	53.609	95.695	129.69	1210.0	254.68	128.56
280	10.610	13590	58.364	97.516	131.82	1165.5	232.42	124.70
290	10.455	14919	63.028	99.429	134.05	1121.8	213.01	120.95
300	10.299	16272	67.611	101.42	136.38	1079.1	195.94	117.34
310	10.142	17647	72.122	103.48	138.79	1037.3	180.84	113.87
320	9.9823	19048	76.568	105.60	141.27	996.50	167.37	110.55
330	9.8208	20473	80.954	107.77	143.83	956.64	155.29	107.38
340	9.6571	21924	85.286	109.98	146.44	917.76	144.39	104.38
350	9.4909	23402	89.569	112.22	149.10	879.90	134.50	101.54
360	9.3222	24906	93.807	114.48	151.80	843.08	125.47	98.875
370	9.1508	26438	98.003	116.75	154.54	807.33	117.19	96.378
380	8.9765	27997	102.16	119.04	157.30	772.69	109.56	94.052
390	8.7992	29584	106.28	121.33	160.08	739.20	102.50	91.899
400	8.6189	31199	110.37	123.62	162.88	706.89	95.939	89.915
410	8.4355	32841	114.43	125.92	165.67	675.82	89.824	88.101
420	8.2491	34512	118.45	128.20	168.46	646.04	84.108	86.453
430	8.0596	36211	122.45	130.47	171.24	617.58	78.752	84.967
440	7.8672	37937	126.42	132.73	173.99	590.48	73.727	83.639
450	7.6722	39690	130.36	134.98	176.71	564.80	69.006	82.463
460	7.4747	41471	134.27	137.20	179.38	540.54	64.570	81.435
470	7.2751	43278	138.16	139.40	181.99	517.75	60.403	80.548
480	7.0739	45110	142.02	141.58	184.53	496.45	56.493	79.796
490	6.8717	46968	145.85	143.73	186.96	476.68	52.831	79.173
500	6.6690	48849	149.65	145.85	189.28	458.47	49.411	78.673
510	6.4668	50753	153.42	147.94	191.45	441.88	46.229	78.293
520	6.2660	52678	157.12	149.99	193.44	426.95	43.280	78.029
530	6.0675	54621	160.86	152.02	195.23	413.70	40.563	77.878
540	5.8726	56582	164.52	154.00	196.81	402.13	38.075	77.837
550	5.6823	58557	168.14	155.96	198.81	392.21	35.809	77.907
560	5.4975	60544	171.73	157.88	199.34	383.87	33.760	78.085