



Designation: **D4650 – 08 D4650 – 14**

Standard Specification for Normal Butane Thermophysical Property Tables¹

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. ~~Tables are provided for gaseous and liquid normal butane at temperatures between 136 and 560 K at pressures to 20 MPa. One table provides properties at the conditions of liquid-vapor equilibrium (saturation properties). The other~~ 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 ~~those conditions: temperatures between 140 K and 560 K at pressures to 20 MPa.~~ The tables were developed by using the National Institute of Standards and Technology ~~from a~~ Standard Reference Database product REFPROP, version 8-0-9.1.

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 gaseous normal butane. ~~However, it is expected that they may find substantial use~~ 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 Coexisting Gaseous and Liquid Normal Butane, 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, Thermophysical Properties of Normal Butane Along Isobars, in SI units.~~ See **Table 23**.

3.3 The tabulated thermophysical properties are:

ρ , molar density ($\text{mol}\cdot\text{l}^{-1}$)

H , molar enthalpy ($\text{J}\cdot\text{mol}^{-1}$)

S , molar entropy ($\text{J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$)

The symbols are:

T , temperature (K)

ρ , molar density ($\text{mol}\cdot\text{L}_{\text{m}}^{-1}$)

H , molar enthalpy ($\text{J}\cdot\text{mol}_{\text{m}}^{-1}$)

S , molar entropy ($\text{J}\cdot\text{K}_{\text{m}}^{-1}\cdot\text{mol}_{\text{m}}^{-1}$)

C_v , constant volume molar heat capacity ($\text{J}\cdot\text{K}_{\text{m}}^{-1}\cdot\text{mol}_{\text{m}}^{-1}$)

C_p , constant pressure molar heat capacity ($\text{J}\cdot\text{K}_{\text{m}}^{-1}\cdot\text{mol}_{\text{m}}^{-1}$)

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.

Current edition approved Dec. 1, 2008; June 1, 2014. Published January 2009; July 2014. Originally approved in 1987. Last previous edition approved in 2003 as D4650 – 93 (2003); D4650 – 08. DOI: 10.1520/D4650-08.10.1520/D4650-14.

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 Coexisting Gaseous and Liquid Normal Butane

<i>T</i> K	<i>p</i> MPa	ρ mol·l ⁻¹	<i>H</i> J·mol ⁻¹	<i>S</i> J·mol ⁻¹ ·K ⁻¹	<i>C_v</i> J·mol ⁻¹ ·K ⁻¹	<i>C_p</i> J·mol ⁻¹ ·K ⁻¹	<i>c</i> m·s ⁻¹	η μPa·s	λ mW·m ⁻¹ ·K ⁻¹
136	8.201E-07	12.627	-22292	134.96	83.79	114.72	1819.4	2201	176.2
136	8.201E-07	7.252E-07	6477.2	346.50	56.23	64.54	149.44	3.349	4.905
140	1.692E-06	12.563	-21832	138.29	83.80	114.92	1793.1	1887	174.8
140	1.692E-06	1.454E-06	6737.0	342.36	57.05	65.36	151.48	3.452	5.091
144	3.338E-06	12.499	-21372	141.53	83.81	115.12	1767.4	1645	173.4
144	3.338E-06	2.788E-06	7000.1	338.56	57.85	66.16	153.49	3.555	5.283
148	6.32E-06	12.435	-20911	144.69	83.82	115.33	1742.2	1452	172.0
148	6.32E-06	5.136E-06	7266.2	335.08	58.62	66.94	155.48	3.658	5.479
152	1.152E-05	12.371	-20450	147.76	83.84	115.55	1717.5	1295	170.4
152	1.152E-05	9.118E-06	7535.4	331.88	59.38	67.70	157.44	3.760	5.681
156	2.029E-05	12.307	-19987	150.77	83.87	115.79	1693.2	1165	168.8
156	2.029E-05	1.565E-05	7807.5	328.94	60.13	68.44	159.37	3.863	5.888
160	3.461E-05	12.243	-19523	153.70	83.92	116.05	1669.2	1055	167.2
160	3.461E-05	2.602E-05	8082.6	326.24	60.86	69.18	161.28	3.965	6.099
164	5.732E-05	12.178	-19059	156.57	83.98	116.32	1645.4	961.7	165.6
164	5.732E-05	4.205E-05	8360.5	323.76	61.59	69.91	163.17	4.067	6.316
168	9.238E-05	12.114	-18593	159.38	84.07	116.62	1621.8	881.0	163.9
168	9.238E-05	6.615E-05	8641.1	321.49	62.31	70.63	165.02	4.170	6.538
172	0.0001452	12.050	-18126	162.13	84.17	116.93	1598.4	810.7	162.1
172	0.0001452	0.0001016	8924.5	319.40	63.03	71.36	166.85	4.271	6.766
176	0.0002229	11.986	-17657	164.82	84.30	117.27	1575.2	749.1	160.4
176	0.0002229	0.0001524	9210.6	317.48	63.75	72.09	168.66	4.373	6.998
180	0.0003348	11.921	-17187	167.46	84.46	117.64	1552.1	694.6	158.6
180	0.0003348	0.0002238	9499.3	315.72	64.48	72.82	170.43	4.475	7.235
184	0.0004928	11.856	-16716	170.05	84.64	118.03	1529.2	646.1	156.8
184	0.0004928	0.0003223	9790.6	314.11	65.21	73.56	172.18	4.576	7.478
188	0.0007118	11.792	-16243	172.59	84.85	118.44	1506.3	602.7	154.9
188	0.0007118	0.0004558	10084	312.63	65.95	74.31	173.90	4.677	7.725
192	0.0010102	11.727	-15768	175.09	85.08	118.89	1483.5	563.7	153.1
192	0.0010102	0.0006337	10381	311.28	66.70	75.07	175.59	4.778	7.977
196	0.0014104	11.661	-15292	177.55	85.34	119.36	1460.8	528.5	151.2
196	0.0014104	0.000867	10680	310.05	67.46	75.85	177.25	4.879	8.235
200	0.001939	11.596	-14814	179.96	85.63	119.86	1438.2	496.5	149.4
200	0.001939	0.0011686	10981	308.93	68.23	76.64	178.87	4.979	8.497
204	0.0026276	11.531	-14333	182.34	85.94	120.38	1415.7	467.4	147.5
204	0.0026276	0.0015535	11284	307.92	69.01	77.45	180.46	5.079	8.765
208	0.003513	11.465	-13850	184.68	86.29	120.94	1393.2	440.8	145.6
208	0.003513	0.0020385	11590	306.99	69.81	78.28	182.01	5.179	9.037
212	0.0046377	11.399	-13365	186.99	86.65	121.53	1370.8	416.5	143.7
212	0.0046377	0.0026425	11898	306.16	70.63	79.13	183.53	5.279	9.315
216	0.00605	11.332	-12878	189.27	87.05	122.15	1348.5	394.1	141.8
216	0.00605	0.0033866	12208	305.41	71.46	80.01	185.00	5.378	9.597
220	0.0078045	11.265	-12388	191.52	87.47	122.80	1326.2	373.4	139.9
220	0.0078045	0.0042942	12520	304.74	72.32	80.91	186.44	5.477	9.884
224	0.0099624	11.198	-11895	193.73	87.92	123.48	1304.0	354.4	138.0
224	0.0099624	0.0053905	12835	304.14	73.18	81.83	187.82	5.575	10.176
228	0.012592	11.131	-11400	195.93	88.40	124.19	1281.8	336.7	136.1
228	0.012592	0.0067034	13151	303.60	74.07	82.78	189.16	5.674	10.47
232	0.015766	11.063	-10901	198.09	88.89	124.93	1259.7	320.3	134.2

TABLE 1 *Continued*

<i>T</i> K	<i>p</i> MPa	ρ mol·l ⁻¹	<i>H</i> J·mol ⁻¹	<i>S</i> J·mol ⁻¹ ·K ⁻¹	<i>C_v</i> J·mol ⁻¹ ·K ⁻¹	<i>C_p</i> J·mol ⁻¹ ·K ⁻¹	<i>c</i> m·s ⁻¹	η μPa·s	λ mW·m ⁻¹ ·K ⁻¹
232	0.015766	0.0082627	13469	303.13	74.98	83.75	190.45	5.772	10.78
236	0.019568	10.995	-10400	200.23	89.42	125.70	1237.6	305.1	132.3
236	0.019568	0.0101	13788	302.73	75.90	84.76	191.69	5.869	11.08
240	0.024086	10.926	-9895.3	202.35	89.96	126.50	1215.6	290.9	130.4
240	0.024086	0.012251	14109	302.37	76.84	85.79	192.87	5.966	11.40
244	0.029415	10.857	-9387.3	204.45	90.53	127.33	1193.7	277.6	128.6
244	0.029415	0.01475	14432	302.07	77.80	86.85	194.00	6.064	11.71
248	0.035656	10.787	-8875.9	206.53	91.13	128.20	1171.8	265.2	126.7
248	0.035656	0.017637	14756	301.82	78.78	87.94	195.06	6.160	12.03
252	0.042919	10.717	-8360.9	208.58	91.74	129.10	1149.9	253.5	124.8
252	0.042919	0.020952	15082	301.61	79.78	89.06	196.06	6.257	12.36
256	0.051319	10.646	-7842.3	210.62	92.37	130.02	1128.1	242.6	123.0
256	0.051319	0.024739	15408	301.44	80.80	90.22	197.00	6.354	12.70
260	0.060978	10.575	-7319.7	212.64	93.03	130.98	1106.4	232.3	121.19
260	0.060978	0.029042	15736	301.32	81.84	91.40	197.86	6.450	13.03
264	0.072022	10.503	-6793.2	214.65	93.70	131.98	1084.7	222.6	119.4
264	0.072022	0.033908	16065	301.23	82.89	92.62	198.66	6.547	13.38
268	0.084586	10.430	-6262.7	216.64	94.39	133.00	1063.0	213.5	117.6
268	0.084586	0.039388	16394	301.18	83.96	93.88	199.38	6.644	13.73
272	0.098809	10.357	-5727.8	218.62	95.10	134.06	1041.4	204.9	115.8
272	0.098809	0.045533	16725	301.16	85.05	95.16	200.03	6.740	14.08
276	0.11484	10.283	-5188.6	220.58	95.83	135.15	1019.8	196.7	114.1
276	0.11484	0.052397	17055	301.17	86.15	96.49	200.59	6.838	14.45
280	0.13282	10.208	-4644.9	222.53	96.57	136.28	998.26	189.0	112.3
280	0.13282	0.060039	17387	301.21	87.27	97.85	201.08	6.935	14.82
284	0.15291	10.132	-4096.6	224.46	97.33	137.44	976.74	181.6	110.6
284	0.15291	0.068517	17719	301.28	88.41	99.25	201.47	7.034	15.20
288	0.17526	10.055	-3543.4	226.39	98.10	138.64	955.24	174.6	108.9
288	0.17526	0.077896	18051	301.37	89.56	100.69	201.78	7.133	15.58
292	0.20005	9.9773	-2985.3	228.31	98.89	139.88	933.77	168.0	107.2
292	0.20005	0.088241	18383	301.48	90.72	102.17	202.00	7.233	15.97
296	0.22744	9.8985	-2422.1	230.21	99.70	141.15	912.32	161.7	105.6
296	0.22744	0.099622	18714	301.62	91.90	103.70	202.13	7.334	16.37
300	0.2576	9.8186	-1853.7	232.11	100.51	142.47	890.88	155.6	103.9
300	0.2576	0.11212	19046	301.78	93.10	105.27	202.15	7.436	16.78
304	0.2907	9.7376	-1279.9	234.00	101.34	143.83	869.44	149.9	102.3
304	0.2907	0.12580	19377	301.95	94.31	106.89	202.08	7.540	17.20
308	0.32694	9.6553	-700.5	235.88	102.18	145.24	848.01	144.3	100.7
308	0.32694	0.14075	19707	302.14	95.53	108.56	201.89	7.646	17.64
312	0.36648	9.5717	-115.4	237.75	103.03	146.69	826.57	139.0	99.16
312	0.36648	0.15707	20037	302.35	96.76	110.29	201.61	7.754	18.08
316	0.40952	9.4867	475.7	239.62	103.90	148.20	805.11	134.0	97.62
316	0.40952	0.17485	20365	302.56	98.01	112.08	201.2	7.865	18.53
320	0.45624	9.4002	1072.8	241.48	104.78	149.76	783.62	129.1	96.10
320	0.45624	0.19420	20693	302.80	99.27	113.94	200.69	7.978	18.90
324	0.50684	9.3122	1676.3	243.34	105.66	151.38	762.10	124.4	94.61
324	0.50684	0.21521	21018	303.04	100.55	115.87	200.05	8.095	19.48
328	0.56152	9.2224	2286.3	245.20	106.56	153.07	740.53	119.9	93.14
328	0.56152	0.23803	21342	303.29	101.84	117.87	199.28	8.215	19.98

TABLE 1 *Continued*

<i>T</i> K	<i>p</i> MPa	ρ mol·l ⁻¹	<i>H</i> J·mol ⁻¹	<i>S</i> J·mol ⁻¹ ·K ⁻¹	<i>C_v</i> J·mol ⁻¹ ·K ⁻¹	<i>C_p</i> J·mol ⁻¹ ·K ⁻¹	<i>c</i> m·s ⁻¹	η μPa·s	λ mW·m ⁻¹ ·K ⁻¹
332	0.62047	9.1307	2903.0	247.04	107.47	154.83	718.90	115.5	91.69
332	0.62047	0.26278	21663	303.55	103.13	119.97	198.38	8.339	20.49
336	0.6839	9.0371	3526.8	248.89	108.40	156.67	697.19	111.3	90.27
336	0.6839	0.28961	21982	303.82	104.45	122.17	197.35	8.467	21.02
340	0.75201	8.9414	4157.8	250.74	109.33	158.60	675.39	107.2	88.88
340	0.75201	0.31868	22298	304.09	105.77	124.47	196.17	8.601	21.58
344	0.82501	8.8434	4796.3	252.58	110.28	160.62	653.49	103.3	87.51
344	0.82501	0.35017	22611	304.36	107.10	126.90	194.83	8.740	22.15
348	0.90313	8.7429	5442.7	254.42	111.24	162.77	631.45	99.44	86.16
348	0.90313	0.38429	22919	304.64	108.43	129.46	193.35	8.886	22.75
352	0.98658	8.6397	6097.4	256.26	112.22	165.04	609.25	95.71	84.84
352	0.98658	0.42128	23223	304.92	109.77	132.19	191.69	9.038	23.37
356	1.0756	8.5335	6760.7	258.11	113.21	167.46	586.88	92.08	83.54
356	1.0756	0.46139	23523	305.19	111.11	135.10	189.86	9.199	24.03
360	1.1704	8.4241	7433.0	259.96	114.22	170.06	564.31	88.54	82.27
360	1.1704	0.50492	23816	305.46	112.46	138.25	187.85	9.369	24.72
364	1.2712	8.3111	8115.0	261.81	115.26	172.86	541.49	85.07	81.02
364	1.2712	0.55224	24102	305.73	113.82	141.68	185.65	9.550	25.44
368	1.3783	8.1941	8807.2	263.66	116.31	175.92	518.41	81.68	79.79
368	1.3783	0.60376	24380	305.98	115.21	145.48	183.24	9.742	26.20
372	1.492	8.0727	9510.3	265.52	117.39	179.27	495.02	78.36	78.58
372	1.492	0.65996	24650	306.22	116.63	149.72	180.62	9.947	27.02
376	1.6124	7.9462	10225	267.40	118.51	183.00	471.27	75.09	77.39
376	1.6124	0.72142	24909	306.45	118.10	154.54	177.76	10.17	27.88
380	1.7399	7.8141	10953	269.28	119.66	187.19	447.13	71.86	76.22
380	1.7399	0.78888	25155	306.65	119.62	160.09	174.66	10.41	28.81
384	1.8749	7.6755	11694	271.17	120.86	191.99	422.54	68.67	75.07
384	1.8749	0.86320	25388	306.83	121.21	166.57	171.29	10.67	29.82
388	2.0175	7.5292	12451	273.09	122.10	197.59	397.44	65.49	73.93
388	2.0175	0.94551	25604	306.98	122.88	174.29	167.64	10.95	30.92
392	2.1682	7.3739	13226	275.02	123.41	204.28	371.76	62.33	72.81
392	2.1682	1.0372	25801	307.10	124.63	183.68	163.69	11.27	32.13
396	2.3274	7.2077	14021	276.98	124.80	212.51	345.43	59.16	71.70
396	2.3274	1.1403	25973	307.16	126.47	195.40	159.41	11.62	33.48
400	2.4954	7.0280	14841	278.98	126.28	223.05	318.35	55.96	70.60
400	2.4954	1.2573	26116	307.17	128.42	210.57	154.77	12.03	35.03
404	2.6729	6.8308	15690	281.03	127.89	237.22	290.40	52.70	69.53
404	2.6729	1.3920	26220	307.10	130.51	231.11	149.74	12.50	36.85
408	2.8602	6.6104	16577	283.15	129.65	257.67	261.43	49.34	68.48
408	2.8602	1.5502	26275	306.92	132.78	260.79	144.27	13.05	39.07
412	3.0582	6.3565	17518	285.37	131.63	290.35	231.23	45.79	67.51
412	3.0582	1.7415	26259	306.58	135.31	308.00	138.31	13.74	41.93
416	3.2676	6.0492	18541	287.76	133.97	352.04	199.49	41.93	66.79
416	3.2676	1.9840	26134	306.01	138.28	396.04	131.77	14.64	46.01
420	3.4897	5.6393	19721	290.49	136.99	514.51	165.59	37.39	67.19
420	3.4897	2.3227	25806	304.98	142.07	623.01	124.46	15.96	53.10
424	3.7262	4.8868	21424	294.42	142.65	2001.10	127.24	30.58	79.51
424	3.7262	2.9801	24823	302.43	148.13	2609.40	115.73	18.84	77.92

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*

<i>T</i> K	<i>p</i> MPa	ρ mol·l ⁻¹	<i>H</i> J·mol ⁻¹	<i>S</i> J·mol ⁻¹ ·K ⁻¹	<i>C_v</i> J·mol ⁻¹ ·K ⁻¹	<i>C_p</i> J·mol ⁻¹ ·K ⁻¹	<i>c</i> m·s ⁻¹	η μPa·s	λ mW·m ⁻¹ ·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