Designation: D4651 – 14

Standard Specification for Isobutane Thermophysical Property Tables[1]

This standard is issued under the fixed designation D4651; 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 isobutane are for use in the calculation of the pressure-volume-temperature (PVT), thermodynamic, and transport properties of isobutane 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 120 K and the critical point, 407.81 K. A third table provides properties at selected *T*, *p* points for the equilibrium phase at temperatures between 120 K and 570 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 isobutane. They may also be used in mathematical models and tables for the thermophysical properties of mixtures containing isobutane.

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 Isobutane Liquid at Vapor-Liquid Equilibrium,* in SI units. See Table 1.

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

3.2.3 *Thermophysical Properties of Isobutane 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 ($J \cdot K^{-1} \cdot mol^{-1}$)
C_v, constant volume molar heat capacity ($J \cdot K^{-1} \cdot mol^{-1}$)
C_p, 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 ($J \cdot K^{-1} \cdot mol^{-1}$)
C_v, constant volume molar heat capacity ($J \cdot K^{-1} \cdot mol^{-1}$)
C_p, 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 isobutane is 58.122 g/mol.

5. Keywords

5.1 isobutane; isobutane gas tables; natural gas; thermodynamic properties of isobutane; transport properties of isobutane; 2-methylpropane

[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 Isobutane Liquid at Vapor-Liquid Equilibrium

T	P	ρ	H	S	C_v	C_p	c	η	λ
K	MPa	$mol \cdot l^{-1}$	$J \cdot mol^{-1}$	$J \cdot mol^{-1} \cdot K^{-1}$	$J \cdot mol^{-1} \cdot K^{-1}$	$J \cdot mol^{-1} \cdot K^{-1}$	$m \cdot s^{-1}$	μPa·s	$mW \cdot m^{-1} \cdot K^{-1}$
120	1.0633E-07	12.636	-5912.6	-34.216	69.001	99.308	1945.4	6055.8	156.73
122	1.6734E-07	12.603	-5713.6	-32.571	69.251	99.681	1928.5	5441.0	156.30
124	2.5915E-07	12.571	-5513.9	-30.948	69.501	100.06	1911.9	4910.8	155.85
126	3.9524E-07	12.538	-5313.4	-29.344	69.752	100.43	1895.5	4450.9	155.38
128	5.9407E-07	12.506	-5112.1	-27.759	70.004	100.81	1879.3	4049.9	154.89
130	8.8064E-07	12.473	-4910.1	-26.193	70.255	101.18	1863.4	3698.4	154.39
132	1.2883E-06	12.441	-4707.4	-24.646	70.505	101.56	1847.7	3389.0	153.86
134	1.8611E-06	12.408	-4503.9	-23.116	70.754	101.93	1832.2	3115.4	153.32
136	2.6564E-06	12.376	-4299.7	-21.603	71.003	102.30	1816.9	2872.5	152.76
138	3.7483E-06	12.343	-4094.7	-20.107	71.250	102.68	1801.7	2656.0	152.19
140	5.2314E-06	12.311	-3889.0	-18.627	71.497	103.05	1786.8	2462.5	151.60
142	7.2252E-06	12.278	-3682.5	-17.162	71.743	103.42	1772.0	2288.8	150.99
144	9.8793E-06	12.245	-3475.3	-15.713	71.988	103.79	1757.4	2132.5	150.37
146	1.3379E-05	12.213	-3267.4	-14.279	72.233	104.16	1742.9	1991.3	149.74
148	1.7953E-05	12.180	-3058.7	-12.859	72.477	104.53	1728.6	1863.6	149.09
150	2.3880E-05	12.147	-2849.3	-11.454	72.720	104.89	1714.4	1747.6	148.43
152	3.1496E-05	12.115	-2639.1	-10.062	72.964	105.26	1700.3	1642.0	147.75
154	4.1206E-05	12.082	-2428.2	-8.6838	73.207	105.63	1686.4	1545.6	147.07
156	5.3493E-05	12.049	-2216.6	-7.3185	73.451	106.00	1672.6	1457.5	146.37
158	6.8925E-05	12.016	-2004.2	-5.9659	73.695	106.36	1658.9	1376.7	145.67
160	8.8176E-05	11.984	-1791.1	-4.6257	73.940	106.73	1645.3	1302.4	144.95
162	0.00011203	11.951	-1577.3	-3.2975	74.186	107.10	1631.8	1234.1	144.22
164	0.00014139	11.918	-1362.8	-1.9812	74.432	107.47	1618.3	1171.0	143.48
166	0.00017732	11.885	-1147.5	-0.67634	74.679	107.83	1605.0	1112.6	142.74
168	0.00022101	11.852	-931.41	0.61730	74.928	108.20	1591.8	1058.6	141.98
170	0.00027386	11.819	-714.63	1.9000	75.178	108.57	1578.6	1008.4	141.22
172	0.00033740	11.786	-497.11	3.1721	75.430	108.95	1565.6	961.80	140.45
174	0.00041343	11.752	-278.84	4.4337	75.684	109.32	1552.6	918.37	139.67
176	0.00050391	11.719	-59.816	5.6852	75.939	109.69	1539.6	877.85	138.88
178	0.00061107	11.686	159.96	6.9268	76.197	110.07	1526.8	839.98	138.09
180	0.00073738	11.653	380.48	8.1588	76.456	110.45	1514.0	804.54	137.30
182	0.00088560	11.619	601.77	9.3813	76.718	110.83	1501.3	771.33	136.49
184	0.0010588	11.586	823.82	10.595	76.983	111.21	1488.6	740.15	135.68
186	0.0012602	11.552	1046.6	11.799	77.250	111.60	1476.0	710.84	134.87
188	0.0014935	11.519	1270.2	12.995	77.519	111.98	1463.4	683.26	134.05
190	0.0017628	11.485	1494.6	14.182	77.792	112.37	1450.9	657.25	133.23
192	0.0020724	11.451	1719.8	15.360	78.067	112.77	1438.5	632.72	132.40
194	0.0024270	11.418	1945.7	16.531	78.345	113.16	1426.1	609.54	131.57
196	0.0028316	11.384	2172.5	17.694	78.627	113.56	1413.7	587.61	130.73
198	0.0032918	11.350	2400.0	18.849	78.911	113.96	1401.4	566.84	129.90
200	0.0038135	11.316	2628.4	19.996	79.199	114.37	1389.1	547.15	129.06
202	0.0044031	11.282	2857.6	21.136	79.490	114.78	1376.9	528.46	128.21
204	0.0050671	11.248	3087.6	22.269	79.785	115.19	1364.7	510.71	127.37
206	0.0058130	11.213	3318.5	23.394	80.082	115.61	1352.6	493.83	126.52
208	0.0066482	11.179	3550.1	24.513	80.384	116.03	1340.5	477.76	125.67
210	0.0075808	11.145	3782.7	25.626	80.689	116.46	1328.4	462.45	124.82
212	0.0086196	11.110	4016.1	26.731	80.998	116.88	1316.3	447.85	123.97
214	0.0097734	11.075	4250.4	27.831	81.310	117.32	1304.4	433.92	123.12
216	0.011052	11.041	4485.5	28.924	81.626	117.76	1292.4	420.62	122.27
218	0.012465	11.006	4721.5	30.011	81.946	118.20	1280.5	407.90	121.41
220	0.014023	10.971	4958.5	31.092	82.269	118.65	1268.6	395.73	120.56
222	0.015736	10.936	5196.3	32.168	82.596	119.10	1256.7	384.08	119.71
224	0.017618	10.901	5435.1	33.238	82.927	119.55	1244.9	372.92	118.86
226	0.019678	10.865	5674.8	34.302	83.262	120.02	1233.0	362.23	118.02
228	0.021930	10.830	5915.4	35.361	83.601	120.48	1221.3	351.97	117.17
230	0.024387	10.794	6157.0	36.415	83.944	120.96	1209.5	342.12	116.32
232	0.027061	10.759	6399.5	37.464	84.290	121.43	1197.8	332.66	115.47
234	0.029967	10.723	6643.0	38.508	84.640	121.92	1186.1	323.57	114.63
236	0.033118	10.687	6887.5	39.547	84.995	122.41	1174.4	314.83	113.79
238	0.036530	10.651	7133.0	40.582	85.353	122.90	1162.8	306.42	112.94
240	0.040218	10.615	7379.5	41.612	85.714	123.40	1151.2	298.32	112.10
242	0.044196	10.578	7627.1	42.637	86.080	123.91	1139.6	290.53	111.27
244	0.048482	10.542	7875.6	43.658	86.450	124.42	1128.0	283.01	110.43
246	0.053092	10.505	8125.2	44.675	86.823	124.94	1116.4	275.77	109.60
248	0.058042	10.468	8375.9	45.688	87.200	125.46	1104.9	268.78	108.77
250	0.063350	10.431	8627.7	46.697	87.581	126.00	1093.4	262.04	107.94
252	0.069033	10.394	8880.5	47.703	87.966	126.54	1081.9	255.54	107.12
254	0.075109	10.357	9134.4	48.704	88.354	127.08	1070.4	249.25	106.30
256	0.081597	10.319	9389.5	49.702	88.746	127.63	1059.0	243.18	105.48
258	0.088516	10.281	9645.6	50.696	89.142	128.19	1047.5	237.31	104.67
260	0.095885	10.243	9903.0	51.687	89.541	128.76	1036.1	231.63	103.86
262	0.10372	10.205	10161	52.674	89.944	129.33	1024.7	226.14	103.05
264	0.11205	10.167	10421	53.658	90.351	129.91	1013.3	220.83	102.25
266	0.12089	10.128	10682	54.639	90.761	130.50	1002.0	215.68	101.45

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 $mW \cdot m^{-1} \cdot K^{-1}$
268	0.13025	10.090	10944	55.617	91.175	131.10	990.63	210.70	100.66
270	0.14017	10.051	11207	56.592	91.592	131.70	979.29	205.87	99.867
272	0.15066	10.012	11472	57.564	92.012	132.32	967.96	201.19	99.082
274	0.16174	9.9721	11738	58.534	92.436	132.94	956.65	196.65	98.301
276	0.17344	9.9324	12005	59.501	92.864	133.57	945.35	192.25	97.524
278	0.18577	9.8925	12273	60.465	93.294	134.21	934.06	187.98	96.753
280	0.19876	9.8523	12543	61.427	93.728	134.86	922.77	183.83	95.986
282	0.21243	9.8118	12813	62.386	94.165	135.52	911.50	179.81	95.224
284	0.22681	9.7710	13086	63.343	94.606	136.19	900.23	175.89	94.467
286	0.24192	9.7300	13359	64.298	95.050	136.87	888.97	172.09	93.715
288	0.25777	9.6887	13635	65.250	95.496	137.56	877.72	168.40	92.969
290	0.27440	9.6470	13911	66.201	95.946	138.26	866.47	164.80	92.227
292	0.29183	9.6051	14189	67.150	96.400	138.97	855.22	161.31	91.491
294	0.31008	9.5628	14468	68.096	96.856	139.70	843.98	157.91	90.761
296	0.32917	9.5202	14749	69.042	97.315	140.43	832.74	154.59	90.036
298	0.34914	9.4773	15031	69.985	97.778	141.18	821.50	151.37	89.316
300	0.37000	9.4339	15315	70.927	98.243	141.94	810.25	148.22	88.602
302	0.39177	9.3902	15600	71.867	98.711	142.72	799.01	145.16	87.894
304	0.41450	9.3462	15887	72.806	99.183	143.51	787.76	142.17	87.191
306	0.43819	9.3017	16176	73.743	99.657	144.32	776.50	139.26	86.494
308	0.46288	9.2568	16466	74.680	100.13	145.14	765.24	136.41	85.803
310	0.48858	9.2114	16758	75.615	100.62	145.98	753.97	133.64	85.118
312	0.51534	9.1657	17051	76.549	101.10	146.84	742.69	130.92	84.439
314	0.54317	9.1194	17346	77.482	101.59	147.71	731.40	128.27	83.765
316	0.57209	9.0727	17643	78.414	102.07	148.61	720.10	125.68	83.098
318	0.60215	9.0255	17942	79.346	102.57	149.52	708.78	123.15	82.437
320	0.63335	8.9777	18242	80.276	103.06	150.46	697.45	120.67	81.781
322	0.66573	8.9295	18544	81.207	103.56	151.42	686.10	118.24	81.132
324	0.69932	8.8806	18848	82.137	104.06	152.40	674.72	115.86	80.489
326	0.73415	8.8312	19154	83.066	104.57	153.41	663.33	113.53	79.851
328	0.77023	8.7811	19462	83.995	105.08	154.45	651.91	111.25	79.220
330	0.80761	8.7304	19772	84.925	105.59	155.52	640.46	109.01	78.595
332	0.84630	8.6790	20084	85.854	106.11	156.62	628.99	106.81	77.976
334	0.88635	8.6270	20398	86.783	106.63	157.75	617.48	104.65	77.363
336	0.92776	8.5741	20715	87.713	107.15	158.92	605.94	102.53	76.757
338	0.97059	8.5206	21033	88.643	107.68	160.13	594.36	100.45	76.156
340	1.0148	8.4662	21354	89.574	108.21	161.39	582.74	98.394	75.561
342	1.0606	8.4109	21677	90.505	108.74	162.69	571.08	96.375	74.973
344	1.1078	8.3548	22002	91.438	109.28	164.04	559.37	94.387	74.390
346	1.1565	8.2977	22330	92.371	109.83	165.44	547.62	92.427	73.814
348	1.2068	8.2396	22661	93.306	110.38	166.91	535.81	90.495	73.243
350	1.2587	8.1805	22994	94.242	110.93	168.44	523.94	88.587	72.679
352	1.3123	8.1202	23330	95.180	111.49	170.04	512.02	86.704	72.120
354	1.3674	8.0588	23668	96.120	112.06	171.73	500.02	84.842	71.567
356	1.4243	7.9961	24010	97.062	112.63	173.50	487.96	83.000	71.020
358	1.4829	7.9321	24354	98.007	113.21	175.38	475.82	81.177	70.479
360	1.5433	7.8666	24702	98.954	113.80	177.37	463.60	79.371	69.944
362	1.6054	7.7996	25053	99.904	114.39	179.48	451.29	77.580	69.415
364	1.6694	7.7310	25408	100.86	114.99	181.74	438.89	75.802	68.891
366	1.7352	7.6606	25766	101.82	115.60	184.15	426.38	74.034	68.374
368	1.8030	7.5883	26128	102.78	116.22	186.76	413.76	72.277	67.862
370	1.8727	7.5139	26494	103.75	116.86	189.58	401.01	70.526	67.356
372	1.9444	7.4372	26864	104.72	117.50	192.66	388.14	68.779	66.856
374	2.0181	7.3580	27239	105.7	118.17	196.03	375.12	67.036	66.363
376	2.0939	7.2762	27619	106.68	118.84	199.74	361.94	65.292	65.877
378	2.1718	7.1913	28005	107.68	119.54	203.88	348.59	63.544	65.398
380	2.2519	7.1031	28396	108.68	120.26	208.53	335.05	61.791	64.926
382	2.3343	7.0111	28794	109.69	121.01	213.80	321.32	60.027	64.465
384	2.4189	6.9149	29198	110.72	121.79	219.85	307.36	58.248	64.014
386	2.5058	6.8138	29611	111.76	122.62	226.90	293.15	56.450	63.577
388	2.5951	6.7072	30032	112.81	123.49	235.25	278.69	54.626	63.158
390	2.6869	6.5941	30464	113.88	124.42	245.34	263.93	52.770	62.764
392	2.7812	6.4732	30907	114.98	125.42	257.82	248.86	50.870	62.403
394	2.8782	6.3430	31365	116.11	126.52	273.75	233.42	48.915	62.093
396	2.9778	6.2012	31840	117.27	127.74	294.88	217.58	46.887	61.861
398	3.0802	6.0444	32336	118.48	129.14	324.44	201.26	44.761	61.762
400	3.1856	5.8674	32862	119.75	130.78	369.01	184.38	42.498	61.898
402	3.2940	5.6611	33429	121.12	132.80	444.47	166.79	40.030	62.501
404	3.4057	5.4067	34065	122.65	135.47	601.19	148.23	37.215	64.151
406	3.5210	5.0501	34847	124.52	139.62	1125.7	128.12	33.651	68.999
407.81	3.6284	4.0403	36583	128.73	152.07	329210	106.84	25.500	348.88

TABLE 2 Thermophysical Properties of Isobutane Vapor 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}
120	1.0633E-07	1.0657E-07	21733	196.17	44.496	52.811	142.74	3.0131	2.6257
122	1.6734E-07	1.6497E-07	21840	193.27	45.023	53.338	143.79	3.0658	2.7408
124	2.5915E-07	2.5136E-07	21947	190.51	45.546	53.861	144.83	3.1185	2.8569
126	3.9524E-07	3.7727E-07	22055	187.87	46.064	54.379	145.87	3.1711	2.9740
128	5.9407E-07	5.5821E-07	22164	185.34	46.578	54.892	146.90	3.2237	3.0922
130	8.8064E-07	8.1474E-07	22275	182.92	47.087	55.402	147.92	3.2763	3.2114
132	1.2883E-06	1.1738E-06	22386	180.61	47.592	55.907	148.93	3.3288	3.3317
134	1.8611E-06	1.6704E-06	22498	178.39	48.094	56.409	149.94	3.3813	3.4530
136	2.6564E-06	2.3492E-06	22611	176.27	48.591	56.906	150.94	3.4337	3.5753
138	3.7483E-06	3.2669E-06	22726	174.24	49.085	57.400	151.94	3.4860	3.6987
140	5.2314E-06	4.4943E-06	22841	172.30	49.575	57.891	152.92	3.5384	3.8231
142	7.2252E-06	6.1198E-06	22957	170.44	50.062	58.378	153.90	3.5906	3.9485
144	9.8793E-06	8.2517E-06	23074	168.66	50.546	58.862	154.88	3.6429	4.0750
146	1.3379E-05	1.1022E-05	23193	166.95	51.028	59.344	155.84	3.6950	4.2025
148	1.7953E-05	1.4591E-05	23312	165.32	51.506	59.823	156.80	3.7472	4.3310
150	2.3880E-05	1.9149E-05	23432	163.75	51.982	60.300	157.76	3.7992	4.4606
152	3.1496E-05	2.4924E-05	23553	162.25	52.456	60.774	158.71	3.8513	4.5912
154	4.1206E-05	3.2185E-05	23675	160.82	52.928	61.247	159.65	3.9032	4.7228
156	5.3493E-05	4.1247E-05	23798	159.44	53.397	61.717	160.58	3.9551	4.8555
158	6.8925E-05	5.2475E-05	23921	158.12	53.866	62.187	161.51	4.0070	4.9892
160	8.8176E-05	6.6294E-05	24046	156.86	54.332	62.655	162.43	4.0588	5.1239
162	0.00011203	8.3191E-05	24171	155.65	54.798	63.122	163.35	4.1105	5.2596
164	0.00014139	0.00010372	24298	154.49	55.262	63.589	164.26	4.1622	5.3964
166	0.00017732	0.00012852	24425	153.38	55.726	64.054	165.16	4.2138	5.5342
168	0.00022101	0.00015829	24553	152.31	56.188	64.520	166.06	4.2654	5.6729
170	0.00027386	0.00019384	24682	151.29	56.651	64.985	166.95	4.3168	5.8127
172	0.00033740	0.00023606	24812	150.32	57.113	65.451	167.83	4.3682	5.9535
174	0.00041343	0.00028595	24943	149.39	57.575	65.917	168.70	4.4196	6.0953
176	0.00050391	0.00034461	25075	148.49	58.037	66.384	169.57	4.4708	6.2381
178	0.00061107	0.00041325	25207	147.64	58.500	66.852	170.43	4.5220	6.3819
180	0.00073738	0.00049321	25340	146.82	58.963	67.320	171.29	4.5732	6.5267
182	0.00088560	0.00058593	25474	146.04	59.426	67.791	172.13	4.6242	6.6725
184	0.0010588	0.00069300	25609	145.30	59.891	68.262	172.97	4.6751	6.8192
186	0.0012602	0.00081613	25745	144.58	60.356	68.736	173.80	4.7260	6.9669
188	0.0014935	0.00095718	25881	143.90	60.823	69.212	174.63	4.7768	7.1156
190	0.0017628	0.0011181	26018	143.25	61.291	69.690	175.44	4.8275	7.2652
192	0.0020724	0.0013012	26156	142.63	61.760	70.170	176.25	4.8781	7.4158
194	0.0024270	0.0015085	26295	142.04	62.231	70.653	177.05	4.9286	7.5673
196	0.0028316	0.0017426	26434	141.48	62.704	71.140	177.83	4.9790	7.7198
198	0.0032918	0.0020061	26574	140.94	63.179	71.629	178.61	5.0294	7.8732
200	0.0038135	0.0023017	26715	140.43	63.656	72.122	179.38	5.0796	8.0275
202	0.0044031	0.0026324	26857	139.94	64.135	72.618	180.14	5.1297	8.1827
204	0.0050671	0.0030011	26999	139.48	64.617	73.118	180.89	5.1797	8.3389
206	0.0058130	0.0034111	27142	139.04	65.101	73.623	181.63	5.2297	8.4959
208	0.0066482	0.0038658	27285	138.62	65.587	74.131	182.36	5.2795	8.6539
210	0.0075808	0.0043687	27429	138.23	66.077	74.644	183.08	5.3292	8.8127
212	0.0086196	0.0049235	27574	137.85	66.569	75.161	183.78	5.3789	8.9724
214	0.0097734	0.0055342	27720	137.50	67.064	75.684	184.48	5.4284	9.1330
216	0.011052	0.0062046	27866	137.16	67.561	76.211	185.16	5.4778	9.2945
218	0.012465	0.0069390	28012	136.85	68.062	76.743	185.83	5.5271	9.4569
220	0.014023	0.0077418	28159	136.55	68.567	77.281	186.48	5.5763	9.6201
222	0.015736	0.0086174	28307	136.27	69.074	77.824	187.12	5.6254	9.7842
224	0.017618	0.0095704	28455	136.01	69.585	78.373	187.75	5.6744	9.9492
226	0.019678	0.010606	28604	135.76	70.099	78.928	188.37	5.7234	10.115
228	0.021930	0.011728	28753	135.53	70.616	79.488	188.97	5.7722	10.282
230	0.024387	0.012943	28903	135.31	71.137	80.055	189.56	5.8209	10.449
232	0.027061	0.014256	29053	135.11	71.662	80.629	190.13	5.8696	10.618
234	0.029967	0.015671	29204	134.92	72.190	81.208	190.68	5.9182	10.787
236	0.033118	0.017195	29355	134.75	72.722	81.795	191.22	5.9666	10.957
238	0.036530	0.018834	29506	134.59	73.257	82.388	191.75	6.0151	11.128
240	0.040218	0.020593	29658	134.44	73.796	82.988	192.25	6.0634	11.300
242	0.044196	0.022477	29810	134.30	74.339	83.595	192.74	6.1117	11.473
244	0.048482	0.024495	29963	134.18	74.886	84.210	193.22	6.1600	11.647
246	0.053092	0.026651	30116	134.07	75.436	84.832	193.67	6.2082	11.822
248	0.058042	0.028952	30269	133.97	75.990	85.462	194.11	6.2564	11.997
250	0.063350	0.031405	30423	133.88	76.548	86.099	194.52	6.3045	12.174
252	0.069033	0.034017	30577	133.80	77.110	86.744	194.92	6.3527	12.352
254	0.075109	0.036794	30731	133.73	77.676	87.398	195.30	6.4008	12.530
256	0.081597	0.039744	30886	133.67	78.245	88.060	195.66	6.4489	12.710
258	0.088516	0.042874	31041	133.62	78.819	88.730	196.00	6.4971	12.891
260	0.095885	0.046192	31196	133.58	79.396	89.409	196.32	6.5453	13.073
262	0.10372	0.049705	31351	133.55	79.977	90.097	196.62	6.5935	13.256
264	0.11205	0.053421	31506	133.53	80.561	90.793	196.89	6.6419	13.440
266	0.12089	0.057348	31662	133.51	81.150	91.499	197.15	6.6903	13.625

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}
268	0.13025	0.061495	31818	133.50	81.742	92.215	197.38	6.7387	13.812
270	0.14017	0.065869	31974	133.50	82.338	92.940	197.59	6.7873	14.000
272	0.15066	0.070480	32130	133.51	82.938	93.675	197.78	6.8361	14.189
274	0.16174	0.075336	32286	133.53	83.542	94.421	197.94	6.8850	14.380
276	0.17344	0.080446	32442	133.55	84.149	95.177	198.08	6.9340	14.572
278	0.18577	0.085821	32598	133.58	84.760	95.944	198.20	6.9833	14.766
280	0.19876	0.091469	32754	133.61	85.375	96.722	198.29	7.0328	14.961
282	0.21243	0.097400	32911	133.65	85.993	97.511	198.35	7.0825	15.159
284	0.22681	0.10362	33067	133.70	86.615	98.312	198.39	7.1325	15.357
286	0.24192	0.11015	33223	133.75	87.241	99.126	198.41	7.1828	15.558
288	0.25777	0.11700	33379	133.81	87.870	99.952	198.39	7.2334	15.761
290	0.27440	0.12417	33535	133.87	88.503	100.79	198.35	7.2844	15.966
292	0.29183	0.13168	33691	133.94	89.140	101.64	198.29	7.3357	16.173
294	0.31008	0.13954	33847	134.01	89.780	102.51	198.19	7.3875	16.382
296	0.32917	0.14776	34003	134.09	90.423	103.39	198.07	7.4397	16.593
298	0.34914	0.15635	34158	134.17	91.070	104.29	197.92	7.4925	16.807
300	0.37000	0.16534	34314	134.26	91.721	105.20	197.74	7.5457	17.024
302	0.39177	0.17472	34469	134.34	92.375	106.13	197.52	7.5996	17.243
304	0.41450	0.18452	34623	134.44	93.033	107.08	197.28	7.6541	17.465
306	0.43819	0.19476	34778	134.53	93.695	108.04	197.01	7.7092	17.691
308	0.46288	0.20544	34932	134.63	94.361	109.02	196.70	7.7650	17.919
310	0.48858	0.21659	35086	134.74	95.030	110.03	196.37	7.8217	18.151
312	0.51534	0.22822	35239	134.84	95.703	111.05	196.00	7.8791	18.387
314	0.54317	0.24034	35392	134.95	96.380	112.10	195.59	7.9375	18.627
316	0.57209	0.25298	35544	135.06	97.061	113.17	195.15	7.9967	18.870
318	0.60215	0.26617	35696	135.18	97.746	114.27	194.68	8.0570	19.118
320	0.63335	0.27991	35847	135.29	98.434	115.39	194.17	8.1184	19.370
322	0.66573	0.29422	35997	135.41	99.125	116.54	193.62	8.1810	19.627
324	0.69932	0.30915	36147	135.53	99.819	117.72	193.04	8.2448	19.889
326	0.73415	0.32470	36296	135.65	100.51	118.93	192.41	8.3100	20.156
328	0.77023	0.34090	36444	135.77	101.21	120.17	191.75	8.3766	20.429
330	0.80761	0.35779	36592	135.89	101.91	121.44	191.05	8.4448	20.708
332	0.84630	0.37539	36738	136.02	102.61	122.75	190.31	8.5146	20.994
334	0.88635	0.39372	36884	136.14	103.31	124.10	189.52	8.5861	21.286
336	0.92776	0.41284	37028	136.26	104.01	125.49	188.69	8.6596	21.585
338	0.97059	0.43277	37171	136.39	104.71	126.93	187.82	8.7352	21.892
340	1.0148	0.45354	37313	136.51	105.41	128.42	186.90	8.8129	22.207
342	1.0606	0.47521	37453	136.64	106.11	129.97	185.94	8.8930	22.531
344	1.1078	0.49781	37592	136.76	106.81	131.58	184.92	8.9757	22.865
346	1.1565	0.52140	37729	136.88	107.52	133.26	183.86	9.0611	23.208
348	1.2068	0.54602	37865	137.00	108.23	135.03	182.75	9.1495	23.562
350	1.2587	0.57173	37998	137.11	108.95	136.89	181.59	9.2411	23.928
352	1.3123	0.59860	38130	137.23	109.67	138.86	180.38	9.3362	24.306
354	1.3674	0.62668	38259	137.34	110.41	140.94	179.11	9.4350	24.698
356	1.4243	0.65606	38386	137.45	111.16	143.17	177.78	9.5379	25.105
358	1.4829	0.68681	38510	137.55	111.93	145.55	176.40	9.6453	25.528
360	1.5433	0.71903	38632	137.65	112.72	148.11	174.96	9.7575	25.968
362	1.6054	0.75280	38751	137.74	113.53	150.87	173.45	9.8750	26.427
364	1.6694	0.78824	38866	137.83	114.37	153.86	171.89	9.9982	26.908
366	1.7352	0.82548	38978	137.92	115.23	157.11	170.25	10.128	27.411
368	1.8030	0.86464	39086	137.99	116.11	160.66	168.55	10.264	27.941
370	1.8727	0.90588	39190	138.06	117.03	164.55	166.77	10.409	28.498
372	1.9444	0.94937	39290	138.12	117.98	168.84	164.92	10.561	29.088
374	2.0181	0.99533	39385	138.17	118.96	173.60	163.00	10.723	29.713
376	2.0939	1.0440	39474	138.21	119.97	178.92	160.99	10.896	30.378
378	2.1718	1.0956	39558	138.24	121.02	184.89	158.90	11.081	31.089
380	2.2519	1.1505	39635	138.25	122.11	191.67	156.73	11.278	31.853
382	2.3343	1.2090	39704	138.25	123.23	199.43	154.46	11.491	32.677
384	2.4189	1.2716	39765	138.24	124.41	208.42	152.10	11.721	33.572
386	2.5058	1.3389	39817	138.20	125.63	218.98	149.63	11.972	34.551
388	2.5951	1.4115	39858	138.13	126.92	231.58	147.06	12.245	35.630
390	2.6869	1.4904	39886	138.04	128.27	246.92	144.37	12.546	36.832
392	2.7812	1.5766	39899	137.92	129.70	266.03	141.57	12.881	38.187
394	2.8782	1.6716	39894	137.75	131.24	290.57	138.63	13.256	39.738
396	2.9778	1.7777	39866	137.54	132.91	323.33	135.56	13.682	41.551
398	3.0802	1.8978	39809	137.25	134.75	369.40	132.32	14.175	43.728
400	3.1856	2.0369	39712	136.88	136.83	439.11	128.90	14.761	46.452
402	3.2940	2.2035	39559	136.37	139.26	557.25	125.27	15.484	50.083
404	3.4057	2.4155	39312	135.63	142.29	801.43	121.33	16.437	55.527
406	3.5210	2.7246	38868	134.43	146.50	1601.4	116.78	17.902	66.347
407.81	3.6284	3.7092	37136	130.09	153.85	409210	107.93	23.329	402.21

TABLE 3 Thermophysical Properties of Isobutane 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								
120	12.636	-5905.9	-34.226	69.010	99.305	1945.6	6062.7	156.74
130	12.474	-4903.5	-26.204	70.263	101.18	1863.7	3702.4	154.41
140	12.311	-3882.4	-18.637	71.505	103.04	1787.1	2465.0	151.62
150	12.148	-2842.7	-11.465	72.728	104.89	1714.8	1749.3	148.46
160	11.985	-1784.6	-4.6371	73.948	106.72	1645.7	1303.7	144.98
170	11.820	-708.20	1.8882	75.186	108.57	1579.1	1009.4	141.25
180	11.654	386.81	8.1466	76.463	110.44	1514.5	805.33	137.33
190	11.486	1500.8	14.169	77.799	112.37	1451.5	657.90	133.26
200	11.317	2634.3	19.983	79.206	114.36	1389.7	547.68	129.10
210	11.146	3788.3	25.613	80.695	116.44	1329.0	462.89	124.86
220	10.972	4963.6	31.080	82.275	118.63	1269.2	396.09	120.60
230	10.796	6161.3	36.404	83.949	120.94	1210.1	342.40	116.36
240	10.616	7382.9	41.602	85.718	123.39	1151.6	298.53	112.14
250	10.432	8629.6	46.691	87.584	125.99	1093.7	262.16	107.96
260	10.244	9903.2	51.686	89.542	128.76	1036.2	231.65	103.86
261.07	10.223	10040	52.213	89.756	129.06	1030.1	228.69	103.43
261.07	0.048038	31278	133.56	79.705	89.774	196.48	6.5710	13.170
270	0.046232	32089	136.62	81.849	91.688	200.26	6.7970	14.034
280	0.044385	33017	139.99	84.328	93.959	204.32	7.0478	15.025
290	0.042696	33968	143.33	86.874	96.336	208.25	7.2966	16.041
300	0.041143	34944	146.64	89.474	98.798	212.04	7.5436	17.082
310	0.039709	35945	149.92	92.116	101.32	215.73	7.7888	18.148
320	0.038379	36971	153.17	94.788	103.90	219.32	8.0324	19.239
330	0.037141	38023	156.41	97.481	106.51	222.83	8.2743	20.355
340	0.035985	39101	159.63	100.19	109.15	226.26	8.5148	21.497
350	0.034902	40206	162.83	102.90	111.80	229.61	8.7539	22.664
360	0.033886	41337	166.02	105.61	114.45	232.90	8.9915	23.856
370	0.032930	42495	169.19	108.31	117.11	236.13	9.2279	25.074
380	0.032029	43679	172.35	111.00	119.76	239.30	9.4629	26.317
390	0.031178	44890	175.49	113.66	122.39	242.43	9.6967	27.585
400	0.030372	46127	178.63	116.31	125.01	245.50	9.9294	28.880
410	0.029608	47390	181.75	118.93	127.60	248.53	10.161	30.199
420	0.028882	48679	184.85	121.52	130.16	251.51	10.391	31.545
430	0.028193	49993	187.94	124.08	132.70	254.46	10.620	32.916
440	0.027536	51333	191.02	126.61	135.21	257.36	10.848	34.313
450	0.026910	52697	194.09	129.10	137.68	260.23	11.075	35.735
460	0.026312	54086	197.14	131.56	140.12	263.07	11.301	37.183
470	0.025741	55499	200.18	133.98	142.53	265.87	11.526	38.657
480	0.025194	56937	203.21	136.36	144.89	268.64	11.750	40.156
490	0.024671	58397	206.22	138.70	147.23	271.38	11.973	41.681
500	0.024169	59881	209.22	141.01	149.52	274.09	12.195	43.232
510	0.023688	61388	212.20	143.28	151.78	276.77	12.416	44.809
520	0.023225	62916	215.17	145.51	154.00	279.42	12.637	46.411
530	0.022781	64467	218.12	147.71	156.19	282.05	12.856	48.039
540	0.022353	66040	221.06	149.87	158.34	284.65	13.074	49.693
550	0.021942	67634	223.99	151.99	160.46	287.23	13.292	51.373
560	0.021545	69249	226.90	154.08	162.54	289.78	13.508	53.079
570	0.021163	70885	229.79	156.13	164.58	292.31	13.724	54.810
Pressure = 1 MPa								
120	12.642	-5845.6	-34.318	69.091	99.277	1947.8	6124.6	156.91
130	12.480	-4843.5	-26.297	70.340	101.14	1866.3	3738.2	154.60
140	12.318	-3822.8	-18.734	71.579	103.00	1790.1	2488.1	151.84
150	12.156	-2783.5	-11.564	72.799	104.84	1718.1	1765.3	148.70
160	11.993	-1726.0	-4.7397	74.016	106.67	1649.4	1315.4	145.25
170	11.829	-650.14	1.7820	75.252	108.50	1583.2	1018.4	141.55
180	11.663	444.19	8.0365	76.528	110.37	1519.0	812.47	137.65
190	11.497	1557.4	14.055	77.862	112.28	1456.3	663.77	133.61
200	11.329	2690.0	19.864	79.268	114.26	1395.0	552.65	129.47
210	11.158	3842.9	25.488	80.757	116.33	1334.7	467.20	125.27
220	10.986	5016.9	30.950	82.335	118.50	1275.4	399.90	121.03
230	10.811	6213.2	36.267	84.008	120.78	1216.8	345.82	116.82
240	10.632	7433.0	41.458	85.777	123.20	1158.9	301.65	112.62
250	10.450	8677.6	46.538	87.641	125.76	1101.6	265.05	108.48
260	10.264	9948.7	51.523	89.598	128.48	1044.7	234.36	104.41
270	10.073	11248	56.426	91.643	131.39	988.22	208.33	100.42
280	9.8753	12577	61.260	93.773	134.50	931.89	186.03	96.536
290	9.6707	13939	66.038	95.984	137.85	875.56	166.74	92.757
300	9.4575	15335	70.771	98.270	141.50	819.00	149.88	89.092
310	9.2336	16770	75.475	100.63	145.51	761.91	134.98	85.544
320	8.9965	18247	80.165	103.07	150.01	703.88	121.64	82.110
330	8.7422	19772	84.858	105.59	155.19	644.33	109.54	78.783
339.34	8.4843	21247	89.265	108.03	160.97	586.60	99.071	75.758
339.34	0.44655	37266	136.47	105.18	127.92	187.21	8.7869	22.102

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}
340	0.44469	37351	136.72	105.28	127.80	187.76	8.8002	22.173
350	0.41942	38623	140.41	107.08	126.80	195.45	9.0083	23.292
360	0.39823	39891	143.98	109.15	126.93	202.25	9.2252	24.469
370	0.37999	41163	147.47	111.37	127.71	208.41	9.4476	25.690
380	0.36400	42446	150.89	113.65	128.89	214.08	9.6732	26.947
390	0.34978	43742	154.25	115.97	130.34	219.35	9.9007	28.238
400	0.33698	45054	157.57	118.33	132.00	224.30	10.129	29.559
410	0.32536	46383	160.86	120.71	133.81	228.99	10.358	30.908
420	0.31474	47730	164.10	123.10	135.73	233.45	10.587	32.284
430	0.30496	49097	167.32	125.49	137.72	237.72	10.815	33.688
440	0.29591	50485	170.51	127.87	139.75	241.82	11.043	35.117
450	0.28749	51893	173.67	130.24	141.83	245.77	11.270	36.573
460	0.27964	53321	176.81	132.59	143.92	249.58	11.496	38.054
470	0.27228	54771	179.93	134.92	146.02	253.28	11.721	39.560
480	0.26537	56242	183.03	137.22	148.11	256.88	11.945	41.092
490	0.25885	57733	186.10	139.49	150.21	260.37	12.169	42.649
500	0.25270	59246	189.16	141.74	152.29	263.78	12.391	44.232
510	0.24687	60779	192.19	143.95	154.36	267.11	12.612	45.839
520	0.24135	62333	195.21	146.13	156.41	270.37	12.832	47.472
530	0.23609	63907	198.21	148.28	158.45	273.55	13.051	49.129
540	0.23109	65502	201.19	150.40	160.46	276.68	13.270	50.812
550	0.22632	67116	204.15	152.49	162.45	279.74	13.487	52.520
560	0.22176	68751	207.10	154.54	164.41	282.75	13.703	54.254
570	0.21740	70404	210.03	156.56	166.35	285.70	13.918	56.012
				Pressure = 2 MPa				
120	12.649	-5778.7	-34.419	69.180	99.247	1950.2	6193.9	157.09
130	12.488	-4776.9	-26.401	70.426	101.11	1869.1	3778.4	154.81
140	12.326	-3756.6	-18.840	71.660	102.96	1793.3	2513.8	152.08
150	12.164	-2717.8	-11.674	72.877	104.79	1721.8	1783.1	148.97
160	12.002	-1660.8	-4.8531	74.091	106.61	1653.5	1328.5	145.55
170	11.839	-585.6	1.6648	75.325	108.44	1587.7	1028.4	141.88
180	11.674	508.0	7.9150	76.599	110.29	1523.9	820.44	138.01
190	11.509	1620.3	13.929	77.932	112.19	1461.7	670.33	134.00
200	11.341	2752.0	19.733	79.337	114.15	1400.8	558.19	129.89
210	11.172	3903.7	25.351	80.824	116.20	1341.0	471.99	125.71
220	11.001	5076.3	30.806	82.402	118.35	1282.2	404.13	121.51
230	10.827	6271.0	36.117	84.074	120.61	1224.1	349.62	117.32
240	10.651	7488.9	41.300	85.842	123.00	1166.9	305.12	113.16
250	10.471	8731.4	46.371	87.705	125.52	1110.2	268.26	109.05
260	10.286	9999.8	51.346	89.660	128.20	1054.1	237.36	105.01
270	10.098	11296	56.237	91.703	131.04	998.39	211.17	101.06
280	9.9033	12621	61.057	93.830	134.07	942.99	188.75	97.211
290	9.7024	13978	65.817	96.035	137.33	887.74	169.38	93.473
300	9.4937	15369	70.531	98.315	140.83	832.46	152.47	89.854
310	9.2755	16796	75.211	100.67	144.66	776.91	137.56	86.358
320	9.0456	18263	79.869	103.09	148.88	720.78	124.25	82.985
330	8.8010	19775	84.521	105.58	153.65	663.66	112.23	79.731
340	8.5374	21339	89.188	108.16	159.20	604.95	101.20	76.587
350	8.2479	22963	93.897	110.85	165.96	543.77	90.873	73.534
360	7.9214	24665	98.690	113.69	174.85	478.61	80.959	70.542
370	7.5356	26475	103.65	116.80	188.24	406.45	71.058	67.551
373.51	7.3775	27148	105.46	118.00	195.18	378.30	67.459	66.482
373.51	0.98392	39362	138.16	118.71	172.40	163.47	10.683	29.557
380	0.92017	40440	141.02	119.20	161.27	172.92	10.678	29.718
390	0.84773	42005	145.09	120.26	152.79	184.56	10.750	30.433
400	0.79285	43511	148.90	121.72	148.88	194.12	10.875	31.422
410	0.74859	44990	152.55	123.48	147.16	202.36	11.030	32.560
420	0.71151	46458	156.09	125.43	146.67	209.69	11.203	33.795
430	0.67964	47926	159.54	127.49	146.90	216.34	11.389	35.100
440	0.65172	49398	162.93	129.60	147.62	222.44	11.583	36.460
450	0.62692	50879	166.26	131.76	148.65	228.12	11.783	37.866
460	0.60463	52372	169.54	133.93	149.92	233.43	11.987	39.313
470	0.58442	53878	172.78	136.11	151.34	238.45	12.194	40.795
480	0.56594	55399	175.98	138.29	152.88	243.22	12.403	42.312
490	0.54895	56936	179.15	140.45	154.50	247.76	12.614	43.859
500	0.53324	58489	182.29	142.61	156.19	252.12	12.825	45.438
510	0.51864	60060	185.39	144.74	157.92	256.30	13.036	47.045
520	0.50501	61648	188.48	146.86	159.67	260.33	13.247	48.680
530	0.49226	63253	191.54	148.95	161.45	264.22	13.459	50.343
540	0.48027	64877	194.57	151.01	163.23	268.00	13.670	52.033
550	0.46898	66518	197.58	153.05	165.02	271.66	13.881	53.750
560	0.45831	68177	200.57	155.07	166.81	275.22	14.091	55.493
570	0.44822	69854	203.54	157.05	168.59	278.69	14.301	57.262

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}
Pressure = 3 MPa								
120	12.655	-5711.7	-34.519	69.269	99.217	1952.7	6264.0	157.28
130	12.495	-4710.3	-26.504	70.510	101.07	1872.0	3818.8	155.03
140	12.334	-3690.3	-18.946	71.741	102.92	1796.6	2539.8	152.32
150	12.173	-2652.0	-11.783	72.954	104.74	1725.4	1801.1	149.24
160	12.011	-1595.5	-4.9658	74.165	106.55	1657.5	1341.6	145.85
170	11.848	-520.93	1.5483	75.397	108.37	1592.2	1038.5	142.20
180	11.685	571.93	7.7944	76.670	110.21	1528.8	828.45	138.37
190	11.520	1683.4	13.803	78.001	112.10	1467.0	676.90	134.38
200	11.354	2814.1	19.603	79.404	114.05	1406.5	563.75	130.30
210	11.186	3964.7	25.216	80.891	116.08	1347.2	476.79	126.15
220	11.016	5136.0	30.665	82.468	118.21	1288.9	408.36	121.98
230	10.844	6329.2	35.968	84.139	120.44	1231.4	353.42	117.82
240	10.669	7545.3	41.143	85.906	122.80	1174.7	308.58	113.69
250	10.490	8785.6	46.206	87.768	125.29	1118.7	271.45	109.61
260	10.308	10052	51.171	89.721	127.92	1063.2	240.34	105.60
270	10.122	11345	56.051	91.762	130.71	1008.3	213.99	101.69
280	9.9306	12666	60.857	93.886	133.68	953.80	191.45	97.874
290	9.7332	14019	65.603	96.088	136.84	899.56	171.99	94.176
300	9.5287	15404	70.298	98.362	140.23	845.45	155.03	90.599
310	9.3156	16824	74.955	100.70	143.89	791.28	140.09	87.150
320	9.0922	18283	79.586	103.11	147.89	736.83	126.80	83.832
330	8.8561	19783	84.203	105.59	152.32	681.79	114.83	80.642
340	8.6038	21331	88.823	108.13	157.36	625.77	103.91	77.575
350	8.3306	22933	93.467	110.76	163.26	568.19	93.779	74.622
360	8.0288	24601	98.164	113.51	170.53	508.19	84.191	71.765
370	7.6855	26352	102.96	116.42	180.26	444.33	74.873	68.971
380	7.2749	28223	107.95	119.65	195.26	373.75	65.437	66.190
390	6.7277	30309	113.37	123.70	227.13	289.24	55.061	63.363
396.44	6.1683	31946	117.53	128.03	300.48	214.04	46.431	61.826
396.44	1.8026	39856	137.48	133.29	332.05	134.86	13.784	41.992
400	1.6415	40853	139.99	130.29	246.25	145.97	13.292	39.009
410	1.4093	42958	145.19	128.36	189.47	165.88	12.769	37.052
420	1.2752	44758	149.52	128.90	172.95	179.78	12.612	37.092
430	1.1799	46446	153.50	130.20	165.53	190.90	12.593	37.745
440	1.1060	48080	157.25	131.82	161.78	200.34	12.646	38.697
450	1.0457	49688	160.87	133.61	159.92	208.63	12.743	39.826
460	0.99497	51282	164.37	135.51	159.16	216.07	12.869	41.076
470	0.95122	52873	167.79	137.48	159.10	222.85	13.014	42.414
480	0.91283	54466	171.15	139.48	159.52	229.11	13.173	43.821
490	0.87869	56065	174.44	141.51	160.27	234.95	13.342	45.285
500	0.84799	57672	177.69	143.55	161.26	240.43	13.519	46.798
510	0.82015	59290	180.89	145.59	162.42	245.60	13.702	48.355
520	0.79471	60921	184.06	147.62	163.70	250.51	13.888	49.950
530	0.77131	62565	187.19	149.64	165.08	255.20	14.078	51.582
540	0.74967	64223	190.29	151.64	166.53	259.68	14.270	53.248
550	0.72956	65895	193.36	153.63	168.03	263.99	14.464	54.946
560	0.71081	67583	196.40	155.60	169.57	268.14	14.659	56.675
570	0.69325	69287	199.42	157.54	171.14	272.14	14.856	58.434
Pressure = 4 MPa								
120	12.662	-5644.7	-34.619	69.357	99.188	1955.1	6334.6	157.46
130	12.502	-4643.6	-26.607	70.594	101.04	1874.8	3859.6	155.24
140	12.341	-3624.0	-19.052	71.821	102.88	1799.8	2565.9	152.56
150	12.181	-2586.2	-11.892	73.030	104.69	1729.1	1819.1	149.51
160	12.020	-1530.2	-5.0778	74.239	106.50	1661.6	1354.8	146.14
170	11.858	-456.2	1.4326	75.468	108.30	1596.6	1048.6	142.53
180	11.695	635.9	7.6747	76.739	110.13	1533.6	836.49	138.72
190	11.532	1746.6	13.679	78.069	112.01	1472.3	683.51	134.76
200	11.366	2876.3	19.474	79.471	113.95	1412.2	569.32	130.71
210	11.200	4025.8	25.082	80.957	115.96	1353.4	481.60	126.59
220	11.031	5195.9	30.524	82.534	118.07	1295.5	412.60	122.44
230	10.860	6387.5	35.821	84.204	120.28	1238.6	357.22	118.31
240	10.686	7601.9	40.989	85.970	122.61	1182.4	312.04	114.21
250	10.510	8840.2	46.044	87.830	125.07	1127.0	274.64	110.16
260	10.330	10104	50.999	89.782	127.66	1072.2	243.32	106.19
270	10.146	11394	55.868	91.822	130.40	1018.0	216.80	102.31
280	9.9572	12712	60.662	93.943	133.30	964.35	194.13	98.527
290	9.7630	14061	65.393	96.141	136.38	911.04	174.58	94.865
300	9.5624	15441	70.072	98.410	139.67	858.01	157.55	91.328
310	9.3541	16855	74.708	100.74	143.19	805.10	142.58	87.923
320	9.1366	18305	79.314	103.14	147.00	752.14	129.29	84.653
330	8.9080	19796	83.900	105.60	151.17	698.92	117.36	81.519
340	8.6655	21330	88.480	108.12	155.80	645.15	106.51	78.520
350	8.4056	22914	93.070	110.71	161.08	590.48	96.523	75.648

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}
360	8.1230	24555	97.693	113.39	167.30	534.39	87.166	72.896
370	7.8095	26265	102.38	116.18	175.01	476.14	78.226	70.244
380	7.4510	28064	107.17	119.15	185.38	414.52	69.461	67.667
390	7.0201	29991	112.18	122.48	201.37	347.41	60.527	65.128
400	6.4474	32143	117.63	126.64	234.11	270.30	50.738	62.614
410	5.3865	35014	124.71	134.58	408.46	167.67	37.165	61.607
420	2.4410	41709	140.86	136.52	333.89	138.66	16.948	48.737
430	1.9786	44314	146.99	134.28	221.01	160.25	15.290	43.863
440	1.7500	46363	151.71	134.74	193.10	175.50	14.701	42.910
450	1.5982	48226	155.89	135.90	180.86	187.69	14.437	43.053
460	1.4852	49999	159.79	137.37	174.47	198.00	14.327	43.704
470	1.3956	51724	163.50	139.03	170.93	207.02	14.306	44.644
480	1.3217	53423	167.08	140.80	169.02	215.08	14.342	45.770
490	1.2591	55108	170.55	142.65	168.12	222.40	14.416	47.028
500	1.2048	56788	173.94	144.55	167.89	229.14	14.517	48.384
510	1.1570	58467	177.27	146.47	168.11	235.39	14.638	49.820
520	1.1144	60151	180.54	148.40	168.66	241.25	14.774	51.320
530	1.0761	61841	183.76	150.34	169.46	246.77	14.920	52.875
540	1.0413	63541	186.94	152.28	170.43	251.99	15.076	54.480
550	1.0094	65250	190.07	154.21	171.53	256.96	15.238	56.128
560	0.98014	66972	193.17	156.13	172.73	261.70	15.406	57.815
570	0.95305	68705	196.24	158.03	174.01	266.25	15.577	59.540
				Pressure = 5 MPa				
120	12.668	-5577.7	-34.719	69.444	99.159	1957.5	6406.0	157.64
130	12.509	-4576.9	-26.709	70.677	101.00	1877.6	3900.7	155.45
140	12.349	-3557.7	-19.157	71.900	102.84	1803.0	2592.2	152.80
150	12.189	-2520.3	-12.000	73.106	104.65	1732.7	1837.3	149.77
160	12.029	-1464.9	-5.1892	74.312	106.44	1665.6	1368.1	146.44
170	11.868	-391.48	1.3176	75.539	108.24	1601.0	1058.7	142.85
180	11.706	699.98	7.5558	76.808	110.06	1538.4	844.56	139.07
190	11.543	1809.9	13.556	78.136	111.92	1477.5	690.13	135.14
200	11.379	2938.7	19.346	79.538	113.85	1417.9	574.91	131.11
210	11.213	4087.1	24.948	81.023	115.85	1359.5	486.43	127.02
220	11.045	5255.9	30.386	82.598	117.94	1302.1	416.85	122.91
230	10.876	6446.2	35.676	84.268	120.13	1245.6	361.02	118.80
240	10.704	7658.9	40.837	86.033	122.43	1190.0	315.49	114.73
250	10.529	8895.3	45.884	87.892	124.86	1135.2	277.82	110.71
260	10.351	10157	50.830	89.843	127.41	1081.0	246.29	106.77
270	10.169	11444	55.689	91.881	130.11	1027.6	219.60	102.92
280	9.9831	12759	60.471	94.000	132.95	974.64	196.80	99.170
290	9.7920	14104	65.189	96.194	135.96	922.21	177.14	95.542
300	9.5950	15479	69.851	98.458	139.15	870.18	160.04	92.042
310	9.3911	16887	74.469	100.79	142.55	818.42	145.03	88.677
320	9.1790	18331	79.052	103.17	146.20	766.80	131.72	85.451
330	8.9571	19812	83.610	105.62	150.14	715.17	119.81	82.368
340	8.7232	21335	88.155	108.12	154.46	663.34	109.03	79.426
350	8.4746	22903	92.701	110.68	159.27	611.08	99.139	76.624
360	8.2075	24523	97.262	113.31	164.75	558.07	89.949	73.955
370	7.9162	26201	101.86	116.02	171.22	503.94	81.271	71.411
380	7.5925	27952	106.53	118.84	179.22	448.12	72.923	68.978
390	7.2222	29794	111.32	121.86	189.87	389.89	64.705	66.636
400	6.7797	31767	116.31	125.20	205.84	328.20	56.352	64.364
410	6.2072	33954	121.71	129.15	235.20	261.71	47.419	62.179
420	5.3358	36620	128.13	134.37	312.81	190.64	36.891	60.479
430	3.8293	40474	137.19	139.08	414.95	145.61	24.651	58.184
440	2.8386	43880	145.03	138.28	277.95	154.34	19.331	51.402
450	2.3965	46344	150.57	138.50	223.71	168.79	17.557	48.582
460	2.1337	48453	155.20	139.42	200.91	181.55	16.728	47.728
470	1.9511	50398	159.39	140.70	189.22	192.63	16.285	47.783
480	1.8130	52254	163.30	142.19	182.61	202.39	16.041	48.337
490	1.7029	54059	167.02	143.83	178.71	211.13	15.918	49.200
500	1.6118	55834	170.60	145.56	176.44	219.06	15.871	50.270
510	1.5345	57592	174.08	147.36	175.20	226.34	15.877	51.490
520	1.4676	59340	177.48	149.19	174.67	233.09	15.922	52.825
530	1.4088	61087	180.80	151.04	174.62	239.38	15.995	54.250
540	1.3564	62834	184.07	152.91	174.94	245.30	16.089	55.749
550	1.3094	64586	187.29	154.78	175.51	250.88	16.199	57.312
560	1.2667	66345	190.46	156.64	176.28	256.18	16.322	58.930
570	1.2277	68112	193.58	158.50	177.20	261.23	16.456	60.597
				Pressure = 7.5 MPa				
120	12.684	-5410.2	-34.966	69.659	99.089	1963.4	6587.3	158.09
130	12.526	-4410.2	-26.963	70.882	100.92	1884.6	4004.8	155.96
140	12.368	-3391.9	-19.417	72.095	102.74	1811.0	2658.9	153.39
150	12.209	-2355.5	-12.268	73.292	104.53	1741.7	1883.2	150.43

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}
160	12.051	-1301.3	-5.4648	74.491	106.31	1675.5	1401.6	147.16
170	11.892	-229.37	1.0333	75.713	108.08	1611.9	1084.4	143.65
180	11.732	860.44	7.2620	76.978	109.88	1550.3	864.91	139.93
190	11.571	1968.4	13.252	78.302	111.72	1490.3	706.81	136.08
200	11.409	3095.0	19.030	79.701	113.61	1431.8	588.95	132.12
210	11.246	4240.9	24.621	81.184	115.58	1374.4	498.53	128.10
220	11.081	5406.9	30.044	82.757	117.63	1318.1	427.49	124.05
230	10.915	6593.7	35.320	84.425	119.77	1262.9	370.54	120.01
240	10.746	7802.6	40.464	86.188	122.02	1208.5	324.12	116.01
250	10.575	9034.4	45.493	88.045	124.37	1155.0	285.76	112.06
260	10.402	10290	50.418	89.992	126.84	1102.4	253.66	108.18
270	10.225	11572	55.254	92.026	129.44	1050.5	226.53	104.41
280	10.045	12880	60.010	94.140	132.16	999.38	203.38	100.73
290	9.8612	14215	64.697	96.328	135.01	948.91	183.45	97.186
300	9.6723	15580	69.324	98.583	138.01	899.07	166.15	93.769
310	9.4781	16976	73.901	100.90	141.17	849.80	151.00	90.492
320	9.2775	18404	78.435	103.27	144.50	801.03	137.62	87.361
330	9.0697	19867	82.935	105.69	148.03	752.68	125.70	84.382
340	8.8533	21366	87.409	108.15	151.79	704.70	114.98	81.557
350	8.6268	22904	91.867	110.66	155.82	657.00	105.25	78.886
360	8.3883	24483	96.317	113.21	160.19	609.53	96.307	76.372
370	8.1353	26109	100.77	115.80	164.97	562.21	88.012	74.011
380	7.8648	27785	105.24	118.45	170.30	515.01	80.229	71.801
390	7.5726	29517	109.74	121.15	176.34	467.94	72.845	69.740
400	7.2534	31315	114.29	123.93	183.38	421.09	65.765	67.821
410	6.8996	33189	118.92	126.80	191.84	374.73	58.910	66.041
420	6.5011	35158	123.66	129.76	202.34	329.40	52.222	64.398
430	6.0449	37245	128.57	132.79	215.59	286.27	45.684	62.895
440	5.5189	39479	133.71	135.82	231.33	247.80	39.378	61.532
450	4.9309	41865	139.07	138.65	244.74	218.34	33.616	60.253
460	4.3390	44333	144.49	141.01	246.32	201.75	28.938	58.924
470	3.8240	46751	149.69	142.88	235.96	196.68	25.628	57.633
480	3.4163	49043	154.52	144.49	222.57	198.44	23.451	56.683
490	3.1010	51209	158.99	146.03	211.21	203.44	22.028	56.217
500	2.8541	53277	163.16	147.58	202.77	209.80	21.078	56.207
510	2.6561	55273	167.12	149.19	196.79	216.62	20.432	56.570
520	2.4935	57219	170.90	150.84	192.64	223.47	19.987	57.225
530	2.3571	59130	174.54	152.54	189.82	230.17	19.682	58.109
540	2.2404	61018	178.07	154.27	187.97	236.64	19.477	59.172
550	2.1392	62892	181.50	156.01	186.83	242.85	19.345	60.379
560	2.0503	64757	184.86	157.78	186.22	248.79	19.268	61.703
570	1.9712	66618	188.16	159.54	186.02	254.49	19.234	63.123
				Pressure = 10 MPa				
120	12.700	-5242.6	-35.211	69.871	99.021	1969.4	6773.0	158.53
130	12.543	-4243.3	-27.213	71.083	100.84	1891.5	4111.1	156.48
140	12.386	-3225.8	-19.674	72.286	102.64	1818.9	2726.7	153.97
150	12.230	-2190.5	-12.532	73.474	104.42	1750.5	1929.9	151.08
160	12.072	-1137.5	-5.736	74.666	106.18	1685.3	1435.6	147.88
170	11.915	-66.927	0.75344	75.883	107.94	1622.6	1110.3	144.43
180	11.757	1021.3	6.9732	77.143	109.72	1562.0	885.48	140.79
190	11.598	2127.5	12.954	78.464	111.53	1502.9	723.65	137.00
200	11.438	3252.1	18.721	79.860	113.39	1445.4	603.11	133.10
210	11.278	4395.6	24.300	81.340	115.33	1389.0	510.71	129.15
220	11.116	5558.8	29.711	82.912	117.34	1333.8	438.17	125.16
230	10.952	6742.7	34.973	84.577	119.44	1279.6	380.07	121.18
240	10.787	7947.9	40.103	86.338	121.63	1226.4	332.75	117.25
250	10.620	9175.7	45.114	88.193	123.93	1174.2	293.67	113.37
260	10.451	10427	50.021	90.139	126.33	1122.9	261.00	109.56
270	10.279	11703	54.836	92.169	128.84	1072.4	233.40	105.85
280	10.104	13004	59.569	94.279	131.47	1022.8	209.88	102.25
290	9.9261	14332	64.229	96.462	134.20	974.08	189.65	98.768
300	9.7443	15689	68.827	98.710	137.05	926.11	172.11	95.422
310	9.5582	17074	73.369	101.02	140.03	878.90	156.79	92.220
320	9.3673	18490	77.863	103.37	143.14	832.42	143.30	89.167
330	9.1708	19937	82.317	105.78	146.38	786.64	131.32	86.271
340	8.9679	21418	86.737	108.22	149.78	741.55	120.59	83.534
350	8.7578	22933	91.130	110.69	153.34	697.13	110.90	80.960
360	8.5393	24485	95.502	113.20	157.09	653.38	102.08	78.550
370	8.3113	26076	99.860	115.73	161.06	610.34	93.960	76.306
380	8.0724	27707	104.21	118.29	165.26	568.06	86.438	74.227
390	7.8209	29382	108.56	120.88	169.75	526.64	79.409	72.312
400	7.5550	31103	112.92	123.49	174.56	486.23	72.797	70.562
410	7.2726	32874	117.29	126.12	179.74	447.06	66.544	68.973
420	6.9716	34699	121.69	128.77	185.35	409.42	60.613	67.544

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}
430	6.6499	36583	126.12	131.43	191.40	373.74	54.990	66.274
440	6.3060	38529	130.59	134.08	197.83	340.61	49.686	65.159
450	5.9403	40540	135.11	136.69	204.33	310.82	44.741	64.195
460	5.5567	42613	139.67	139.21	210.20	285.43	40.234	63.376
470	5.1651	44738	144.24	141.61	214.33	265.47	36.266	62.690
480	4.7816	46891	148.77	143.85	215.74	251.50	32.925	62.131
490	4.4227	49044	153.21	145.92	214.44	243.13	30.239	61.717
500	4.0999	51174	157.51	147.86	211.37	239.25	28.154	61.481
510	3.8170	53269	161.66	149.70	207.63	238.57	26.566	61.459
520	3.5719	55327	165.66	151.49	203.99	240.03	25.367	61.663
530	3.3601	57350	169.51	153.26	200.84	242.86	24.460	62.089
540	3.1766	59345	173.24	155.01	198.28	246.56	23.775	62.719
550	3.0165	61318	176.86	156.75	196.32	250.77	23.255	63.530
560	2.8758	63273	180.39	158.50	194.89	255.28	22.862	64.500
570	2.7513	65217	183.83	160.24	193.91	259.93	22.567	65.606
				Pressure = 20 MPa				
130	12.610	-3574.8	-28.187	71.847	100.55	1918.6	4558.2	158.47
140	12.458	-2560.5	-20.672	73.009	102.30	1849.7	3010.2	156.23
150	12.307	-1528.9	-13.555	74.164	104.03	1784.9	2124.1	153.61
160	12.156	-480.1	-6.7865	75.328	105.73	1723.2	1576.6	150.67
170	12.005	585.7	-0.32584	76.522	107.43	1663.9	1217.5	147.48
180	11.854	1668.5	5.8627	77.765	109.13	1606.6	970.14	144.08
190	11.702	2768.4	11.810	79.073	110.87	1551.1	792.66	140.54
200	11.551	3886.0	17.541	80.457	112.65	1496.9	660.90	136.89
210	11.398	5021.6	23.081	81.929	114.48	1444.1	560.22	133.18
220	11.246	6175.8	28.451	83.492	116.38	1392.5	481.41	129.43
230	11.093	7349.4	33.667	85.151	118.35	1342.1	418.46	125.69
240	10.939	8543.1	38.747	86.906	120.40	1292.8	367.32	121.97
250	10.784	9757.7	43.705	88.754	122.53	1244.7	325.19	118.32
260	10.628	10994	48.554	90.692	124.74	1197.6	290.05	114.74
270	10.471	12253	53.305	92.714	127.03	1151.7	260.44	111.25
280	10.313	13535	57.967	94.813	129.40	1106.9	235.25	107.87
290	10.154	14841	62.550	96.983	131.84	1063.2	213.66	104.61
300	9.9930	16172	67.062	99.214	134.34	1020.6	195.01	101.48
310	9.8304	17528	71.509	101.50	136.91	979.12	178.79	98.492
320	9.6660	18910	75.897	103.83	139.54	938.76	164.58	95.655
330	9.4996	20319	80.232	106.20	142.22	899.53	152.04	92.974
340	9.3310	21755	84.518	108.60	144.95	861.43	140.92	90.454
350	9.1601	23218	88.760	111.02	147.72	824.48	130.97	88.098
360	8.9867	24710	92.960	113.46	150.52	788.70	122.03	85.909
370	8.8107	26229	97.123	115.91	153.35	754.14	113.93	83.888
380	8.6320	27777	101.25	118.36	156.20	720.81	106.55	82.035
390	8.4505	29353	105.34	120.82	159.07	688.77	99.792	80.349
400	8.2663	30958	109.41	123.26	161.93	658.06	93.563	78.830
410	8.0792	32592	113.44	125.70	164.79	628.74	87.797	77.474
420	7.8894	34254	117.45	128.12	167.62	600.86	82.441	76.280
430	7.6972	35944	121.42	130.53	170.42	574.47	77.452	75.243
440	7.5027	37662	125.37	132.91	173.18	549.61	72.796	74.359
450	7.3063	39407	129.30	135.26	175.87	526.33	68.450	73.622
460	7.1084	41179	133.19	137.59	178.48	504.65	64.395	73.027
470	6.9097	42976	137.06	139.88	180.99	484.59	60.619	72.568
480	6.7107	44798	140.89	142.14	183.39	466.17	57.114	72.239
490	6.5123	46644	144.70	144.36	185.65	449.39	53.873	72.032
500	6.3153	48511	148.47	146.54	187.76	434.25	50.891	71.942
510	6.1205	50399	152.21	148.68	189.70	420.75	48.164	71.961
520	5.9290	52304	155.91	150.77	191.46	408.85	45.685	72.086
530	5.7416	54227	159.57	152.83	193.02	398.54	43.449	72.309
540	5.5594	56164	163.19	154.84	194.40	389.73	41.445	72.628
550	5.3830	58114	166.77	156.81	195.59	382.36	39.662	73.036
560	5.2132	60076	170.30	158.75	196.63	376.31	38.086	73.531
570	5.0505	62047	173.79	160.65	197.54	371.47	36.701	74.108