



Designation: D7265 – 06

## Standard Specification for Hydrogen Thermophysical Property Tables<sup>1</sup>

This standard is issued under the fixed designation D7265; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

### 1. Scope

1.1 The thermophysical property tables for normal hydrogen are for use in the calculation of the pressure-volume-temperature (PVT), thermodynamic, and transport properties of hydrogen for process design and operations, particularly as they relate to hydrogen fuel cell applications. Tables are provided for gaseous hydrogen at temperatures between 50 K and 500 K at pressures to 50 MPa. These tables were developed by the National Institute of Standards and Technology from a Standard Reference Database product REFPROP, version 7.0.

### 2. Applicability

2.1 These tables apply directly only to pure gaseous hydrogen. However, it is expected that they may find substantial use in mathematical models and tables for the thermophysical properties of mixtures containing hydrogen.

### 3. Tables

3.1 The tabulated thermophysical properties are:

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

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

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

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

$c$ , speed of sound ( $\text{m}\cdot\text{s}^{-1}$ )

$\eta$ , viscosity ( $\mu\text{Pa}\cdot\text{s}$ )

$\lambda$ , thermal conductivity ( $\text{mW}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$ )

3.2 These tables were produced by equations from a computer package, "NIST Standard Reference Database 23; Reference Fluid Thermodynamic and Transport Properties Database (REFPROP): Version 7.0." A wide selection of units (SI units, engineering units, chemical units) is available with this program.

### 4. Additional Information

4.1 A comprehensive equation of state for normal hydrogen is not available at this time. The properties in the table were calculated from individual equations for normal hydrogen and para-hydrogen. For example, to calculate the heat capacity of normal hydrogen, an equation for the heat capacity of normal hydrogen at zero pressure was combined with an integration of PVT equation for para-hydrogen to obtain the heat capacity of normal hydrogen at non-zero pressure. Additional information is available in the REFPROP package.

### 5. Keywords

5.1 hydrogen fuel cell; hydrogen gas tables; thermodynamic properties of hydrogen

<sup>1</sup> 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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**TABLE 1 Hydrogen Thermophysical Property Tables**

$T$ K	$\rho$ mol·l <sup>-1</sup>	$H$ J·mol <sup>-1</sup>	$S$ J·mol <sup>-1</sup> ·K <sup>-1</sup>	$C_v$ J·mol <sup>-1</sup> ·K <sup>-1</sup>	$C_p$ J·mol <sup>-1</sup> ·K <sup>-1</sup>	$c$ m·s <sup>-1</sup>	$\eta$ μPa·s	$\lambda$ mW·m <sup>-1</sup> ·K <sup>-1</sup>
Pressure = 0.1 MPa								
50.	0.24255	1545.8	64.246	12.53	21.12	584.7	2.472	38.39
55.	0.22003	1651.3	66.258	12.57	21.11	613.4	2.673	41.52
60.	0.20139	1756.9	68.095	12.64	21.14	640.4	2.865	44.60
65.	0.18568	1862.8	69.789	12.74	21.21	665.8	3.050	47.68
70.	0.17227	1969.1	71.365	12.87	21.32	689.7	3.228	50.78
75.	0.16068	2076.0	72.840	13.04	21.47	712.3	3.400	53.61
80.	0.15056	2183.8	74.231	13.24	21.65	733.6	3.566	56.47
85.	0.14164	2292.6	75.550	13.46	21.86	753.8	3.728	59.35
90.	0.13373	2402.5	76.807	13.71	22.10	773.0	3.886	62.17
95.	0.12666	2513.6	78.009	13.98	22.36	791.3	4.039	65.25
100.	0.12030	2626.1	79.163	14.26	22.64	808.9	4.190	68.33
105.	0.11455	2740.0	80.274	14.55	22.92	825.9	4.337	71.65
110.	0.10933	2855.4	81.347	14.85	23.21	842.2	4.481	74.97
115.	0.10456	2972.1	82.385	15.15	23.50	858.1	4.623	78.22
120.	0.10020	3090.4	83.392	15.44	23.80	873.6	4.763	81.48
125.	0.096180	3210.1	84.369	15.73	24.08	888.7	4.900	84.78
130.	0.092475	3331.2	85.319	16.02	24.37	903.5	5.036	88.09
135.	0.089046	3453.8	86.244	16.30	24.64	918.0	5.170	91.35
140.	0.085862	3577.6	87.145	16.57	24.91	932.3	5.301	94.62
145.	0.082898	3702.8	88.023	16.82	25.16	946.3	5.432	97.79
150.	0.080132	3829.3	88.881	17.07	25.41	960.2	5.561	101.0
155.	0.077546	3956.9	89.718	17.31	25.65	973.8	5.688	104.2
160.	0.075121	4085.7	90.536	17.54	25.87	987.3	5.814	107.5
165.	0.072844	4215.6	91.335	17.75	26.09	1000.6	5.939	110.7
170.	0.070700	4346.5	92.117	17.96	26.29	1013.8	6.062	114.0
175.	0.068680	4478.5	92.882	18.15	26.48	1026.9	6.184	117.1
180.	0.066772	4611.3	93.630	18.33	26.66	1039.8	6.306	120.3
185.	0.064967	4745.1	94.363	18.51	26.83	1052.6	6.426	123.3
190.	0.063257	4879.7	95.081	18.67	27.00	1065.3	6.545	126.4
195.	0.061635	5015.0	95.784	18.82	27.15	1077.8	6.663	129.4
200.	0.060094	5151.1	96.473	18.97	27.29	1090.3	6.780	132.4
205.	0.058628	5287.9	97.149	19.10	27.43	1102.6	6.896	135.4
210.	0.057233	5425.4	97.811	19.23	27.55	1114.8	7.011	138.3
215.	0.055902	5563.4	98.461	19.35	27.67	1126.9	7.125	141.2
220.	0.054632	5702.1	99.098	19.46	27.78	1139.0	7.239	144.1
225.	0.053418	5841.3	99.724	19.57	27.89	1150.9	7.351	146.9
230.	0.052257	5980.9	100.34	19.67	27.99	1162.7	7.463	149.7
235.	0.051145	6121.1	100.94	19.76	28.08	1174.4	7.574	152.5
240.	0.050080	6261.7	101.53	19.85	28.17	1186.1	7.684	155.2
245.	0.049058	6402.8	102.11	19.93	28.25	1197.6	7.794	157.9
250.	0.048077	6544.2	102.69	20.00	28.32	1209.1	7.903	160.6
255.	0.047135	6686.0	103.25	20.07	28.39	1220.5	8.011	163.2
260.	0.046229	6828.1	103.80	20.14	28.46	1231.8	8.118	165.8
265.	0.045357	6970.6	104.34	20.20	28.52	1243.0	8.224	168.4
270.	0.044517	7113.3	104.88	20.26	28.58	1254.1	8.330	171.0
275.	0.043708	7256.4	105.40	20.32	28.63	1265.2	8.436	173.5
280.	0.042928	7399.7	105.92	20.37	28.68	1276.1	8.540	176.0
285.	0.042175	7543.2	106.43	20.41	28.73	1287.0	8.645	178.5
290.	0.041448	7687.0	106.93	20.46	28.77	1297.9	8.748	181.0
295.	0.040746	7831.0	107.42	20.50	28.81	1308.6	8.851	183.4
300.	0.040067	7975.1	107.90	20.53	28.85	1319.3	8.953	185.8
310.	0.038775	8264.0	108.85	20.60	28.92	1340.5	9.156	190.6
320.	0.037564	8553.5	109.77	20.66	28.97	1361.4	9.357	195.2
330.	0.036426	8843.4	110.66	20.70	29.02	1382.0	9.555	200.3
340.	0.035355	9133.8	111.53	20.74	29.06	1402.4	9.752	205.3
350.	0.034345	9424.6	112.37	20.78	29.09	1422.5	9.946	210.3
360.	0.033392	9715.7	113.19	20.80	29.12	1442.4	10.14	215.3
370.	0.032490	10007.	113.99	20.82	29.14	1462.1	10.33	219.9
380.	0.031635	10298.	114.77	20.84	29.16	1481.5	10.52	224.7
390.	0.030824	10590.	115.52	20.85	29.17	1500.7	10.71	229.4
400.	0.030054	10882.	116.26	20.86	29.18	1519.7	10.89	234.1
410.	0.029321	11174.	116.98	20.87	29.19	1538.4	11.08	238.2
420.	0.028623	11466.	117.69	20.88	29.20	1557.0	11.26	242.9
430.	0.027958	11758.	118.37	20.89	29.20	1575.3	11.44	247.6
440.	0.027323	12050.	119.04	20.89	29.21	1593.5	11.62	252.3
450.	0.026716	12342.	119.70	20.90	29.22	1611.4	11.80	256.9
460.	0.026135	12634.	120.34	20.91	29.22	1629.1	11.98	261.6
470.	0.025580	12926.	120.97	20.92	29.23	1646.6	12.15	266.4
480.	0.025047	13219.	121.59	20.92	29.24	1663.9	12.33	271.1
490.	0.024536	13511.	122.19	20.93	29.25	1681.1	12.50	275.8
500.	0.024045	13803.	122.78	20.94	29.25	1698.0	12.67	280.5

**TABLE 1** *Continued*

<i>T</i> K	$\rho$ mol·l <sup>-1</sup>	<i>H</i> J·mol <sup>-1</sup>	<i>S</i> J·mol <sup>-1</sup> ·K <sup>-1</sup>	<i>C<sub>v</sub></i> J·mol <sup>-1</sup> ·K <sup>-1</sup>	<i>C<sub>p</sub></i> J·mol <sup>-1</sup> ·K <sup>-1</sup>	<i>c</i> m·s <sup>-1</sup>	$\eta$ μPa·s	$\lambda$ mW·m <sup>-1</sup> ·K <sup>-1</sup>
Pressure = 0.2 MPa								
50.	0.48916	1535.5	58.344	12.54	21.42	583.7	2.485	38.74
55.	0.44279	1642.4	60.382	12.58	21.35	612.9	2.686	41.83
60.	0.40463	1749.1	62.239	12.65	21.34	640.2	2.877	44.89
65.	0.37265	1855.8	63.948	12.75	21.38	665.9	3.061	47.94
70.	0.34543	1962.9	65.535	12.88	21.46	690.0	3.238	51.02
75.	0.32197	2070.5	67.020	13.05	21.59	712.7	3.409	53.85
80.	0.30153	2178.9	68.419	13.25	21.76	734.2	3.575	56.72
85.	0.28356	2288.2	69.744	13.47	21.96	754.5	3.736	59.62
90.	0.26763	2398.5	71.005	13.72	22.19	773.7	3.893	62.43
95.	0.25341	2510.1	72.212	13.99	22.44	792.1	4.047	65.50
100.	0.24064	2623.0	73.369	14.27	22.71	809.8	4.197	68.57
105.	0.22910	2737.2	74.484	14.56	22.98	826.7	4.344	71.87
110.	0.21863	2852.8	75.560	14.86	23.27	843.1	4.488	75.18
115.	0.20907	2969.9	76.600	15.15	23.56	859.1	4.630	78.43
120.	0.20032	3088.4	77.609	15.45	23.84	874.5	4.769	81.67
125.	0.19228	3208.3	78.588	15.74	24.13	889.7	4.906	84.97
130.	0.18486	3329.6	79.540	16.03	24.41	904.5	5.041	88.28
135.	0.17800	3452.3	80.466	16.30	24.68	919.0	5.175	91.53
140.	0.17163	3576.4	81.368	16.57	24.94	933.3	5.307	94.79
145.	0.16570	3701.7	82.248	16.83	25.20	947.3	5.437	97.96
150.	0.16016	3828.3	83.106	17.08	25.44	961.2	5.565	101.1
155.	0.15499	3956.1	83.944	17.32	25.67	974.8	5.693	104.4
160.	0.15014	4085.0	84.763	17.54	25.90	988.3	5.819	107.7
165.	0.14559	4215.0	85.563	17.76	26.11	1001.6	5.943	110.9
170.	0.14130	4346.1	86.345	17.96	26.31	1014.8	6.066	114.1
175.	0.13726	4478.1	87.111	18.15	26.50	1027.9	6.189	117.3
180.	0.13345	4611.1	87.860	18.34	26.68	1040.8	6.310	120.4
185.	0.12984	4744.9	88.593	18.51	26.85	1053.6	6.430	123.5
190.	0.12642	4879.6	89.311	18.67	27.01	1066.2	6.548	126.6
195.	0.12318	5015.0	90.015	18.83	27.16	1078.8	6.666	129.6
200.	0.12010	5151.2	90.705	18.97	27.31	1091.2	6.783	132.6
205.	0.11717	5288.1	91.380	19.10	27.44	1103.6	6.899	135.5
210.	0.11438	5425.6	92.043	19.23	27.57	1115.8	7.014	138.5
215.	0.11172	5563.7	92.693	19.35	27.68	1127.9	7.129	141.3
220.	0.10919	5702.4	93.331	19.46	27.80	1139.9	7.242	144.2
225.	0.10676	5841.7	93.957	19.57	27.90	1151.8	7.355	147.0
230.	0.10444	5981.4	94.571	19.67	28.00	1163.6	7.466	149.8
235.	0.10222	6121.6	95.174	19.76	28.09	1175.4	7.577	152.6
240.	0.10009	6262.3	95.767	19.85	28.18	1187.0	7.687	155.3
245.	0.098050	6403.4	96.348	19.93	28.26	1198.6	7.797	158.0
250.	0.096090	6544.8	96.920	20.01	28.33	1210.0	7.905	160.7
255.	0.094207	6686.7	97.482	20.08	28.40	1221.4	8.013	163.3
260.	0.092397	6828.9	98.034	20.14	28.47	1232.7	8.121	165.9
265.	0.090655	6971.4	98.577	20.21	28.53	1243.9	8.227	168.5
270.	0.088977	7114.2	99.111	20.26	28.59	1255.0	8.333	171.1
275.	0.087361	7257.2	99.636	20.32	28.64	1266.1	8.438	173.6
280.	0.085802	7400.6	100.15	20.37	28.69	1277.0	8.543	176.1
285.	0.084298	7544.1	100.66	20.42	28.74	1287.9	8.647	178.6
290.	0.082845	7687.9	101.16	20.46	28.78	1298.7	8.750	181.1
295.	0.081442	7831.9	101.65	20.50	28.82	1309.5	8.853	183.5
300.	0.080086	7976.1	102.14	20.54	28.86	1320.2	8.955	185.9
310.	0.077505	8265.0	103.08	20.60	28.92	1341.3	9.158	190.7
320.	0.075084	8554.6	104.00	20.66	28.98	1362.2	9.359	195.3
330.	0.072811	8844.6	104.90	20.71	29.03	1382.8	9.557	200.4
340.	0.070671	9135.0	105.76	20.75	29.06	1403.2	9.754	205.4
350.	0.068654	9425.8	106.61	20.78	29.10	1423.3	9.948	210.4
360.	0.066748	9716.9	107.43	20.80	29.12	1443.2	10.14	215.3
370.	0.064946	10008.	108.22	20.82	29.14	1462.8	10.33	220.0
380.	0.063238	10300.	109.00	20.84	29.16	1482.3	10.52	224.8
390.	0.061618	10591.	109.76	20.86	29.17	1501.5	10.71	229.5
400.	0.060079	10883.	110.50	20.87	29.18	1520.4	10.89	234.1
410.	0.058615	11175.	111.22	20.88	29.19	1539.2	11.08	238.3
420.	0.057220	11467.	111.92	20.88	29.20	1557.7	11.26	243.0
430.	0.055891	11759.	112.61	20.89	29.21	1576.1	11.44	247.6
440.	0.054621	12051.	113.28	20.90	29.21	1594.2	11.62	252.3
450.	0.053409	12343.	113.94	20.90	29.22	1612.1	11.80	257.0
460.	0.052248	12635.	114.58	20.91	29.22	1629.8	11.98	261.7
470.	0.051138	12928.	115.21	20.92	29.23	1647.3	12.15	266.4
480.	0.050073	13220.	115.82	20.92	29.24	1664.6	12.33	271.1
490.	0.049052	13513.	116.43	20.93	29.25	1681.7	12.50	275.8
500.	0.048072	13805.	117.02	20.94	29.26	1698.7	12.67	280.6

**TABLE 1** *Continued*

<i>T</i> K	$\rho$ mol·l <sup>-1</sup>	<i>H</i> J·mol <sup>-1</sup>	<i>S</i> J·mol <sup>-1</sup> ·K <sup>-1</sup>	<i>C<sub>v</sub></i> J·mol <sup>-1</sup> ·K <sup>-1</sup>	<i>C<sub>p</sub></i> J·mol <sup>-1</sup> ·K <sup>-1</sup>	<i>c</i> m·s <sup>-1</sup>	$\eta$ μPa·s	$\lambda$ mW·m <sup>-1</sup> ·K <sup>-1</sup>
Pressure = 0.5 MPa								
50.	1.2544	1504.1	50.304	12.59	22.40	580.8	2.528	39.86
55.	1.1277	1615.3	52.424	12.62	22.12	611.5	2.724	42.82
60.	1.0256	1725.5	54.341	12.68	21.96	639.9	2.913	45.78
65.	0.94119	1835.1	56.096	12.78	21.89	666.4	3.094	48.75
70.	0.87016	1944.5	57.718	12.91	21.90	691.1	3.269	51.76
75.	0.80944	2054.2	59.231	13.07	21.97	714.3	3.438	54.59
80.	0.75689	2164.3	60.653	13.27	22.09	736.1	3.602	57.48
85.	0.71091	2275.1	61.996	13.50	22.25	756.6	3.762	60.43
90.	0.67033	2386.8	63.273	13.75	22.44	776.1	3.917	63.21
95.	0.63423	2499.6	64.493	14.01	22.67	794.6	4.070	66.23
100.	0.60189	2613.5	65.661	14.29	22.91	812.4	4.218	69.26
105.	0.57274	2728.7	66.785	14.58	23.17	829.5	4.364	72.53
110.	0.54633	2845.2	67.869	14.88	23.43	845.9	4.508	75.81
115.	0.52228	2963.1	68.917	15.17	23.71	861.9	4.648	79.02
120.	0.50029	3082.3	69.932	15.47	23.98	877.5	4.787	82.25
125.	0.48010	3202.9	70.916	15.76	24.25	892.6	4.923	85.52
130.	0.46149	3324.8	71.872	16.04	24.52	907.4	5.058	88.81
135.	0.44428	3448.1	72.803	16.32	24.78	922.0	5.191	92.04
140.	0.42833	3572.6	73.709	16.59	25.04	936.3	5.322	95.29
145.	0.41349	3698.4	74.592	16.85	25.29	950.3	5.452	98.44
150.	0.39965	3825.5	75.453	17.09	25.52	964.2	5.580	101.6
155.	0.38671	3953.7	76.294	17.33	25.75	977.8	5.707	104.8
160.	0.37459	4083.0	77.115	17.56	25.97	991.3	5.832	108.1
165.	0.36322	4213.4	77.917	17.77	26.18	1004.6	5.956	111.3
170.	0.35252	4344.7	78.702	17.98	26.37	1017.8	6.079	114.5
175.	0.34243	4477.1	79.469	18.17	26.56	1030.9	6.201	117.7
180.	0.33291	4610.3	80.220	18.35	26.74	1043.8	6.322	120.8
185.	0.32391	4744.4	80.954	18.52	26.90	1056.5	6.441	123.9
190.	0.31538	4879.4	81.674	18.68	27.06	1069.2	6.560	126.9
195.	0.30729	5015.0	82.379	18.84	27.21	1081.7	6.677	129.9
200.	0.29961	5151.4	83.070	18.98	27.35	1094.1	6.794	132.9
205.	0.29231	5288.5	83.747	19.12	27.48	1106.4	6.910	135.9
210.	0.28535	5426.3	84.410	19.24	27.61	1118.7	7.025	138.8
215.	0.27872	5564.6	85.061	19.36	27.72	1130.8	7.139	141.7
220.	0.27239	5703.5	85.700	19.47	27.83	1142.7	7.252	144.5
225.	0.26634	5842.9	86.327	19.58	27.93	1154.6	7.364	147.3
230.	0.26056	5982.8	86.942	19.68	28.03	1166.5	7.476	150.1
235.	0.25502	6123.2	87.545	19.77	28.12	1178.2	7.586	152.9
240.	0.24972	6264.0	88.138	19.86	28.20	1189.8	7.696	155.6
245.	0.24463	6405.2	88.721	19.94	28.28	1201.3	7.805	158.3
250.	0.23974	6546.8	89.293	20.01	28.36	1212.7	7.914	161.0
255.	0.23505	6688.8	89.855	20.09	28.43	1224.1	8.022	163.6
260.	0.23054	6831.1	90.408	20.15	28.49	1235.4	8.129	166.2
265.	0.22619	6973.7	90.951	20.21	28.55	1246.6	8.235	168.8
270.	0.22201	7116.6	91.485	20.27	28.61	1257.7	8.341	171.4
275.	0.21798	7259.8	92.011	20.33	28.66	1268.7	8.446	173.9
280.	0.21410	7403.2	92.528	20.38	28.71	1279.7	8.551	176.4
285.	0.21035	7546.9	93.036	20.42	28.76	1290.5	8.655	178.8
290.	0.20673	7690.8	93.537	20.47	28.80	1301.3	8.758	181.3
295.	0.20323	7834.9	94.029	20.51	28.84	1312.1	8.861	183.7
300.	0.19985	7979.1	94.514	20.54	28.87	1322.7	8.963	186.1
310.	0.19342	8268.2	95.462	20.61	28.94	1343.8	9.165	190.9
320.	0.18739	8557.9	96.382	20.66	28.99	1364.7	9.366	195.5
330.	0.18172	8848.0	97.275	20.71	29.04	1385.3	9.564	200.6
340.	0.17639	9138.6	98.142	20.75	29.08	1405.6	9.760	205.6
350.	0.17136	9429.5	98.985	20.78	29.11	1425.7	9.954	210.6
360.	0.16661	9720.7	99.806	20.81	29.13	1445.5	10.15	215.6
370.	0.16211	10012.	100.60	20.83	29.15	1465.2	10.34	220.2
380.	0.15786	10304.	101.38	20.85	29.17	1484.6	10.53	225.0
390.	0.15382	10596.	102.14	20.86	29.18	1503.7	10.71	229.7
400.	0.14998	10887.	102.88	20.87	29.19	1522.7	10.90	234.3
410.	0.14633	11179.	103.60	20.88	29.20	1541.4	11.08	238.5
420.	0.14285	11471.	104.30	20.89	29.21	1559.9	11.27	243.2
430.	0.13954	11763.	104.99	20.89	29.21	1578.2	11.45	247.8
440.	0.13637	12056.	105.66	20.90	29.22	1596.3	11.63	252.5
450.	0.13335	12348.	106.32	20.91	29.22	1614.2	11.80	257.2
460.	0.13045	12640.	106.96	20.91	29.23	1631.9	11.98	261.9
470.	0.12768	12932.	107.59	20.92	29.24	1649.4	12.16	266.6
480.	0.12503	13225.	108.21	20.93	29.24	1666.6	12.33	271.3
490.	0.12248	13517.	108.81	20.94	29.25	1683.7	12.51	276.0
500.	0.12004	13810.	109.40	20.94	29.26	1700.7	12.68	280.7

**TABLE 1** *Continued*

<i>T</i> K	$\rho$ mol·l <sup>-1</sup>	<i>H</i> J·mol <sup>-1</sup>	<i>S</i> J·mol <sup>-1</sup> ·K <sup>-1</sup>	<i>C<sub>v</sub></i> J·mol <sup>-1</sup> ·K <sup>-1</sup>	<i>C<sub>p</sub></i> J·mol <sup>-1</sup> ·K <sup>-1</sup>	<i>c</i> m·s <sup>-1</sup>	$\eta$ μPa·s	$\lambda$ mW·m <sup>-1</sup> ·K <sup>-1</sup>
Pressure = 1.0 MPa								
50.	2.6201	1450.3	43.807	12.67	24.28	577.4	2.608	42.11
55.	2.3263	1569.7	46.083	12.68	23.52	610.4	2.795	44.75
60.	2.0978	1686.1	48.108	12.73	23.06	640.4	2.976	47.47
65.	1.9137	1800.6	49.943	12.83	22.79	668.0	3.151	50.26
70.	1.7615	1914.2	51.626	12.95	22.65	693.6	3.322	53.12
75.	1.6332	2027.3	53.186	13.12	22.60	717.4	3.487	55.91
80.	1.5233	2140.4	54.646	13.31	22.64	739.6	3.648	58.79
85.	1.4280	2253.7	56.021	13.54	22.73	760.6	3.805	61.80
90.	1.3444	2367.7	57.323	13.79	22.87	780.3	3.958	64.50
95.	1.2704	2482.5	58.564	14.05	23.04	799.1	4.108	67.46
100.	1.2044	2598.2	59.751	14.33	23.24	817.0	4.255	70.41
105.	1.1452	2714.9	60.891	14.62	23.47	834.2	4.399	73.62
110.	1.0917	2832.9	61.988	14.91	23.71	850.8	4.541	76.84
115.	1.0431	2952.0	63.047	15.21	23.95	866.8	4.680	80.01
120.	.99871	3072.4	64.072	15.50	24.21	882.4	4.817	83.19
125.	.95806	3194.1	65.065	15.79	24.46	897.6	4.952	86.43
130.	.92065	3317.0	66.029	16.07	24.71	912.5	5.086	89.68
135.	.88612	3441.2	66.966	16.35	24.96	927.0	5.217	92.89
140.	.85413	3566.6	67.879	16.62	25.20	941.3	5.348	96.10
145.	.82441	3693.2	68.767	16.87	25.44	955.4	5.476	99.22
150.	.79672	3820.9	69.633	17.12	25.66	969.2	5.604	102.3
155.	.77085	3949.8	70.478	17.36	25.88	982.9	5.730	105.6
160.	.74664	4079.7	71.303	17.58	26.09	996.4	5.854	108.8
165.	.72392	4210.7	72.109	17.79	26.29	1009.7	5.978	112.0
170.	.70256	4342.6	72.897	18.00	26.48	1022.8	6.100	115.2
175.	.68243	4475.4	73.667	18.19	26.66	1035.8	6.221	118.3
180.	.66344	4609.2	74.420	18.37	26.83	1048.7	6.341	121.4
185.	.64549	4743.7	75.158	18.54	26.99	1061.5	6.461	124.5
190.	.62850	4879.1	75.880	18.70	27.14	1074.1	6.579	127.6
195.	.61238	5015.2	76.587	18.86	27.29	1086.6	6.696	130.5
200.	.59708	5151.9	77.279	19.00	27.42	1099.0	6.812	133.5
205.	.58253	5289.4	77.958	19.13	27.55	1111.3	6.927	136.4
210.	.56867	5427.4	78.623	19.26	27.67	1123.5	7.042	139.4
215.	.55547	5566.1	79.276	19.38	27.78	1135.5	7.155	142.2
220.	.54287	5705.3	79.916	19.49	27.89	1147.5	7.268	145.0
225.	.53083	5845.0	80.544	19.60	27.99	1159.4	7.380	147.8
230.	.51932	5985.1	81.160	19.69	28.08	1171.1	7.491	150.6
235.	.50830	6125.8	81.765	19.79	28.17	1182.8	7.602	153.4
240.	.49774	6266.8	82.359	19.87	28.25	1194.4	7.711	156.1
245.	.48761	6408.3	82.942	19.95	28.33	1205.9	7.820	158.8
250.	.47788	6550.1	83.515	20.03	28.40	1217.3	7.928	161.5
255.	.46854	6692.3	84.078	20.10	28.47	1228.6	8.036	164.1
260.	.45956	6834.8	84.632	20.17	28.53	1239.9	8.143	166.7
265.	.45092	6977.6	85.176	20.23	28.59	1251.0	8.249	169.3
270.	.44260	7120.7	85.711	20.28	28.65	1262.1	8.354	171.8
275.	.43458	7264.1	86.237	20.34	28.70	1273.1	8.459	174.3
280.	.42685	7407.7	86.754	20.39	28.74	1284.0	8.563	176.8
285.	.41939	7551.5	87.263	20.43	28.79	1294.9	8.667	179.3
290.	.41219	7695.5	87.764	20.48	28.83	1305.7	8.770	181.7
295.	.40523	7839.8	88.257	20.52	28.87	1316.4	8.873	184.1
300.	.39850	7984.2	88.743	20.55	28.90	1327.0	8.975	186.5
310.	.38570	8273.5	89.692	20.62	28.96	1348.0	9.177	191.3
320.	.37370	8563.4	90.612	20.68	29.02	1368.8	9.377	195.9
330.	.36242	8853.8	91.506	20.72	29.06	1389.4	9.575	201.0
340.	.35180	9144.6	92.374	20.76	29.10	1409.6	9.771	206.0
350.	.34179	9435.7	93.218	20.79	29.13	1429.7	9.964	211.0
360.	.33234	9727.1	94.038	20.82	29.15	1449.5	10.16	215.9
370.	.32339	10019.	94.837	20.84	29.17	1469.0	10.35	220.5
380.	.31492	10310.	95.615	20.85	29.18	1488.4	10.54	225.4
390.	.30688	10602.	96.374	20.87	29.19	1507.5	10.72	230.0
400.	.29924	10894.	97.113	20.88	29.20	1526.4	10.91	234.7
410.	.29197	11186.	97.834	20.89	29.21	1545.1	11.09	238.8
420.	.28505	11479.	98.538	20.89	29.22	1563.6	11.27	243.5
430.	.27844	11771.	99.226	20.90	29.22	1581.8	11.45	248.1
440.	.27214	12063.	99.897	20.91	29.23	1599.9	11.63	252.8
450.	.26612	12355.	100.55	20.91	29.23	1617.7	11.81	257.5
460.	.26035	12648.	101.20	20.92	29.24	1635.3	11.99	262.2
470.	.25484	12940.	101.83	20.93	29.24	1652.8	12.16	266.9
480.	.24955	13233.	102.44	20.93	29.25	1670.0	12.34	271.6
490.	.24447	13525.	103.04	20.94	29.26	1687.1	12.51	276.3
500.	.23960	13818.	103.64	20.95	29.27	1704.0	12.68	281.0

**TABLE 1** *Continued*

<i>T</i> K	$\rho$ mol·l <sup>-1</sup>	<i>H</i> J·mol <sup>-1</sup>	<i>S</i> J·mol <sup>-1</sup> ·K <sup>-1</sup>	<i>C<sub>v</sub></i> J·mol <sup>-1</sup> ·K <sup>-1</sup>	<i>C<sub>p</sub></i> J·mol <sup>-1</sup> ·K <sup>-1</sup>	<i>c</i> m·s <sup>-1</sup>	$\eta$ μPa·s	$\lambda$ mW·m <sup>-1</sup> ·K <sup>-1</sup>
Pressure = 1.0 MPa								
50.	5.7320	1337.3	36.460	12.88	29.30	577.8	2.829	48.32
55.	4.9428	1477.0	39.125	12.81	26.85	613.7	2.970	49.73
60.	4.3773	1607.6	41.398	12.84	25.50	645.8	3.124	51.65
65.	3.9449	1733.0	43.405	12.92	24.69	674.8	3.281	53.88
70.	3.6000	1855.1	45.215	13.04	24.19	701.4	3.438	56.32
75.	3.3168	1975.2	46.872	13.20	23.89	725.9	3.593	58.88
80.	3.0789	2094.2	48.408	13.39	23.73	748.7	3.745	61.66
85.	2.8757	2212.6	49.845	13.61	23.67	770.1	3.895	64.66
90.	2.6997	2331.0	51.198	13.86	23.69	790.1	4.043	67.21
95.	2.5454	2449.6	52.481	14.12	23.77	809.1	4.187	69.98
100.	2.4089	2568.8	53.703	14.40	23.89	827.2	4.330	72.78
105.	2.2871	2688.6	54.872	14.69	24.05	844.5	4.470	75.83
110.	2.1777	2809.3	55.995	14.98	24.23	861.2	4.608	78.93
115.	2.0788	2931.0	57.077	15.27	24.43	877.3	4.744	82.00
120.	1.9888	3053.7	58.121	15.56	24.64	892.9	4.878	85.10
125.	1.9067	3177.4	59.131	15.85	24.86	908.1	5.011	88.26
130.	1.8313	3302.2	60.110	16.13	25.08	923.0	5.142	91.43
135.	1.7619	3428.2	61.061	16.40	25.30	937.5	5.271	94.57
140.	1.6977	3555.2	61.985	16.67	25.51	951.8	5.399	97.73
145.	1.6382	3683.3	62.884	16.93	25.72	965.8	5.526	100.8
150.	1.5829	3812.4	63.759	17.17	25.93	979.6	5.652	103.9
155.	1.5312	3942.6	64.613	17.40	26.13	993.2	5.776	107.1
160.	1.4829	4073.7	65.446	17.63	26.32	1006.6	5.899	110.2
165.	1.4376	4205.8	66.258	17.84	26.51	1019.9	6.021	113.4
170.	1.3951	4338.8	67.052	18.04	26.68	1033.0	6.142	116.6
175.	1.3551	4472.6	67.828	18.23	26.85	1046.0	6.262	119.6
180.	1.3173	4607.2	68.587	18.41	27.01	1058.8	6.381	122.7
185.	1.2817	4742.7	69.329	18.58	27.16	1071.5	6.499	125.7
190.	1.2479	4878.8	70.055	18.74	27.30	1084.0	6.616	128.8
195.	1.2160	5015.7	70.766	18.89	27.44	1096.5	6.732	131.7
200.	1.1856	5153.2	71.462	19.04	27.56	1108.8	6.848	134.6
205.	1.1567	5291.3	72.145	19.17	27.68	1121.0	6.962	137.6
210.	1.1293	5430.0	72.813	19.29	27.80	1133.1	7.076	140.5
215.	1.1031	5569.3	73.468	19.41	27.90	1145.1	7.188	143.3
220.	1.0781	5709.1	74.111	19.52	28.00	1157.0	7.300	146.1
225.	1.0543	5849.3	74.741	19.63	28.10	1168.8	7.412	148.9
230.	1.0315	5990.0	75.360	19.72	28.19	1180.5	7.522	151.6
235.	1.0096	6131.2	75.967	19.82	28.27	1192.2	7.632	154.4
240.	0.98872	6272.7	76.563	19.90	28.35	1203.7	7.741	157.1
245.	0.96867	6414.6	77.148	19.98	28.42	1215.1	7.849	159.8
250.	0.94941	6556.9	77.723	20.06	28.49	1226.5	7.957	162.4
255.	0.93092	6699.4	78.288	20.13	28.55	1237.7	8.064	165.0
260.	0.91314	6842.3	78.843	20.19	28.61	1248.9	8.170	167.6
265.	0.89603	6985.5	79.388	20.25	28.66	1260.0	8.276	170.1
270.	0.87956	7129.0	79.924	20.31	28.72	1271.0	8.381	172.7
275.	0.86368	7272.7	80.452	20.36	28.76	1281.9	8.485	175.2
280.	0.84837	7416.6	80.970	20.41	28.81	1292.8	8.589	177.6
285.	0.83360	7560.7	81.481	20.46	28.85	1303.6	8.692	180.1
290.	0.81934	7705.1	81.983	20.50	28.89	1314.3	8.795	182.6
295.	0.80557	7849.6	82.477	20.54	28.92	1324.9	8.897	184.9
300.	0.79225	7994.3	82.963	20.58	28.96	1335.5	8.998	187.3
310.	0.76689	8284.2	83.914	20.64	29.01	1356.4	9.200	192.1
320.	0.74312	8574.6	84.836	20.70	29.06	1377.1	9.399	196.6
330.	0.72079	8865.4	85.731	20.74	29.10	1397.5	9.596	201.7
340.	0.69976	9156.6	86.600	20.78	29.14	1417.7	9.791	206.7
350.	0.67994	9448.1	87.445	20.81	29.16	1437.6	9.985	211.7
360.	0.66121	9739.8	88.267	20.83	29.18	1457.3	10.18	216.6
370.	0.64348	10032.	89.067	20.85	29.20	1476.8	10.37	221.2
380.	0.62669	10324.	89.845	20.87	29.21	1496.0	10.55	226.0
390.	0.61075	10616.	90.604	20.88	29.22	1515.1	10.74	230.6
400.	0.59561	10908.	91.344	20.89	29.23	1533.9	10.93	235.3
410.	0.58120	11201.	92.066	20.90	29.23	1552.5	11.11	239.4
420.	0.56748	11493.	92.771	20.91	29.24	1570.8	11.29	244.1
430.	0.55438	11785.	93.459	20.91	29.24	1589.0	11.47	248.7
440.	0.54189	12078.	94.131	20.92	29.25	1607.0	11.65	253.4
450.	0.52994	12370.	94.788	20.93	29.25	1624.7	11.83	258.1
460.	0.51851	12663.	95.431	20.93	29.26	1642.3	12.00	262.7
470.	0.50756	12955.	96.061	20.94	29.26	1659.6	12.18	267.4
480.	0.49707	13248.	96.677	20.94	29.27	1676.8	12.35	272.1
490.	0.48700	13541.	97.280	20.95	29.27	1693.8	12.53	276.8
500.	0.47733	13833.	97.872	20.96	29.28	1710.6	12.70	281.5