Designation: D7265 – 12 (Reapproved 2018)

# Standard Specification for Hydrogen Thermophysical Property Tables[1]

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 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 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 9.0.

1.2 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 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:

ρ, molar density ($mol \cdot L^{-1}$)
$V$, molar volume ($L^{-1} \cdot mol$)
$H$, 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 ($mW \cdot m^{-1} \cdot K^{-1}$)

3.2 These tables were produced by equations from a computer package, "NIST Standard Reference Database 23; Reference Fluid Thermodynamic and Transport Properties Database (REFPROP): Version 9.0." 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.

## 5. Keywords

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

[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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**TABLE 1 Hydrogen Thermophysical Property Tables**

| $T$ (K) | ρ (mol·L$^{-1}$) | $V$ (L$^{-1}$·mol) | $H$ (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$^{-1}$) | λ (mW·m$^{-1}$·K$^{-1}$) | η (μPa·s) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 0.1 MPa | | | | | |
| 50 | 0.24247 | 4.1243 | 1549.8 | 64.230 | 12.543 | 21.131 | 584.8 | 38.40 | 2.4717 |
| 55 | 0.21997 | 4.5461 | 1655.4 | 66.243 | 12.579 | 21.113 | 613.4 | 41.52 | 2.6729 |
| 60 | 0.20134 | 4.9668 | 1761.0 | 68.081 | 12.643 | 21.137 | 640.4 | 44.60 | 2.8655 |
| 65 | 0.18565 | 5.3866 | 1866.8 | 69.775 | 12.740 | 21.204 | 665.8 | 47.68 | 3.0502 |
| 70 | 0.17224 | 5.8057 | 1973.1 | 71.350 | 12.871 | 21.312 | 689.7 | 50.78 | 3.2281 |
| 75 | 0.16066 | 6.2244 | 2080.0 | 72.825 | 13.037 | 21.460 | 712.3 | 53.61 | 3.3999 |
| 80 | 0.15054 | 6.6426 | 2187.7 | 74.216 | 13.235 | 21.643 | 733.6 | 56.47 | 3.5663 |
| 85 | 0.14163 | 7.0605 | 2296.5 | 75.534 | 13.462 | 21.858 | 753.8 | 59.35 | 3.7280 |
| 90 | 0.13372 | 7.4781 | 2406.4 | 76.791 | 13.712 | 22.098 | 773.0 | 62.17 | 3.8855 |
| 95 | 0.12665 | 7.8955 | 2517.5 | 77.992 | 13.981 | 22.359 | 791.3 | 65.26 | 4.0392 |
| 100 | 0.12030 | 8.3127 | 2630.0 | 79.146 | 14.264 | 22.635 | 808.9 | 68.33 | 4.1896 |
| 105 | 0.11455 | 8.7298 | 2743.9 | 80.257 | 14.556 | 22.921 | 825.8 | 71.65 | 4.3368 |
| 110 | 0.10933 | 9.1467 | 2859.2 | 81.330 | 14.852 | 23.212 | 842.1 | 74.97 | 4.4813 |
| 115 | 0.10456 | 9.5635 | 2976.0 | 82.369 | 15.150 | 23.506 | 858.0 | 78.22 | 4.6232 |
| 120 | 0.10020 | 9.9802 | 3094.2 | 83.375 | 15.446 | 23.798 | 873.5 | 81.48 | 4.7629 |
| 125 | 0.09618 | 10.3970 | 3214.0 | 84.352 | 15.738 | 24.086 | 888.6 | 84.78 | 4.9004 |
| 130 | 0.09248 | 10.8130 | 3335.1 | 85.303 | 16.023 | 24.368 | 903.4 | 88.09 | 5.0359 |
| 135 | 0.08905 | 11.2300 | 3457.6 | 86.228 | 16.300 | 24.643 | 917.9 | 91.36 | 5.1696 |
| 140 | 0.08587 | 11.6460 | 3581.5 | 87.129 | 16.568 | 24.908 | 932.2 | 94.62 | 5.3015 |
| 145 | 0.08290 | 12.0630 | 3706.7 | 88.007 | 16.825 | 25.164 | 946.3 | 97.79 | 5.4318 |
| 150 | 0.08014 | 12.4790 | 3833.1 | 88.864 | 17.073 | 25.410 | 960.1 | 100.96 | 5.5606 |
| 155 | 0.07755 | 12.8950 | 3960.8 | 89.701 | 17.309 | 25.645 | 973.8 | 104.24 | 5.6880 |
| 160 | 0.07512 | 13.3110 | 4089.6 | 90.519 | 17.535 | 25.869 | 987.3 | 107.51 | 5.8140 |
| 165 | 0.07285 | 13.7280 | 4219.4 | 91.318 | 17.750 | 26.082 | 1000.6 | 110.74 | 5.9387 |
| 170 | 0.07070 | 14.1440 | 4350.4 | 92.100 | 17.954 | 26.285 | 1013.8 | 113.98 | 6.0622 |
| 175 | 0.06868 | 14.5600 | 4482.3 | 92.865 | 18.147 | 26.477 | 1026.9 | 117.11 | 6.1845 |
| 180 | 0.06677 | 14.9760 | 4615.1 | 93.613 | 18.330 | 26.659 | 1039.8 | 120.25 | 6.3056 |
| 185 | 0.06497 | 15.3920 | 4748.8 | 94.346 | 18.503 | 26.831 | 1052.6 | 123.34 | 6.4257 |
| 190 | 0.06326 | 15.8080 | 4883.4 | 95.064 | 18.666 | 26.994 | 1065.3 | 126.44 | 6.5447 |
| 195 | 0.06164 | 16.2240 | 5018.8 | 95.767 | 18.821 | 27.147 | 1077.8 | 129.44 | 6.6627 |
| 200 | 0.06010 | 16.6400 | 5154.9 | 96.456 | 18.966 | 27.292 | 1090.2 | 132.44 | 6.7798 |
| 205 | 0.05863 | 17.0560 | 5291.7 | 97.132 | 19.103 | 27.428 | 1102.6 | 135.39 | 6.8958 |
| 210 | 0.05723 | 17.4720 | 5429.1 | 97.794 | 19.231 | 27.556 | 1114.8 | 138.34 | 7.0110 |
| 215 | 0.05590 | 17.8880 | 5567.2 | 98.444 | 19.352 | 27.676 | 1126.9 | 141.20 | 7.1253 |
| 220 | 0.05463 | 18.3040 | 5705.9 | 99.082 | 19.465 | 27.789 | 1138.9 | 144.07 | 7.2387 |
| 225 | 0.05342 | 18.7200 | 5845.1 | 99.707 | 19.572 | 27.895 | 1150.8 | 146.88 | 7.3513 |
| 230 | 0.05226 | 19.1360 | 5984.8 | 100.320 | 19.672 | 27.994 | 1162.6 | 149.70 | 7.4631 |
| 235 | 0.05115 | 19.5520 | 6125.0 | 100.920 | 19.765 | 28.087 | 1174.4 | 152.46 | 7.5741 |
| 240 | 0.05008 | 19.9680 | 6265.7 | 101.520 | 19.852 | 28.174 | 1186.0 | 155.24 | 7.6843 |
| 245 | 0.04906 | 20.3840 | 6406.7 | 102.100 | 19.934 | 28.255 | 1197.6 | 157.91 | 7.7938 |
| 250 | 0.04808 | 20.8000 | 6548.2 | 102.670 | 20.010 | 28.331 | 1209.0 | 160.59 | 7.9025 |
| 255 | 0.04714 | 21.2150 | 6690.0 | 103.230 | 20.081 | 28.402 | 1220.4 | 163.21 | 8.0105 |
| 260 | 0.04623 | 21.6310 | 6832.2 | 103.780 | 20.148 | 28.468 | 1231.7 | 165.84 | 8.1178 |
| 265 | 0.04536 | 22.0470 | 6974.7 | 104.330 | 20.209 | 28.529 | 1242.9 | 168.43 | 8.2245 |
| 270 | 0.04452 | 22.4630 | 7117.5 | 104.860 | 20.267 | 28.587 | 1254.1 | 171.01 | 8.3305 |
| 275 | 0.04371 | 22.8790 | 7260.6 | 105.390 | 20.320 | 28.640 | 1265.1 | 173.50 | 8.4358 |
| 280 | 0.04293 | 23.2950 | 7403.9 | 105.900 | 20.370 | 28.689 | 1276.1 | 175.99 | 8.5405 |
| 285 | 0.04218 | 23.7110 | 7547.5 | 106.410 | 20.416 | 28.735 | 1287.0 | 178.48 | 8.6445 |
| 290 | 0.04145 | 24.1260 | 7691.2 | 106.910 | 20.459 | 28.777 | 1297.9 | 180.97 | 8.7480 |
| 295 | 0.04075 | 24.5420 | 7835.2 | 107.400 | 20.498 | 28.817 | 1308.6 | 183.37 | 8.8508 |
| 300 | 0.04007 | 24.9580 | 7979.4 | 107.890 | 20.534 | 28.853 | 1319.3 | 185.76 | 8.9531 |
| 305 | 0.03941 | 25.3740 | 8123.8 | 108.360 | 20.568 | 28.886 | 1329.9 | 188.16 | 9.0548 |
| 310 | 0.03878 | 25.7900 | 8268.3 | 108.830 | 20.599 | 28.917 | 1340.5 | 190.56 | 9.1559 |
| 315 | 0.03816 | 26.2050 | 8412.9 | 109.300 | 20.628 | 28.946 | 1351.0 | 192.86 | 9.2565 |
| 320 | 0.03756 | 26.6210 | 8557.7 | 109.750 | 20.654 | 28.972 | 1361.4 | 195.17 | 9.3566 |
| 325 | 0.03699 | 27.0370 | 8702.6 | 110.200 | 20.679 | 28.996 | 1371.8 | 197.72 | 9.4561 |
| 330 | 0.03643 | 27.4530 | 8847.7 | 110.650 | 20.701 | 29.018 | 1382.0 | 200.28 | 9.5551 |
| 335 | 0.03588 | 27.8690 | 8992.8 | 111.080 | 20.722 | 29.039 | 1392.3 | 202.79 | 9.6536 |
| 340 | 0.03536 | 28.2840 | 9138.1 | 111.510 | 20.740 | 29.058 | 1402.4 | 205.30 | 9.7515 |
| 345 | 0.03484 | 28.7000 | 9283.4 | 111.940 | 20.758 | 29.075 | 1412.5 | 207.81 | 9.8490 |
| 350 | 0.03435 | 29.1160 | 9428.8 | 112.360 | 20.773 | 29.090 | 1422.6 | 210.32 | 9.9461 |
| 355 | 0.03386 | 29.5320 | 9574.3 | 112.770 | 20.788 | 29.105 | 1432.5 | 212.79 | 10.0430 |
| 360 | 0.03339 | 29.9480 | 9719.9 | 113.180 | 20.801 | 29.118 | 1442.4 | 215.26 | 10.1390 |
| 365 | 0.03293 | 30.3630 | 9865.5 | 113.580 | 20.813 | 29.130 | 1452.3 | 217.58 | 10.2340 |
| 370 | 0.03249 | 30.7790 | 10011.0 | 113.970 | 20.824 | 29.141 | 1462.1 | 219.90 | 10.3300 |
| 375 | 0.03206 | 31.1950 | 10157.0 | 114.360 | 20.834 | 29.151 | 1471.8 | 222.32 | 10.4240 |
| 380 | 0.03164 | 31.6110 | 10303.0 | 114.750 | 20.843 | 29.160 | 1481.5 | 224.74 | 10.5190 |
| 385 | 0.03122 | 32.0260 | 10448.0 | 115.130 | 20.852 | 29.168 | 1491.1 | 227.07 | 10.6130 |
| 390 | 0.03082 | 32.4420 | 10594.0 | 115.510 | 20.859 | 29.175 | 1500.7 | 229.40 | 10.7060 |
| 395 | 0.03043 | 32.8580 | 10740.0 | 115.880 | 20.866 | 29.182 | 1510.2 | 231.72 | 10.7990 |
| 400 | 0.03005 | 33.2740 | 10886.0 | 116.250 | 20.873 | 29.189 | 1519.6 | 234.06 | 10.8920 |
| 405 | 0.02968 | 33.6900 | 11032.0 | 116.610 | 20.878 | 29.194 | 1529.0 | 236.14 | 10.9840 |
| 410 | 0.02932 | 34.1050 | 11178.0 | 116.970 | 20.884 | 29.200 | 1538.4 | 238.22 | 11.0760 |

**TABLE 1** *Continued*

| $T$ (K) | ρ (mol·L$^{-1}$) | $V$ (L$^{-1}$·mol) | $H$ (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$^{-1}$) | λ (mW·m$^{-1}$·K$^{-1}$) | η (μPa·s) |
|---|---|---|---|---|---|---|---|---|---|
| 415 | 0.02897 | 34.5210 | 11324.0 | 117.320 | 20.889 | 29.205 | 1547.7 | 240.56 | 11.1680 |
| 420 | 0.02862 | 34.9370 | 11470.0 | 117.670 | 20.893 | 29.209 | 1556.9 | 242.89 | 11.2590 |
| 425 | 0.02829 | 35.3530 | 11616.0 | 118.020 | 20.897 | 29.213 | 1566.1 | 245.23 | 11.3500 |
| 430 | 0.02796 | 35.7680 | 11762.0 | 118.360 | 20.901 | 29.217 | 1575.2 | 247.57 | 11.4400 |
| 435 | 0.02764 | 36.1840 | 11908.0 | 118.700 | 20.905 | 29.221 | 1584.3 | 249.91 | 11.5300 |
| 440 | 0.02732 | 36.6000 | 12054.0 | 119.030 | 20.908 | 29.224 | 1593.4 | 252.26 | 11.6200 |
| 445 | 0.02702 | 37.0160 | 12201.0 | 119.360 | 20.912 | 29.227 | 1602.3 | 254.60 | 11.7090 |
| 450 | 0.02672 | 37.4310 | 12347.0 | 119.690 | 20.915 | 29.230 | 1611.3 | 256.95 | 11.7980 |
| 455 | 0.02642 | 37.8470 | 12493.0 | 120.010 | 20.917 | 29.233 | 1620.2 | 259.30 | 11.8870 |
| 460 | 0.02614 | 38.2630 | 12639.0 | 120.330 | 20.920 | 29.236 | 1629.0 | 261.65 | 11.9750 |
| 465 | 0.02585 | 38.6790 | 12785.0 | 120.650 | 20.923 | 29.238 | 1637.8 | 264.00 | 12.0630 |
| 470 | 0.02558 | 39.0940 | 12931.0 | 120.960 | 20.926 | 29.241 | 1646.5 | 266.35 | 12.1510 |
| 475 | 0.02531 | 39.5100 | 13078.0 | 121.270 | 20.928 | 29.244 | 1655.2 | 268.71 | 12.2390 |
| 480 | 0.02505 | 39.9260 | 13224.0 | 121.580 | 20.931 | 29.246 | 1663.9 | 271.06 | 12.3260 |
| 485 | 0.02479 | 40.3420 | 13370.0 | 121.880 | 20.933 | 29.249 | 1672.5 | 273.42 | 12.4130 |
| 490 | 0.02454 | 40.7570 | 13516.0 | 122.180 | 20.936 | 29.251 | 1681.1 | 275.78 | 12.4990 |
| 495 | 0.02429 | 41.1730 | 13663.0 | 122.480 | 20.939 | 29.254 | 1689.6 | 278.14 | 12.5860 |
| 500 | 0.02405 | 41.5890 | 13809.0 | 122.770 | 20.941 | 29.256 | 1698.0 | 280.50 | 12.6720 |
| | | | | 0.2 MPa | | | | | |
| 50 | 0.48886 | 2.0456 | 1539.6 | 58.330 | 12.577 | 21.451 | 583.6 | 38.74 | 2.4854 |
| 55 | 0.44256 | 2.2596 | 1646.6 | 60.370 | 12.606 | 21.366 | 612.8 | 41.83 | 2.6855 |
| 60 | 0.40446 | 2.4724 | 1753.4 | 62.228 | 12.665 | 21.343 | 640.1 | 44.89 | 2.8770 |
| 65 | 0.37252 | 2.6844 | 1860.2 | 63.937 | 12.758 | 21.374 | 665.8 | 47.94 | 3.0609 |
| 70 | 0.34534 | 2.8957 | 1967.2 | 65.524 | 12.886 | 21.456 | 689.9 | 51.02 | 3.2381 |
| 75 | 0.32191 | 3.1065 | 2074.8 | 67.008 | 13.050 | 21.582 | 712.6 | 53.85 | 3.4093 |
| 80 | 0.30149 | 3.3168 | 2183.1 | 68.406 | 13.246 | 21.749 | 734.1 | 56.72 | 3.5752 |
| 85 | 0.28354 | 3.5269 | 2292.3 | 69.731 | 13.472 | 21.950 | 754.4 | 59.62 | 3.7364 |
| 90 | 0.26762 | 3.7366 | 2402.7 | 70.992 | 13.721 | 22.179 | 773.6 | 62.43 | 3.8935 |
| 95 | 0.25341 | 3.9462 | 2514.2 | 72.197 | 13.989 | 22.430 | 792.0 | 65.50 | 4.0468 |
| 100 | 0.24064 | 4.1555 | 2627.0 | 73.355 | 14.271 | 22.698 | 809.6 | 68.57 | 4.1968 |
| 105 | 0.22911 | 4.3647 | 2741.2 | 74.469 | 14.562 | 22.978 | 826.6 | 71.88 | 4.3437 |
| 110 | 0.21864 | 4.5738 | 2856.8 | 75.544 | 14.858 | 23.264 | 843.0 | 75.19 | 4.4878 |
| 115 | 0.20909 | 4.7827 | 2973.8 | 76.585 | 15.156 | 23.552 | 858.9 | 78.43 | 4.6295 |
| 120 | 0.20034 | 4.9916 | 3092.3 | 77.593 | 15.451 | 23.840 | 874.4 | 81.67 | 4.7689 |
| 125 | 0.19230 | 5.2003 | 3212.2 | 78.572 | 15.742 | 24.125 | 889.5 | 84.97 | 4.9061 |
| 130 | 0.18488 | 5.4090 | 3333.5 | 79.524 | 16.027 | 24.404 | 904.3 | 88.28 | 5.0414 |
| 135 | 0.17801 | 5.6176 | 3456.2 | 80.450 | 16.304 | 24.675 | 918.9 | 91.53 | 5.1749 |
| 140 | 0.17164 | 5.8261 | 3580.3 | 81.352 | 16.572 | 24.938 | 933.2 | 94.79 | 5.3066 |
| 145 | 0.16571 | 6.0346 | 3705.6 | 82.232 | 16.829 | 25.192 | 947.2 | 97.96 | 5.4368 |
| 150 | 0.16018 | 6.2431 | 3832.2 | 83.090 | 17.076 | 25.436 | 961.1 | 101.12 | 5.5654 |
| 155 | 0.15500 | 6.4515 | 3959.9 | 83.928 | 17.313 | 25.669 | 974.8 | 104.39 | 5.6926 |
| 160 | 0.15015 | 6.6598 | 4088.8 | 84.746 | 17.538 | 25.891 | 988.3 | 107.67 | 5.8185 |
| 165 | 0.14560 | 6.8682 | 4218.8 | 85.546 | 17.753 | 26.103 | 1001.6 | 110.89 | 5.9431 |
| 170 | 0.14131 | 7.0764 | 4349.9 | 86.329 | 17.957 | 26.304 | 1014.8 | 114.12 | 6.0664 |
| 175 | 0.13727 | 7.2847 | 4481.9 | 87.094 | 18.150 | 26.496 | 1027.8 | 117.25 | 6.1886 |
| 180 | 0.13346 | 7.4929 | 4614.8 | 87.843 | 18.333 | 26.676 | 1040.7 | 120.39 | 6.3096 |
| 185 | 0.12985 | 7.7012 | 4748.6 | 88.576 | 18.506 | 26.848 | 1053.5 | 123.48 | 6.4296 |
| 190 | 0.12643 | 7.9093 | 4883.3 | 89.294 | 18.669 | 27.009 | 1066.2 | 126.57 | 6.5485 |
| 195 | 0.12319 | 8.1175 | 5018.7 | 89.998 | 18.823 | 27.162 | 1078.7 | 129.56 | 6.6664 |
| 200 | 0.12011 | 8.3257 | 5154.9 | 90.687 | 18.968 | 27.305 | 1091.2 | 132.56 | 6.7833 |
| 205 | 0.11718 | 8.5338 | 5291.7 | 91.363 | 19.105 | 27.441 | 1103.5 | 135.51 | 6.8993 |
| 210 | 0.11439 | 8.7419 | 5429.3 | 92.026 | 19.234 | 27.568 | 1115.7 | 138.47 | 7.0144 |
| 215 | 0.11173 | 8.9500 | 5567.4 | 92.676 | 19.354 | 27.688 | 1127.8 | 141.32 | 7.1286 |
| 220 | 0.10919 | 9.1581 | 5706.1 | 93.314 | 19.468 | 27.800 | 1139.8 | 144.18 | 7.2420 |
| 225 | 0.10677 | 9.3662 | 5845.4 | 93.940 | 19.574 | 27.905 | 1151.7 | 146.99 | 7.3545 |
| 230 | 0.10445 | 9.5743 | 5985.2 | 94.554 | 19.674 | 28.004 | 1163.6 | 149.81 | 7.4662 |
| 235 | 0.10223 | 9.7823 | 6125.4 | 95.158 | 19.767 | 28.097 | 1175.3 | 152.57 | 7.5771 |
| 240 | 0.10010 | 9.9904 | 6266.1 | 95.750 | 19.854 | 28.183 | 1186.9 | 155.34 | 7.6873 |
| 245 | 0.09806 | 10.1980 | 6407.2 | 96.332 | 19.936 | 28.264 | 1198.5 | 158.02 | 7.7967 |
| 250 | 0.09610 | 10.4060 | 6548.7 | 96.904 | 20.012 | 28.339 | 1209.9 | 160.69 | 7.9054 |
| 255 | 0.09421 | 10.6140 | 6690.6 | 97.466 | 20.083 | 28.410 | 1221.3 | 163.32 | 8.0133 |
| 260 | 0.09240 | 10.8220 | 6832.8 | 98.018 | 20.150 | 28.476 | 1232.6 | 165.95 | 8.1206 |
| 265 | 0.09066 | 11.0300 | 6975.4 | 98.561 | 20.211 | 28.537 | 1243.8 | 168.53 | 8.2272 |
| 270 | 0.08898 | 11.2380 | 7118.2 | 99.095 | 20.269 | 28.594 | 1254.9 | 171.11 | 8.3331 |
| 275 | 0.08736 | 11.4460 | 7261.3 | 99.620 | 20.322 | 28.646 | 1266.0 | 173.60 | 8.4384 |
| 280 | 0.08580 | 11.6540 | 7404.7 | 100.140 | 20.372 | 28.696 | 1277.0 | 176.08 | 8.5430 |
| 285 | 0.08430 | 11.8620 | 7548.3 | 100.650 | 20.418 | 28.741 | 1287.9 | 178.57 | 8.6470 |
| 290 | 0.08285 | 12.0700 | 7692.1 | 101.150 | 20.460 | 28.783 | 1298.7 | 181.06 | 8.7505 |
| 295 | 0.08144 | 12.2780 | 7836.1 | 101.640 | 20.500 | 28.822 | 1309.5 | 183.46 | 8.8533 |
| 300 | 0.08009 | 12.4860 | 7980.3 | 102.120 | 20.536 | 28.858 | 1320.2 | 185.85 | 8.9555 |
| 305 | 0.07878 | 12.6940 | 8124.7 | 102.600 | 20.570 | 28.892 | 1330.8 | 188.25 | 9.0571 |
| 310 | 0.07751 | 12.9020 | 8269.2 | 103.070 | 20.601 | 28.922 | 1341.3 | 190.65 | 9.1582 |
| 315 | 0.07628 | 13.1100 | 8413.9 | 103.530 | 20.630 | 28.951 | 1351.8 | 192.95 | 9.2588 |
| 320 | 0.07509 | 13.3180 | 8558.7 | 103.990 | 20.656 | 28.977 | 1362.2 | 195.26 | 9.3588 |

**TABLE 1** *Continued*

| *T* (K) | ρ (mol·L$^{-1}$) | *V* (L$^{-1}$·mol) | *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$^{-1}$) | λ (mW·m$^{-1}$·K$^{-1}$) | η (μPa·s) |
|---|---|---|---|---|---|---|---|---|---|
| 325 | 0.07393 | 13.5260 | 8703.6 | 104.440 | 20.680 | 29.001 | 1372.6 | 197.81 | 9.4583 |
| 330 | 0.07281 | 13.7340 | 8848.7 | 104.880 | 20.703 | 29.023 | 1382.9 | 200.36 | 9.5572 |
| 335 | 0.07173 | 13.9420 | 8993.9 | 105.320 | 20.723 | 29.043 | 1393.1 | 202.87 | 9.6557 |
| 340 | 0.07067 | 14.1500 | 9139.1 | 105.750 | 20.742 | 29.062 | 1403.2 | 205.38 | 9.7537 |
| 345 | 0.06965 | 14.3580 | 9284.5 | 106.170 | 20.759 | 29.079 | 1413.3 | 207.89 | 9.8511 |
| 350 | 0.06866 | 14.5660 | 9429.9 | 106.590 | 20.775 | 29.094 | 1423.4 | 210.40 | 9.9481 |
| 355 | 0.06769 | 14.7740 | 9575.4 | 107.000 | 20.789 | 29.108 | 1433.3 | 212.87 | 10.0450 |
| 360 | 0.06675 | 14.9820 | 9721.0 | 107.410 | 20.802 | 29.121 | 1443.2 | 215.34 | 10.1410 |
| 365 | 0.06584 | 15.1890 | 9866.6 | 107.810 | 20.814 | 29.133 | 1453.1 | 217.65 | 10.2360 |
| 370 | 0.06495 | 15.3970 | 10012.0 | 108.210 | 20.825 | 29.144 | 1462.9 | 219.97 | 10.3310 |
| 375 | 0.06408 | 15.6050 | 10158.0 | 108.600 | 20.835 | 29.154 | 1472.6 | 222.40 | 10.4260 |
| 380 | 0.06324 | 15.8130 | 10304.0 | 108.990 | 20.845 | 29.163 | 1482.3 | 224.82 | 10.5210 |
| 385 | 0.06242 | 16.0210 | 10450.0 | 109.370 | 20.853 | 29.171 | 1491.9 | 227.14 | 10.6140 |
| 390 | 0.06162 | 16.2290 | 10596.0 | 109.740 | 20.861 | 29.178 | 1501.4 | 229.47 | 10.7080 |
| 395 | 0.06084 | 16.4370 | 10741.0 | 110.120 | 20.868 | 29.185 | 1510.9 | 231.80 | 10.8010 |
| 400 | 0.06008 | 16.6450 | 10887.0 | 110.480 | 20.874 | 29.191 | 1520.4 | 234.13 | 10.8940 |
| 405 | 0.05934 | 16.8530 | 11033.0 | 110.850 | 20.880 | 29.197 | 1529.8 | 236.21 | 10.9860 |
| 410 | 0.05862 | 17.0610 | 11179.0 | 111.200 | 20.885 | 29.202 | 1539.1 | 238.29 | 11.0780 |
| 415 | 0.05791 | 17.2680 | 11325.0 | 111.560 | 20.890 | 29.207 | 1548.4 | 240.63 | 11.1690 |
| 420 | 0.05722 | 17.4760 | 11471.0 | 111.910 | 20.894 | 29.212 | 1557.6 | 242.97 | 11.2600 |
| 425 | 0.05655 | 17.6840 | 11618.0 | 112.250 | 20.899 | 29.216 | 1566.8 | 245.30 | 11.3510 |
| 430 | 0.05589 | 17.8920 | 11764.0 | 112.600 | 20.902 | 29.219 | 1576.0 | 247.64 | 11.4420 |
| 435 | 0.05525 | 18.1000 | 11910.0 | 112.930 | 20.906 | 29.223 | 1585.0 | 249.98 | 11.5320 |
| 440 | 0.05462 | 18.3080 | 12056.0 | 113.270 | 20.909 | 29.226 | 1594.1 | 252.33 | 11.6210 |
| 445 | 0.05401 | 18.5160 | 12202.0 | 113.600 | 20.913 | 29.229 | 1603.1 | 254.67 | 11.7110 |
| 450 | 0.05341 | 18.7240 | 12348.0 | 113.920 | 20.916 | 29.232 | 1612.0 | 257.02 | 11.8000 |
| 455 | 0.05282 | 18.9320 | 12494.0 | 114.250 | 20.919 | 29.235 | 1620.9 | 259.37 | 11.8890 |
| 460 | 0.05225 | 19.1400 | 12640.0 | 114.570 | 20.921 | 29.238 | 1629.7 | 261.71 | 11.9770 |
| 465 | 0.05169 | 19.3470 | 12787.0 | 114.880 | 20.924 | 29.240 | 1638.5 | 264.07 | 12.0650 |
| 470 | 0.05114 | 19.5550 | 12933.0 | 115.200 | 20.927 | 29.243 | 1647.2 | 266.42 | 12.1530 |
| 475 | 0.05060 | 19.7630 | 13079.0 | 115.510 | 20.929 | 29.245 | 1655.9 | 268.77 | 12.2400 |
| 480 | 0.05007 | 19.9710 | 13225.0 | 115.810 | 20.932 | 29.248 | 1664.6 | 271.13 | 12.3270 |
| 485 | 0.04956 | 20.1790 | 13372.0 | 116.110 | 20.934 | 29.250 | 1673.2 | 273.49 | 12.4140 |
| 490 | 0.04905 | 20.3870 | 13518.0 | 116.410 | 20.937 | 29.253 | 1681.7 | 275.84 | 12.5010 |
| 495 | 0.04856 | 20.5950 | 13664.0 | 116.710 | 20.940 | 29.255 | 1690.2 | 278.20 | 12.5870 |
| 500 | 0.04807 | 20.8030 | 13810.0 | 117.010 | 20.942 | 29.258 | 1698.7 | 280.57 | 12.6730 |
| | | | | 0.5 MPa | | | | | |
| 50 | 1.25300 | 0.7981 | 1508.6 | 50.290 | 12.677 | 22.483 | 580.4 | 39.86 | 2.5283 |
| 55 | 1.12660 | 0.8876 | 1620.1 | 52.417 | 12.685 | 22.169 | 611.0 | 42.82 | 2.7243 |
| 60 | 1.02480 | 0.9758 | 1730.5 | 54.337 | 12.729 | 21.985 | 639.5 | 45.78 | 2.9126 |
| 65 | 0.94060 | 1.0632 | 1840.1 | 56.093 | 12.811 | 21.901 | 666.0 | 48.75 | 3.0938 |
| 70 | 0.86974 | 1.1498 | 1949.6 | 57.715 | 12.931 | 21.895 | 690.7 | 51.76 | 3.2687 |
| 75 | 0.80916 | 1.2358 | 2059.2 | 59.228 | 13.088 | 21.955 | 713.9 | 54.59 | 3.4379 |
| 80 | 0.75671 | 1.3215 | 2169.2 | 60.648 | 13.279 | 22.069 | 735.7 | 57.48 | 3.6021 |
| 85 | 0.71082 | 1.4068 | 2280.0 | 61.990 | 13.500 | 22.227 | 756.2 | 60.43 | 3.7618 |
| 90 | 0.67030 | 1.4919 | 2391.6 | 63.266 | 13.746 | 22.422 | 775.7 | 63.21 | 3.9175 |
| 95 | 0.63424 | 1.5767 | 2504.2 | 64.484 | 14.012 | 22.645 | 794.3 | 66.23 | 4.0696 |
| 100 | 0.60193 | 1.6613 | 2618.1 | 65.652 | 14.292 | 22.890 | 812.0 | 69.26 | 4.2185 |
| 105 | 0.57281 | 1.7458 | 2733.2 | 66.775 | 14.581 | 23.149 | 829.1 | 72.53 | 4.3643 |
| 110 | 0.54641 | 1.8301 | 2849.6 | 67.858 | 14.876 | 23.418 | 845.6 | 75.81 | 4.5075 |
| 115 | 0.52237 | 1.9143 | 2967.3 | 68.905 | 15.172 | 23.692 | 861.6 | 79.02 | 4.6483 |
| 120 | 0.50039 | 1.9985 | 3086.5 | 69.919 | 15.466 | 23.967 | 877.1 | 82.25 | 4.7869 |
| 125 | 0.48020 | 2.0825 | 3207.0 | 70.903 | 15.757 | 24.241 | 892.3 | 85.52 | 4.9234 |
| 130 | 0.46159 | 2.1664 | 3328.9 | 71.859 | 16.040 | 24.510 | 907.1 | 88.81 | 5.0580 |
| 135 | 0.44438 | 2.2503 | 3452.1 | 72.789 | 16.317 | 24.773 | 921.7 | 92.04 | 5.1909 |
| 140 | 0.42842 | 2.3341 | 3576.6 | 73.695 | 16.584 | 25.029 | 936.0 | 95.29 | 5.3220 |
| 145 | 0.41358 | 2.4179 | 3702.4 | 74.577 | 16.841 | 25.276 | 950.1 | 98.44 | 5.4517 |
| 150 | 0.39974 | 2.5016 | 3829.4 | 75.438 | 17.087 | 25.513 | 963.9 | 101.59 | 5.5798 |
| 155 | 0.38680 | 2.5853 | 3957.5 | 76.279 | 17.323 | 25.741 | 977.6 | 104.84 | 5.7065 |
| 160 | 0.37468 | 2.6689 | 4086.7 | 77.099 | 17.548 | 25.958 | 991.1 | 108.10 | 5.8320 |
| 165 | 0.36330 | 2.7525 | 4217.1 | 77.901 | 17.763 | 26.166 | 1004.5 | 111.32 | 5.9561 |
| 170 | 0.35260 | 2.8361 | 4348.4 | 78.685 | 17.966 | 26.363 | 1017.7 | 114.53 | 6.0791 |
| 175 | 0.34251 | 2.9197 | 4480.7 | 79.452 | 18.159 | 26.551 | 1030.7 | 117.66 | 6.2009 |
| 180 | 0.33298 | 3.0032 | 4613.9 | 80.203 | 18.342 | 26.728 | 1043.6 | 120.78 | 6.3216 |
| 185 | 0.32397 | 3.0867 | 4747.9 | 80.937 | 18.514 | 26.896 | 1056.4 | 123.86 | 6.4412 |
| 190 | 0.31544 | 3.1701 | 4882.8 | 81.657 | 18.677 | 27.055 | 1069.0 | 126.94 | 6.5598 |
| 195 | 0.30735 | 3.2536 | 5018.5 | 82.362 | 18.831 | 27.205 | 1081.6 | 129.93 | 6.6774 |
| 200 | 0.29967 | 3.3370 | 5154.9 | 83.052 | 18.976 | 27.346 | 1094.0 | 132.92 | 6.7941 |
| 205 | 0.29236 | 3.4204 | 5291.9 | 83.729 | 19.112 | 27.480 | 1106.3 | 135.86 | 6.9098 |
| 210 | 0.28540 | 3.5038 | 5429.7 | 84.393 | 19.241 | 27.605 | 1118.5 | 138.81 | 7.0247 |
| 215 | 0.27877 | 3.5872 | 5568.0 | 85.044 | 19.361 | 27.723 | 1130.6 | 141.66 | 7.1387 |
| 220 | 0.27244 | 3.6706 | 5706.9 | 85.682 | 19.475 | 27.833 | 1142.6 | 144.51 | 7.2518 |
| 225 | 0.26639 | 3.7539 | 5846.3 | 86.309 | 19.581 | 27.937 | 1154.5 | 147.32 | 7.3641 |
| 230 | 0.26060 | 3.8373 | 5986.2 | 86.924 | 19.680 | 28.034 | 1166.3 | 150.13 | 7.4756 |

**TABLE 1** *Continued*

| *T* (K) | ρ (mol·L$^{-1}$) | *V* (L$^{-1}$·mol) | *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$^{-1}$) | λ (mW·m$^{-1}$·K$^{-1}$) | η (μPa·s) |
|---|---|---|---|---|---|---|---|---|---|
| 235 | 0.25506 | 3.9206 | 6126.6 | 87.528 | 19.773 | 28.125 | 1178.0 | 152.89 | 7.5863 |
| 240 | 0.24975 | 4.0040 | 6267.5 | 88.121 | 19.861 | 28.211 | 1189.6 | 155.65 | 7.6963 |
| 245 | 0.24466 | 4.0873 | 6408.7 | 88.704 | 19.942 | 28.290 | 1201.2 | 158.32 | 7.8055 |
| 250 | 0.23977 | 4.1706 | 6550.4 | 89.276 | 20.018 | 28.364 | 1212.6 | 160.99 | 7.9140 |
| 255 | 0.23508 | 4.2539 | 6692.4 | 89.838 | 20.089 | 28.434 | 1224.0 | 163.61 | 8.0218 |
| 260 | 0.23056 | 4.3372 | 6834.7 | 90.391 | 20.155 | 28.499 | 1235.3 | 166.23 | 8.1289 |
| 265 | 0.22622 | 4.4205 | 6977.3 | 90.934 | 20.217 | 28.559 | 1246.5 | 168.81 | 8.2353 |
| 270 | 0.22204 | 4.5037 | 7120.3 | 91.469 | 20.274 | 28.615 | 1257.6 | 171.39 | 8.3411 |
| 275 | 0.21801 | 4.5870 | 7263.5 | 91.994 | 20.328 | 28.667 | 1268.6 | 173.87 | 8.4462 |
| 280 | 0.21412 | 4.6703 | 7406.9 | 92.511 | 20.377 | 28.715 | 1279.6 | 176.35 | 8.5507 |
| 285 | 0.21037 | 4.7535 | 7550.6 | 93.020 | 20.423 | 28.760 | 1290.5 | 178.84 | 8.6546 |
| 290 | 0.20675 | 4.8368 | 7694.5 | 93.520 | 20.465 | 28.801 | 1301.3 | 181.33 | 8.7579 |
| 295 | 0.20325 | 4.9200 | 7838.6 | 94.013 | 20.505 | 28.840 | 1312.0 | 183.72 | 8.8606 |
| 300 | 0.19987 | 5.0033 | 7982.9 | 94.498 | 20.541 | 28.875 | 1322.7 | 186.11 | 8.9627 |
| 305 | 0.19660 | 5.0865 | 8127.4 | 94.976 | 20.575 | 28.908 | 1333.3 | 188.50 | 9.0642 |
| 310 | 0.19343 | 5.1697 | 8272.0 | 95.446 | 20.606 | 28.938 | 1343.8 | 190.90 | 9.1652 |
| 315 | 0.19037 | 5.2530 | 8416.7 | 95.909 | 20.634 | 28.966 | 1354.3 | 193.20 | 9.2656 |
| 320 | 0.18740 | 5.3362 | 8561.6 | 96.366 | 20.661 | 28.991 | 1364.7 | 195.50 | 9.3655 |
| 325 | 0.18452 | 5.4194 | 8706.7 | 96.815 | 20.685 | 29.015 | 1375.0 | 198.05 | 9.4649 |
| 330 | 0.18173 | 5.5026 | 8851.8 | 97.258 | 20.707 | 29.036 | 1385.3 | 200.60 | 9.5638 |
| 335 | 0.17902 | 5.5859 | 8997.0 | 97.695 | 20.727 | 29.056 | 1395.5 | 203.10 | 9.6621 |
| 340 | 0.17640 | 5.6691 | 9142.3 | 98.126 | 20.746 | 29.074 | 1405.6 | 205.61 | 9.7600 |
| 345 | 0.17384 | 5.7523 | 9287.8 | 98.550 | 20.763 | 29.091 | 1415.7 | 208.12 | 9.8574 |
| 350 | 0.17137 | 5.8355 | 9433.2 | 98.969 | 20.779 | 29.106 | 1425.7 | 210.63 | 9.9543 |
| 355 | 0.16896 | 5.9187 | 9578.8 | 99.382 | 20.793 | 29.120 | 1435.7 | 213.09 | 10.0510 |
| 360 | 0.16661 | 6.0019 | 9724.4 | 99.789 | 20.807 | 29.132 | 1445.6 | 215.56 | 10.1470 |
| 365 | 0.16434 | 6.0851 | 9870.1 | 100.190 | 20.819 | 29.144 | 1455.4 | 217.87 | 10.2420 |
| 370 | 0.16212 | 6.1683 | 10016.0 | 100.590 | 20.829 | 29.154 | 1465.2 | 220.19 | 10.3370 |
| 375 | 0.15996 | 6.2515 | 10162.0 | 100.980 | 20.839 | 29.164 | 1474.9 | 222.61 | 10.4320 |
| 380 | 0.15786 | 6.3347 | 10308.0 | 101.370 | 20.848 | 29.172 | 1484.6 | 225.03 | 10.5260 |
| 385 | 0.15581 | 6.4179 | 10453.0 | 101.750 | 20.857 | 29.180 | 1494.2 | 227.35 | 10.6200 |
| 390 | 0.15382 | 6.5011 | 10599.0 | 102.120 | 20.864 | 29.187 | 1503.7 | 229.68 | 10.7130 |
| 395 | 0.15188 | 6.5842 | 10745.0 | 102.500 | 20.871 | 29.194 | 1513.2 | 232.00 | 10.8060 |
| 400 | 0.14998 | 6.6674 | 10891.0 | 102.860 | 20.878 | 29.200 | 1522.6 | 234.33 | 10.8990 |
| 405 | 0.14813 | 6.7506 | 11037.0 | 103.230 | 20.883 | 29.205 | 1532.0 | 236.41 | 10.9910 |
| 410 | 0.14633 | 6.8338 | 11183.0 | 103.580 | 20.889 | 29.210 | 1541.4 | 238.49 | 11.0830 |
| 415 | 0.14457 | 6.9170 | 11329.0 | 103.940 | 20.893 | 29.215 | 1550.6 | 240.83 | 11.1740 |
| 420 | 0.14285 | 7.0002 | 11475.0 | 104.290 | 20.898 | 29.219 | 1559.9 | 243.16 | 11.2660 |
| 425 | 0.14118 | 7.0833 | 11622.0 | 104.630 | 20.902 | 29.223 | 1569.0 | 245.50 | 11.3560 |
| 430 | 0.13954 | 7.1665 | 11768.0 | 104.980 | 20.906 | 29.226 | 1578.1 | 247.84 | 11.4470 |
| 435 | 0.13794 | 7.2497 | 11914.0 | 105.310 | 20.909 | 29.230 | 1587.2 | 250.18 | 11.5370 |
| 440 | 0.13637 | 7.3329 | 12060.0 | 105.650 | 20.913 | 29.233 | 1596.2 | 252.52 | 11.6260 |
| 445 | 0.13484 | 7.4160 | 12206.0 | 105.980 | 20.916 | 29.236 | 1605.2 | 254.86 | 11.7160 |
| 450 | 0.13335 | 7.4992 | 12352.0 | 106.300 | 20.919 | 29.238 | 1614.1 | 257.20 | 11.8050 |
| 455 | 0.13188 | 7.5824 | 12499.0 | 106.630 | 20.922 | 29.241 | 1623.0 | 259.55 | 11.8930 |
| 460 | 0.13045 | 7.6655 | 12645.0 | 106.950 | 20.925 | 29.244 | 1631.8 | 261.90 | 11.9820 |
| 465 | 0.12905 | 7.7487 | 12791.0 | 107.260 | 20.927 | 29.246 | 1640.6 | 264.25 | 12.0700 |
| 470 | 0.12768 | 7.8319 | 12937.0 | 107.580 | 20.930 | 29.248 | 1649.3 | 266.60 | 12.1570 |
| 475 | 0.12634 | 7.9150 | 13083.0 | 107.890 | 20.932 | 29.251 | 1658.0 | 268.95 | 12.2450 |
| 480 | 0.12503 | 7.9982 | 13230.0 | 108.190 | 20.935 | 29.253 | 1666.6 | 271.31 | 12.3320 |
| 485 | 0.12374 | 8.0814 | 13376.0 | 108.500 | 20.938 | 29.256 | 1675.2 | 273.66 | 12.4190 |
| 490 | 0.12248 | 8.1645 | 13522.0 | 108.800 | 20.940 | 29.258 | 1683.8 | 276.02 | 12.5050 |
| 495 | 0.12125 | 8.2477 | 13669.0 | 109.090 | 20.943 | 29.260 | 1692.3 | 278.38 | 12.5910 |
| 500 | 0.12004 | 8.3308 | 13815.0 | 109.390 | 20.945 | 29.263 | 1700.7 | 280.74 | 12.6770 |
| | | | | | 1.0 MPa | | | | |
| 50 | 2.61740 | 0.3821 | 1454.7 | 43.785 | 12.837 | 24.482 | 576.1 | 42.10 | 2.6078 |
| 55 | 2.32380 | 0.4303 | 1574.9 | 46.076 | 12.810 | 23.649 | 609.2 | 44.74 | 2.7944 |
| 60 | 2.09580 | 0.4772 | 1691.7 | 48.110 | 12.830 | 23.135 | 639.3 | 47.46 | 2.9756 |
| 65 | 1.91220 | 0.5230 | 1806.6 | 49.949 | 12.895 | 22.823 | 667.0 | 50.26 | 3.1512 |
| 70 | 1.76050 | 0.5680 | 1920.2 | 51.633 | 13.002 | 22.654 | 692.6 | 53.12 | 3.3215 |
| 75 | 1.63250 | 0.6126 | 2033.3 | 53.193 | 13.149 | 22.591 | 716.5 | 55.91 | 3.4869 |
| 80 | 1.52290 | 0.6566 | 2146.3 | 54.652 | 13.332 | 22.611 | 738.8 | 58.79 | 3.6479 |
| 85 | 1.42780 | 0.7004 | 2259.5 | 56.025 | 13.547 | 22.695 | 759.8 | 61.80 | 3.8048 |
| 90 | 1.34440 | 0.7438 | 2373.3 | 57.326 | 13.788 | 22.830 | 779.6 | 64.51 | 3.9581 |
| 95 | 1.27060 | 0.7871 | 2487.9 | 58.564 | 14.049 | 23.005 | 798.4 | 67.46 | 4.1080 |
| 100 | 1.20470 | 0.8301 | 2603.4 | 59.750 | 14.326 | 23.208 | 816.3 | 70.41 | 4.2550 |
| 105 | 1.14550 | 0.8730 | 2720.0 | 60.887 | 14.612 | 23.434 | 833.6 | 73.62 | 4.3990 |
| 110 | 1.09200 | 0.9157 | 2837.8 | 61.983 | 14.905 | 23.674 | 850.2 | 76.84 | 4.5405 |
| 115 | 1.04350 | 0.9584 | 2956.8 | 63.041 | 15.199 | 23.923 | 866.2 | 80.01 | 4.6798 |
| 120 | 0.99912 | 1.0009 | 3077.0 | 64.064 | 15.491 | 24.178 | 881.8 | 83.19 | 4.8170 |
| 125 | 0.95847 | 1.0433 | 3198.5 | 65.056 | 15.780 | 24.433 | 897.1 | 86.43 | 4.9523 |
| 130 | 0.92107 | 1.0857 | 3321.3 | 66.020 | 16.063 | 24.686 | 911.9 | 89.68 | 5.0857 |
| 135 | 0.88653 | 1.1280 | 3445.4 | 66.956 | 16.337 | 24.935 | 926.5 | 92.89 | 5.2175 |
| 140 | 0.85453 | 1.1702 | 3570.7 | 67.867 | 16.603 | 25.178 | 940.8 | 96.10 | 5.3477 |

**TABLE 1** *Continued*

| $T$ (K) | ρ (mol·L$^{-1}$) | $V$ (L$^{-1}$·mol) | $H$ (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$^{-1}$) | λ (mW·m$^{-1}$·K$^{-1}$) | η (μPa·s) |
|---|---|---|---|---|---|---|---|---|---|
| 145 | 0.82480 | 1.2124 | 3697.1 | 68.755 | 16.860 | 25.413 | 954.9 | 99.22 | 5.4764 |
| 150 | 0.79709 | 1.2546 | 3824.8 | 69.620 | 17.105 | 25.641 | 968.8 | 102.35 | 5.6037 |
| 155 | 0.77121 | 1.2967 | 3953.5 | 70.465 | 17.341 | 25.860 | 982.5 | 105.58 | 5.7297 |
| 160 | 0.74699 | 1.3387 | 4083.4 | 71.289 | 17.565 | 26.069 | 996.0 | 108.82 | 5.8544 |
| 165 | 0.72425 | 1.3807 | 4214.2 | 72.094 | 17.778 | 26.269 | 1009.3 | 112.01 | 5.9778 |
| 170 | 0.70287 | 1.4227 | 4346.0 | 72.881 | 17.981 | 26.460 | 1022.5 | 115.21 | 6.1002 |
| 175 | 0.68273 | 1.4647 | 4478.8 | 73.651 | 18.174 | 26.642 | 1035.5 | 118.31 | 6.2214 |
| 180 | 0.66373 | 1.5066 | 4612.4 | 74.404 | 18.356 | 26.814 | 1048.4 | 121.42 | 6.3415 |
| 185 | 0.64576 | 1.5486 | 4746.9 | 75.141 | 18.528 | 26.977 | 1061.2 | 124.49 | 6.4606 |
| 190 | 0.62875 | 1.5904 | 4882.2 | 75.862 | 18.691 | 27.131 | 1073.8 | 127.55 | 6.5787 |
| 195 | 0.61262 | 1.6323 | 5018.2 | 76.569 | 18.844 | 27.277 | 1086.3 | 130.53 | 6.6958 |
| 200 | 0.59731 | 1.6742 | 5155.0 | 77.261 | 18.989 | 27.414 | 1098.7 | 133.50 | 6.8120 |
| 205 | 0.58274 | 1.7160 | 5292.4 | 77.940 | 19.125 | 27.544 | 1111.0 | 136.43 | 6.9273 |
| 210 | 0.56888 | 1.7578 | 5430.4 | 78.605 | 19.253 | 27.666 | 1123.2 | 139.37 | 7.0417 |
| 215 | 0.55566 | 1.7997 | 5569.0 | 79.257 | 19.373 | 27.780 | 1135.3 | 142.20 | 7.1553 |
| 220 | 0.54305 | 1.8414 | 5708.2 | 79.897 | 19.486 | 27.888 | 1147.2 | 145.04 | 7.2680 |
| 225 | 0.53100 | 1.8832 | 5847.9 | 80.525 | 19.592 | 27.989 | 1159.1 | 147.84 | 7.3800 |
| 230 | 0.51948 | 1.9250 | 5988.1 | 81.141 | 19.691 | 28.084 | 1170.9 | 150.64 | 7.4911 |
| 235 | 0.50845 | 1.9668 | 6128.7 | 81.746 | 19.784 | 28.173 | 1182.6 | 153.39 | 7.6015 |
| 240 | 0.49788 | 2.0085 | 6269.8 | 82.340 | 19.871 | 28.256 | 1194.2 | 156.14 | 7.7112 |
| 245 | 0.48774 | 2.0503 | 6411.2 | 82.924 | 19.952 | 28.333 | 1205.7 | 158.80 | 7.8201 |
| 250 | 0.47801 | 2.0920 | 6553.1 | 83.497 | 20.028 | 28.406 | 1217.1 | 161.46 | 7.9283 |
| 255 | 0.46867 | 2.1337 | 6695.3 | 84.060 | 20.099 | 28.473 | 1228.4 | 164.07 | 8.0358 |
| 260 | 0.45968 | 2.1754 | 6837.8 | 84.614 | 20.165 | 28.536 | 1239.7 | 166.69 | 8.1426 |
| 265 | 0.45103 | 2.2171 | 6980.7 | 85.158 | 20.226 | 28.595 | 1250.9 | 169.26 | 8.2488 |
| 270 | 0.44270 | 2.2588 | 7123.8 | 85.693 | 20.283 | 28.649 | 1262.0 | 171.83 | 8.3543 |
| 275 | 0.43468 | 2.3005 | 7267.1 | 86.219 | 20.337 | 28.700 | 1273.0 | 174.31 | 8.4592 |
| 280 | 0.42694 | 2.3422 | 7410.8 | 86.736 | 20.386 | 28.747 | 1283.9 | 176.78 | 8.5635 |
| 285 | 0.41948 | 2.3839 | 7554.6 | 87.246 | 20.432 | 28.790 | 1294.8 | 179.26 | 8.6671 |
| 290 | 0.41227 | 2.4256 | 7698.7 | 87.747 | 20.474 | 28.831 | 1305.6 | 181.74 | 8.7702 |
| 295 | 0.40531 | 2.4673 | 7842.9 | 88.240 | 20.513 | 28.868 | 1316.3 | 184.13 | 8.8727 |
| 300 | 0.39857 | 2.5089 | 7987.3 | 88.725 | 20.549 | 28.902 | 1326.9 | 186.51 | 8.9746 |
| 305 | 0.39206 | 2.5506 | 8131.9 | 89.203 | 20.583 | 28.934 | 1337.5 | 188.90 | 9.0759 |
| 310 | 0.38576 | 2.5923 | 8276.7 | 89.674 | 20.614 | 28.963 | 1348.0 | 191.29 | 9.1767 |
| 315 | 0.37966 | 2.6339 | 8421.5 | 90.138 | 20.642 | 28.990 | 1358.5 | 193.59 | 9.2770 |
| 320 | 0.37375 | 2.6756 | 8566.6 | 90.594 | 20.668 | 29.015 | 1368.8 | 195.88 | 9.3767 |
| 325 | 0.36802 | 2.7172 | 8711.7 | 91.044 | 20.692 | 29.037 | 1379.1 | 198.43 | 9.4759 |
| 330 | 0.36247 | 2.7589 | 8856.9 | 91.488 | 20.715 | 29.058 | 1389.4 | 200.97 | 9.5746 |
| 335 | 0.35708 | 2.8005 | 9002.3 | 91.925 | 20.735 | 29.077 | 1399.6 | 203.47 | 9.6728 |
| 340 | 0.35184 | 2.8422 | 9147.7 | 92.356 | 20.754 | 29.094 | 1409.7 | 205.97 | 9.7705 |
| 345 | 0.34676 | 2.8838 | 9293.2 | 92.781 | 20.771 | 29.110 | 1419.7 | 208.48 | 9.8677 |
| 350 | 0.34183 | 2.9254 | 9438.8 | 93.200 | 20.786 | 29.125 | 1429.7 | 210.98 | 9.9645 |
| 355 | 0.33703 | 2.9671 | 9584.5 | 93.613 | 20.800 | 29.138 | 1439.7 | 213.44 | 10.0610 |
| 360 | 0.33237 | 3.0087 | 9730.2 | 94.021 | 20.813 | 29.150 | 1449.5 | 215.90 | 10.1570 |
| 365 | 0.32783 | 3.0503 | 9876.0 | 94.423 | 20.825 | 29.161 | 1459.3 | 218.22 | 10.2520 |
| 370 | 0.32342 | 3.0919 | 10022.0 | 94.820 | 20.836 | 29.171 | 1469.1 | 220.53 | 10.3470 |
| 375 | 0.31913 | 3.1336 | 10168.0 | 95.211 | 20.846 | 29.180 | 1478.8 | 222.94 | 10.4410 |
| 380 | 0.31494 | 3.1752 | 10314.0 | 95.598 | 20.855 | 29.188 | 1488.4 | 225.36 | 10.5360 |
| 385 | 0.31087 | 3.2168 | 10460.0 | 95.979 | 20.863 | 29.195 | 1498.0 | 227.68 | 10.6290 |
| 390 | 0.30690 | 3.2584 | 10606.0 | 96.356 | 20.871 | 29.202 | 1507.5 | 230.00 | 10.7230 |
| 395 | 0.30303 | 3.3000 | 10752.0 | 96.728 | 20.878 | 29.208 | 1517.0 | 232.33 | 10.8150 |
| 400 | 0.29925 | 3.3416 | 10898.0 | 97.096 | 20.884 | 29.214 | 1526.4 | 234.65 | 10.9080 |
| 405 | 0.29557 | 3.3833 | 11044.0 | 97.459 | 20.889 | 29.219 | 1535.8 | 236.73 | 11.0000 |
| 410 | 0.29198 | 3.4249 | 11190.0 | 97.817 | 20.895 | 29.223 | 1545.1 | 238.81 | 11.0920 |
| 415 | 0.28848 | 3.4665 | 11336.0 | 98.171 | 20.899 | 29.227 | 1554.3 | 241.14 | 11.1830 |
| 420 | 0.28506 | 3.5081 | 11482.0 | 98.521 | 20.904 | 29.231 | 1563.5 | 243.47 | 11.2740 |
| 425 | 0.28172 | 3.5497 | 11628.0 | 98.867 | 20.908 | 29.235 | 1572.7 | 245.80 | 11.3650 |
| 430 | 0.27845 | 3.5913 | 11774.0 | 99.209 | 20.912 | 29.238 | 1581.8 | 248.14 | 11.4550 |
| 435 | 0.27526 | 3.6329 | 11921.0 | 99.547 | 20.915 | 29.241 | 1590.8 | 250.47 | 11.5450 |
| 440 | 0.27215 | 3.6745 | 12067.0 | 99.882 | 20.918 | 29.244 | 1599.8 | 252.81 | 11.6340 |
| 445 | 0.26910 | 3.7161 | 12213.0 | 100.210 | 20.922 | 29.246 | 1608.8 | 255.15 | 11.7240 |
| 450 | 0.26612 | 3.7577 | 12359.0 | 100.540 | 20.924 | 29.249 | 1617.7 | 257.49 | 11.8130 |
| 455 | 0.26321 | 3.7993 | 12506.0 | 100.860 | 20.927 | 29.251 | 1626.5 | 259.84 | 11.9010 |
| 460 | 0.26036 | 3.8409 | 12652.0 | 101.180 | 20.930 | 29.253 | 1635.3 | 262.18 | 11.9890 |
| 465 | 0.25757 | 3.8825 | 12798.0 | 101.500 | 20.933 | 29.256 | 1644.1 | 264.53 | 12.0770 |
| 470 | 0.25484 | 3.9241 | 12944.0 | 101.810 | 20.935 | 29.258 | 1652.8 | 266.88 | 12.1650 |
| 475 | 0.25217 | 3.9657 | 13091.0 | 102.120 | 20.938 | 29.260 | 1661.5 | 269.23 | 12.2520 |
| 480 | 0.24955 | 4.0072 | 13237.0 | 102.430 | 20.940 | 29.262 | 1670.1 | 271.58 | 12.3390 |
| 485 | 0.24698 | 4.0488 | 13383.0 | 102.730 | 20.943 | 29.264 | 1678.7 | 273.94 | 12.4260 |
| 490 | 0.24447 | 4.0904 | 13530.0 | 103.030 | 20.945 | 29.266 | 1687.2 | 276.29 | 12.5130 |
| 495 | 0.24201 | 4.1320 | 13676.0 | 103.330 | 20.948 | 29.268 | 1695.7 | 278.65 | 12.5990 |
| 500 | 0.23960 | 4.1736 | 13822.0 | 103.620 | 20.950 | 29.271 | 1704.1 | 281.01 | 12.6850 |
| | | | | 2.0 MPa | | | | | |
| 50 | 5.73450 | 0.1744 | 1340.3 | 36.406 | 13.137 | 29.720 | 575.3 | 48.33 | 2.8287 |