CBE 20260
Spring 2011
Test #1
2/17/2011

1. Use of steam tables to analyze a steam table (30 points)


It is amazing what ideas have been turned into TV shows. On the *Food Channel*, there is a show called: “Dinner Impossible” where chef Robert Irvine has to create “theme” dinners under various restricting circumstances (e.g., using food only obtained from containers in a shipyard and being cooked on devices that he put together from available materials ... barrels and metal grates!)

For this problem you will need to analyze the steady state operation of a “steam table” which is designed for use in a kitchen. The analysis will be done inside for its intended use and outside, say if Chef Robert needed to keep food hot for a dinner for the *NHL Winter Classic* -- perhaps in Montreal in January.

Steam tables can be purchased with either electrical or gas heating (i.e. essentially like clothes dryers).

When running at steady state and just holding food at constant T, a steam table gives off heat to the surroundings and a steady stream of steam that is generated inside the device and which flows past the pans of food (where it also keeps the food moist). It is vented out the top. For this problem steam is boiling away at 10 kg/hour (=3600 s).

Note that at steady state the water inside has already been heated to 100C and for the purposes of this problem, this amount stays constant (even though there is a steady venting stream).

a. Obtain the form of the energy balance that can be used to analyze this problem starting with eq. 2.64 in the appendix. Justify any terms that are crossed out with an explanation. Consider the case where electricity is used to power the device and hence is a shaft work (input).

b. The sensible heat loss can be modeled with Newton’s law of cooling, $\dot{\underline{Q}} = hA(T_{metal} - T_{room})$ where $h$ is a heat transfer coefficient, $A$ is the surface area of the steam table (= 4 m$^2$), the temperature of the metal is 80C and the room is 25C. The heat transfer coefficient will have a nominal value of 10 W/m$^2$K. How much electrical power (Watts), will be needed to run the table?

c. Now suppose that this unit is placed outside in January in Montreal. Now the "room" is at -20C. Further, heat transfer coefficient is now 25 $W/m^2K$ because of some wind. The temperature of the metal is lower at 70C. How many Watts are needed now?

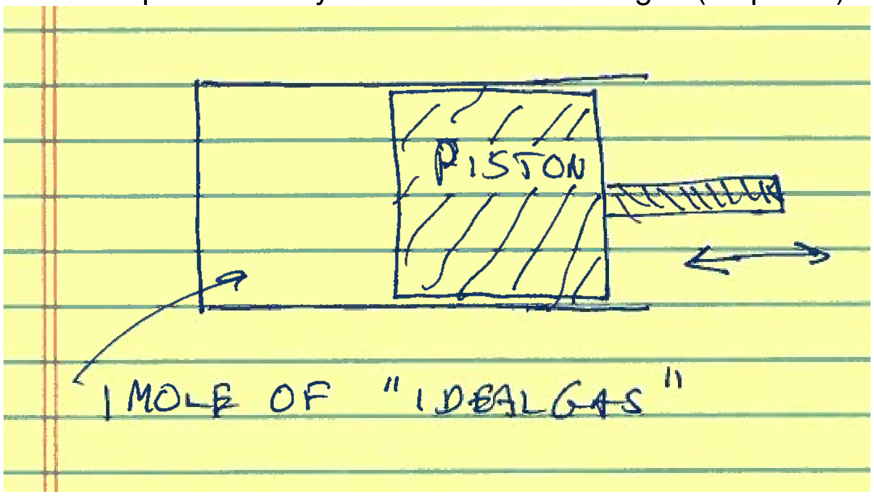
For outside use, he probably needs a unit that is powered by portable chemical fuel (saves on a long extension cord!). Propane is a good choice.

d. Analyze the steam table with a gas input as the heat source. Write down an energy balance that describes this situation and again justify canceling the appropriate terms.

The heat of the combustion reaction for propane is 44 kJ/mole (= 1000 kJ/kg). You can assume that $CO_2$ and water leave the combustion chamber of the steam table at the appropriate reference conditions for the heat of combustion calculation.

e. What is the propane mass flow rate necessary to run the steam table?

2. Just a piston and cylinder filled with ideal gas (40 points)

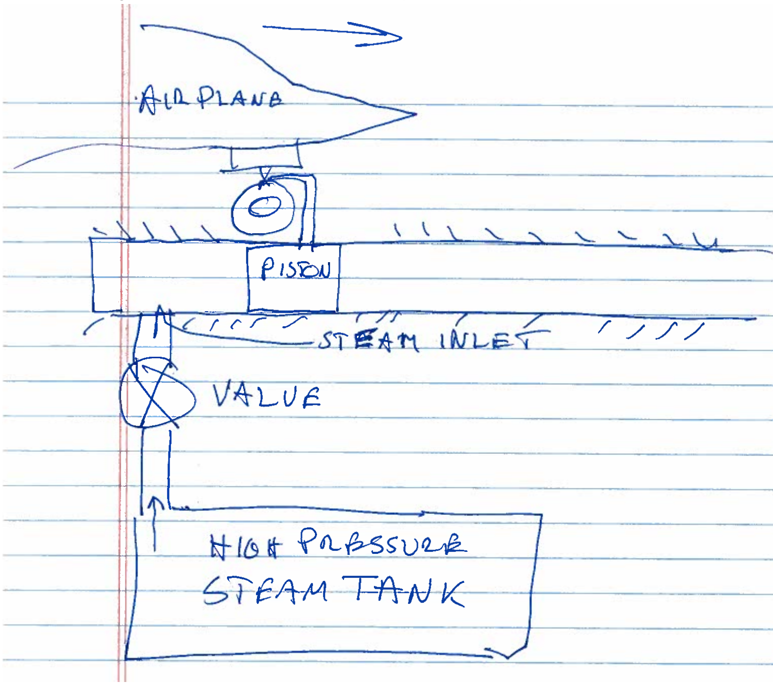



For this problem, consider a piston and cylinder arrangement where 1 mole of "ideal gas" is confined by a piston. This ideal gas has a Cp = 5/2R and Cv = 3/2R. We will use this device in a three-step cycle and examine the various steps and the values of heat and work.

The initial state will be $T_1$, $P_1$. The first step will be to $T_2$, $P_2$, the second step will be from $T_2$, $P_2$ to $T_3$, $P_3$. The third step will be back to $T_1$, $P_1$.

a. What does the internal energy change for the complete cycle have to be? Why is this the case?
b. Using the energy balance given as equation 2.64 in the appendix, derive the form of the energy balance that you will need to solve this problem. For each term that is 0, state why. (You don't have to comment on the kinetic or potential energy terms.)
c. Step one is isothermal compression from $T_1$ = 273K and $P_1$ =1 ATM to $T_{1=}$ $T_2$ = 273K and $P_2$ = 5 ATM. Derive the necessary algebraic expression then calculate the heat, work and change in internal energy for this step.
d. The next step is constant pressure heating to $T_3$ =798 K and $P_2$ = $P_3$ = 5 ATM. Derive the necessary algebraic expression then calculate the heat, work change in internal energy for this step.
e. The third step is an <u>adiabatic</u> expansion back to $P_1$ =1 ATM and $T_1$ =273K. Derive the necessary algebraic expression then calculate the work and internal energy change for this step.
f. What value of change of internal energy for the entire cycle did you calculate?
g. What was the total work for the cycle?
h. What was the total heat for the cycle?
i. Calculate an efficiency for this "heat engine" as: (work out in step 3)/(work in for step 1 + heat in for step 2).
j. If we continue to require a cycle with the same three steps, will the efficiency change if $T_1$ is changed? Show the answer.
k. If we continue to require a cycle with the same three steps, will the efficiency change if $P_2$ is changed? Show the answer.

3. Analysis of a steam catapult (30 points)




While the newest generation of aircraft carriers will have electromagnetic catapults, steam has been the chosen propulsion method for launching airplanes from the flight deck for the past 60 years. This device can accelerate a 45,000 lb (20,000 kg) airplane from 0 to 165 mph (75 m/s) in about 2 seconds. (This acceleration is almost 4 g's! To compare this, the "Top Thrill Dragster" at *Cedar Point* does 0 to 120 MPH in about 4 seconds or only about 1.2 g!)

<u>Use MKS units for this problem.</u>

You can calculate the kinetic energy of the aircraft at take-off as 56,000kJ. The jet engines contribute 35% of this and the catapult contributes 65%.

For each catapult, there are two piston-cylinder assemblies (symmetric across the axis of travel) that are driven by steam from a feed tank. You will be considering just one piston assembly.

Each piston is 0.535 m in diameter and travels 100 m. The force exerted by the piston, which is roughly constant during the launch, is 180,000 Newtons (kg-m$^2$/s$^2$).

a. Write the version of the energy balance that will allow you to analyze cylinder behind in which steam will be entering and pushing the piston forward. Note that no heat exchange occurs during this short launch time.

After a short initial transient, the pressure and temperature behind the piston remain constant during steam injection. (You might think about why keeping T constant is a really good idea!)

b. What pressure is necessary to produce the force (i.e., 180,000 N) needed during the launch?

Note that the source of steam is separated from the cylinder by an adiabatic valve.

c. Write down the version of the energy balance that tells the behavior of the steam as it enters and leaves the valve.

d. If the work done on the piston is (-) 18,000 kJ, how many kg of HP steam are needed? <u>Note that once the steam is inside the cylinder, it will be saturated!</u>

HP steam is 5 MPa and 264C. Note that the working pressure during launch is constant at your value from “b” and the temperature is constant at value for saturation at the working pressure.

Appendix 1.

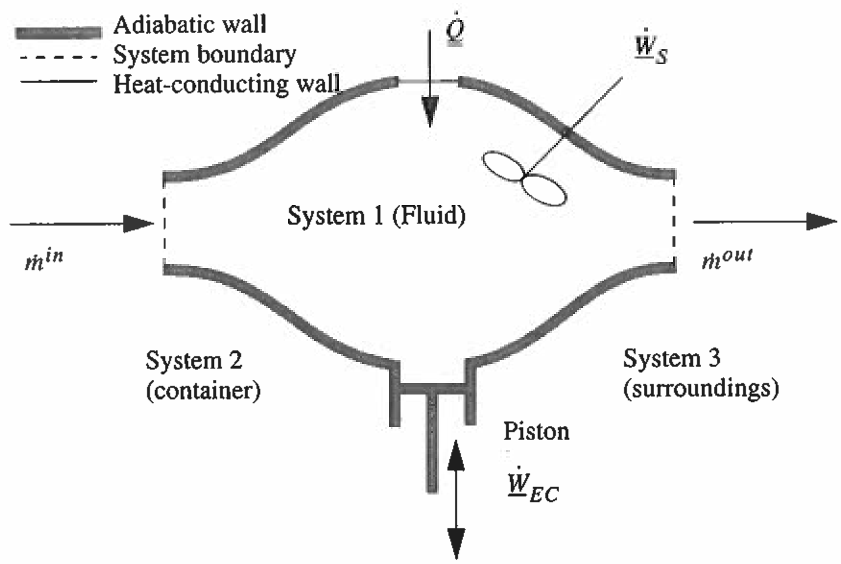



**Figure 2.9** *Schematic of a general system.*

$$\frac{d}{dt}\left(\underline{U} + \frac{1}{2}\frac{mu^2}{g_c} + \frac{mgz}{g_c}\right) = \sum_{inlets}\left(H + \frac{1}{2}\frac{u^2}{g_c} + \frac{gz}{g_c}\right)^{in}\dot{m}^{in} - \sum_{outlets}\left(H + \frac{1}{2}\frac{u^2}{g_c} + \frac{gz}{g_c}\right)^{out}\dot{m}^{out} + \dot{\underline{Q}} + \dot{\underline{W}}_S + \dot{\underline{W}}_{EC} \qquad 2.64$$

Where superscripts "in" and "out" denote properties of the streams which cross the boundaries, which may or may not be equal to properties of the system.

$$\dot{\underline{W}}_{EC} = -P\frac{d\underline{V}}{dt} \quad d\underline{W}_{EC} = -Pd\underline{V} \quad d\underline{Q} = \dot{\underline{Q}}\,dt$$

$$U = \frac{\underline{U}}{m}, V = \frac{\underline{V}}{m}, H = \frac{\underline{H}}{m}, \text{etc, or}$$

$$U = \frac{\underline{U}}{n}, V = \frac{\underline{V}}{n}, H = \frac{\underline{H}}{n}$$

$$C_v \equiv \frac{\partial U}{\partial T}\Big|_V \quad C_P \equiv \frac{\partial H}{\partial T}\Big|_P$$

$$H \equiv U + PV$$

# E.6 PROPERTIES OF WATER[1]

I. Saturation Temperature

| $T$ (°C) | $P$ (MPa) | $V^L$ m³/kg | $V^V$ m³/kg | $U^L$ kJ/kg | $\Delta U^{vap}$ kJ/kg | $U^V$ kJ/kg | $H^L$ kJ/kg | $\Delta H^{vap}$ kJ/kg | $H^V$ kJ/kg | $S^L$ kJ/kg-K | $\Delta S^{vap}$ kJ/kg-K | $S^V$ kJ/kg-K |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.01 | 0.000612 | 0.001000 | 205.9912 | 0.00 | 2374.92 | 2374.92 | 0.00 | 2500.92 | 2500.92 | 0.0000 | 9.1555 | 9.1555 |
| 5 | 0.000873 | 0.001000 | 147.0113 | 21.02 | 2360.76 | 2381.78 | 21.02 | 2489.04 | 2510.06 | 0.0763 | 8.9485 | 9.0248 |
| 10 | 0.001228 | 0.001000 | 106.3032 | 42.02 | 2346.63 | 2388.65 | 42.02 | 2477.19 | 2519.21 | 0.1511 | 8.7487 | 8.8998 |
| 15 | 0.001706 | 0.001001 | 77.8755 | 62.98 | 2332.51 | 2395.49 | 62.98 | 2465.35 | 2528.33 | 0.2245 | 8.5558 | 8.7803 |
| 20 | 0.002339 | 0.001002 | 57.7567 | 83.91 | 2318.41 | 2402.32 | 83.91 | 2453.52 | 2537.43 | 0.2965 | 8.3695 | 8.6660 |
| 25 | 0.003170 | 0.001003 | 43.3373 | 104.83 | 2304.30 | 2409.13 | 104.83 | 2441.68 | 2546.51 | 0.3672 | 8.1894 | 8.5566 |
| 30 | 0.004247 | 0.001004 | 32.8783 | 125.73 | 2290.18 | 2415.91 | 125.73 | 2429.82 | 2555.55 | 0.4368 | 8.0152 | 8.4520 |
| 35 | 0.005629 | 0.001006 | 25.2053 | 146.63 | 2276.04 | 2422.67 | 146.63 | 2417.92 | 2564.55 | 0.5051 | 7.8466 | 8.3517 |
| 40 | 0.007385 | 0.001008 | 19.5151 | 167.53 | 2261.86 | 2429.39 | 167.53 | 2405.98 | 2573.51 | 0.5724 | 7.6831 | 8.2555 |
| 45 | 0.009595 | 0.001010 | 15.2521 | 188.43 | 2247.65 | 2436.08 | 188.43 | 2394.00 | 2582.43 | 0.6386 | 7.5247 | 8.1633 |
| 50 | 0.012400 | 0.001012 | 12.0269 | 209.33 | 2233.40 | 2442.73 | 209.34 | 2381.95 | 2591.29 | 0.7038 | 7.3710 | 8.0748 |
| 55 | 0.015800 | 0.001015 | 9.5643 | 230.24 | 2219.10 | 2449.34 | 230.26 | 2369.83 | 2600.09 | 0.7680 | 7.2218 | 7.9898 |
| 60 | 0.019900 | 0.001017 | 7.6672 | 251.16 | 2204.74 | 2455.90 | 251.18 | 2357.65 | 2608.83 | 0.8313 | 7.0768 | 7.9081 |
| 65 | 0.025000 | 0.001020 | 6.1935 | 272.09 | 2190.32 | 2462.41 | 272.12 | 2345.38 | 2617.50 | 0.8937 | 6.9359 | 7.8296 |
| 70 | 0.031200 | 0.001023 | 5.0395 | 293.03 | 2175.83 | 2468.86 | 293.07 | 2333.03 | 2626.10 | 0.9551 | 6.7989 | 7.7540 |
| 75 | 0.038600 | 0.001026 | 4.1289 | 313.99 | 2161.25 | 2475.24 | 314.03 | 2320.57 | 2634.60 | 1.0158 | 6.6654 | 7.6812 |
| 80 | 0.047400 | 0.001029 | 3.4052 | 334.96 | 2146.60 | 2481.56 | 335.01 | 2308.01 | 2643.02 | 1.0756 | 6.5355 | 7.6111 |
| 85 | 0.057900 | 0.001032 | 2.8258 | 355.95 | 2131.86 | 2487.81 | 356.01 | 2295.32 | 2651.33 | 1.1346 | 6.4088 | 7.5434 |
| 90 | 0.070200 | 0.001036 | 2.3591 | 376.97 | 2117.00 | 2493.97 | 377.04 | 2282.49 | 2659.53 | 1.1929 | 6.2852 | 7.4781 |
| 95 | 0.084600 | 0.001040 | 1.9806 | 398.00 | 2102.04 | 2500.04 | 398.09 | 2269.52 | 2667.61 | 1.2504 | 6.1647 | 7.4151 |
| 100 | 0.101400 | 0.001043 | 1.6718 | 419.06 | 2086.96 | 2506.02 | 419.17 | 2256.40 | 2675.57 | 1.3072 | 6.0469 | 7.3541 |
| 105 | 0.120900 | 0.001047 | 1.4184 | 440.15 | 2071.75 | 2511.90 | 440.27 | 2243.12 | 2683.39 | 1.3633 | 5.9319 | 7.2952 |
| 110 | 0.143400 | 0.001052 | 1.2093 | 461.26 | 2056.41 | 2517.67 | 461.42 | 2229.64 | 2691.06 | 1.4188 | 5.8193 | 7.2381 |
| 115 | 0.169200 | 0.001056 | 1.0358 | 482.41 | 2040.92 | 2523.33 | 482.59 | 2215.99 | 2698.58 | 1.4737 | 5.7091 | 7.1828 |
| 120 | 0.198700 | 0.001060 | 0.8912 | 503.60 | 2025.26 | 2528.86 | 503.81 | 2202.12 | 2705.93 | 1.5279 | 5.6012 | 7.1291 |
| 125 | 0.232200 | 0.001065 | 0.7700 | 524.83 | 2009.44 | 2534.27 | 525.07 | 2188.03 | 2713.10 | 1.5816 | 5.4954 | 7.0770 |
| 130 | 0.270300 | 0.001070 | 0.6680 | 546.09 | 1993.44 | 2539.53 | 546.38 | 2173.70 | 2720.08 | 1.6346 | 5.3918 | 7.0264 |
| 135 | 0.313200 | 0.001075 | 0.5817 | 567.41 | 1977.24 | 2544.65 | 567.74 | 2159.13 | 2726.87 | 1.6872 | 5.2900 | 6.9772 |
| 140 | 0.361500 | 0.001080 | 0.5085 | 588.77 | 1960.85 | 2549.62 | 589.16 | 2144.28 | 2733.44 | 1.7392 | 5.1901 | 6.9293 |
| 145 | 0.415700 | 0.001085 | 0.4460 | 610.19 | 1944.23 | 2554.42 | 610.64 | 2129.16 | 2739.80 | 1.7907 | 5.0919 | 6.8826 |
| 150 | 0.476200 | 0.001091 | 0.3925 | 631.66 | 1927.39 | 2559.05 | 632.18 | 2113.75 | 2745.93 | 1.8418 | 4.9953 | 6.8371 |
| 155 | 0.543500 | 0.001096 | 0.3465 | 653.19 | 1910.32 | 2563.51 | 653.79 | 2098.02 | 2751.81 | 1.8924 | 4.9002 | 6.7926 |
| 160 | 0.618200 | 0.001102 | 0.3068 | 674.79 | 1892.99 | 2567.78 | 675.47 | 2081.97 | 2757.44 | 1.9426 | 4.8065 | 6.7491 |
| 165 | 0.700900 | 0.001108 | 0.2724 | 696.46 | 1875.39 | 2571.85 | 697.24 | 2065.57 | 2762.81 | 1.9923 | 4.7143 | 6.7066 |
| 170 | 0.792200 | 0.001114 | 0.2426 | 718.20 | 1857.53 | 2575.73 | 719.08 | 2048.82 | 2767.90 | 2.0417 | 4.6233 | 6.6650 |
| 175 | 0.892600 | 0.001121 | 0.2166 | 740.02 | 1839.37 | 2579.39 | 741.02 | 2031.69 | 2772.71 | 2.0906 | 4.5335 | 6.6241 |
| 180 | 1.002800 | 0.001127 | 0.1938 | 761.92 | 1820.91 | 2582.83 | 763.05 | 2014.16 | 2777.21 | 2.1392 | 4.4448 | 6.5840 |
| 185 | 1.123500 | 0.001134 | 0.1739 | 783.91 | 1802.13 | 2586.04 | 785.19 | 1996.22 | 2781.41 | 2.1875 | 4.3572 | 6.5447 |

1. Harvey, A. P, Peskin, A. P., Klein, S. A., NIST/ASME Steam Properties, Version 2.1, NIST Standard Reference Data Program, December 1997.

Saturation Temperature (cont.)

| $T$ (°C) | $P$ (MPa) | $V^L$ m³/kg | $V^V$ m³/kg | $U^L$ kJ/kg | $\Delta U^{vap}$ kJ/kg | $U^V$ kJ/kg | $H^L$ kJ/kg | $\Delta H^{vap}$ kJ/kg | $H^V$ kJ/kg | $S^L$ kJ/kg-K | $\Delta S^{vap}$ kJ/kg-K | $S^V$ kJ/kg-K |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 190 | 1.25520 | 0.001141 | 0.1564 | 806.00 | 1783.01 | 2589.01 | 807.43 | 1977.85 | 2785.28 | 2.2355 | 4.2704 | 6.5059 |
| 195 | 1.39880 | 0.001149 | 0.1409 | 828.18 | 1763.56 | 2591.74 | 829.79 | 1959.03 | 2788.82 | 2.2832 | 4.1846 | 6.4678 |
| 200 | 1.55490 | 0.001157 | 0.1272 | 850.47 | 1743.73 | 2594.20 | 852.27 | 1939.74 | 2792.01 | 2.3305 | 4.0997 | 6.4302 |
| 205 | 1.72430 | 0.001164 | 0.1151 | 872.87 | 1723.53 | 2596.40 | 874.88 | 1919.95 | 2794.83 | 2.3777 | 4.0153 | 6.3930 |
| 210 | 1.90770 | 0.001173 | 0.1043 | 895.39 | 1702.92 | 2598.31 | 897.63 | 1899.64 | 2797.27 | 2.4245 | 3.9318 | 6.3563 |
| 215 | 2.10580 | 0.001181 | 0.0947 | 918.04 | 1681.90 | 2599.94 | 920.53 | 1878.79 | 2799.32 | 2.4712 | 3.8488 | 6.3200 |
| 220 | 2.31960 | 0.001190 | 0.0861 | 940.82 | 1660.43 | 2601.25 | 943.58 | 1857.37 | 2800.95 | 2.5177 | 3.7663 | 6.2840 |
| 225 | 2.54970 | 0.001199 | 0.0784 | 963.74 | 1638.50 | 2602.24 | 966.80 | 1835.35 | 2802.15 | 2.5640 | 3.6843 | 6.2483 |
| 230 | 2.79710 | 0.001209 | 0.0715 | 986.81 | 1616.09 | 2602.90 | 990.19 | 1812.71 | 2802.90 | 2.6101 | 3.6027 | 6.2128 |
| 235 | 3.06250 | 0.001219 | 0.0653 | 1010.04 | 1593.16 | 2603.20 | 1013.77 | 1789.40 | 2803.17 | 2.6561 | 3.5214 | 6.1775 |
| 240 | 3.34690 | 0.001229 | 0.0597 | 1033.44 | 1569.69 | 2603.13 | 1037.55 | 1765.41 | 2802.96 | 2.7020 | 3.4403 | 6.1423 |
| 245 | 3.65120 | 0.001240 | 0.0547 | 1057.02 | 1545.65 | 2602.67 | 1061.55 | 1740.67 | 2802.22 | 2.7478 | 3.3594 | 6.1072 |
| 250 | 3.97620 | 0.001252 | 0.0501 | 1080.79 | 1521.00 | 2601.79 | 1085.77 | 1715.16 | 2800.93 | 2.7935 | 3.2786 | 6.0721 |
| 255 | 4.32290 | 0.001264 | 0.0459 | 1104.77 | 1495.72 | 2600.49 | 1110.23 | 1688.84 | 2799.07 | 2.8392 | 3.1977 | 6.0369 |
| 260 | 4.69230 | 0.001276 | 0.0422 | 1128.97 | 1469.75 | 2598.72 | 1134.96 | 1661.64 | 2796.60 | 2.8849 | 3.1167 | 6.0016 |
| 265 | 5.08530 | 0.001289 | 0.0387 | 1153.41 | 1443.04 | 2596.45 | 1159.96 | 1633.53 | 2793.49 | 2.9307 | 3.0354 | 5.9661 |
| 270 | 5.50300 | 0.001303 | 0.0356 | 1178.10 | 1415.57 | 2593.67 | 1185.27 | 1604.42 | 2789.69 | 2.9765 | 2.9539 | 5.9304 |
| 275 | 5.94640 | 0.001318 | 0.0328 | 1203.07 | 1387.26 | 2590.33 | 1210.90 | 1574.27 | 2785.17 | 3.0224 | 2.8720 | 5.8944 |
| 280 | 6.41660 | 0.001333 | 0.0302 | 1228.33 | 1358.06 | 2586.39 | 1236.88 | 1542.99 | 2779.87 | 3.0685 | 2.7894 | 5.8579 |
| 285 | 6.91470 | 0.001349 | 0.0278 | 1253.92 | 1327.89 | 2581.81 | 1263.25 | 1510.48 | 2773.73 | 3.1147 | 2.7062 | 5.8209 |
| 290 | 7.44180 | 0.001366 | 0.0256 | 1279.86 | 1296.67 | 2576.53 | 1290.03 | 1476.67 | 2766.70 | 3.1612 | 2.6222 | 5.7834 |
| 295 | 7.99910 | 0.001385 | 0.0235 | 1306.19 | 1264.30 | 2570.49 | 1317.27 | 1441.43 | 2758.70 | 3.2080 | 2.5371 | 5.7451 |
| 300 | 8.58790 | 0.001404 | 0.0217 | 1332.95 | 1230.67 | 2563.62 | 1345.01 | 1404.63 | 2749.64 | 3.2552 | 2.4507 | 5.7059 |
| 305 | 9.20940 | 0.001425 | 0.0199 | 1360.18 | 1195.67 | 2555.85 | 1373.30 | 1366.13 | 2739.43 | 3.3028 | 2.3629 | 5.6657 |
| 310 | 9.86510 | 0.001448 | 0.0183 | 1387.93 | 1159.14 | 2547.07 | 1402.22 | 1325.73 | 2727.95 | 3.3510 | 2.2734 | 5.6244 |
| 315 | 10.55620 | 0.001472 | 0.0169 | 1416.28 | 1120.89 | 2537.17 | 1431.83 | 1283.22 | 2715.05 | 3.3998 | 2.1818 | 5.5816 |
| 320 | 11.28430 | 0.001499 | 0.0155 | 1445.31 | 1080.70 | 2526.01 | 1462.22 | 1238.37 | 2700.59 | 3.4494 | 2.0878 | 5.5372 |
| 325 | 12.05100 | 0.001528 | 0.0142 | 1475.11 | 1038.30 | 2513.41 | 1493.52 | 1190.81 | 2684.33 | 3.5000 | 1.9908 | 5.4908 |
| 330 | 12.85810 | 0.001561 | 0.0130 | 1505.80 | 993.35 | 2499.15 | 1525.87 | 1140.16 | 2666.03 | 3.5518 | 1.8904 | 5.4422 |
| 335 | 13.70730 | 0.001597 | 0.0118 | 1537.56 | 945.40 | 2482.96 | 1559.45 | 1085.90 | 2645.35 | 3.6050 | 1.7856 | 5.3906 |
| 340 | 14.60070 | 0.001638 | 0.0108 | 1570.62 | 893.82 | 2464.44 | 1594.53 | 1027.32 | 2621.85 | 3.6601 | 1.6755 | 5.3356 |
| 345 | 15.54060 | 0.001685 | 0.0098 | 1605.30 | 837.79 | 2443.09 | 1631.48 | 963.42 | 2594.90 | 3.7176 | 1.5586 | 5.2762 |
| 350 | 16.52940 | 0.001740 | 0.0088 | 1642.13 | 776.01 | 2418.14 | 1670.89 | 892.75 | 2563.64 | 3.7784 | 1.4326 | 5.2110 |
| 355 | 17.57010 | 0.001808 | 0.0079 | 1681.96 | 706.44 | 2388.40 | 1713.72 | 812.93 | 2526.65 | 3.8439 | 1.2941 | 5.1380 |
| 360 | 18.66600 | 0.001895 | 0.0069 | 1726.28 | 625.50 | 2351.78 | 1761.66 | 719.83 | 2481.49 | 3.9167 | 1.1369 | 5.0536 |
| 365 | 19.82140 | 0.002017 | 0.0060 | 1777.79 | 526.00 | 2303.79 | 1817.77 | 605.18 | 2422.95 | 4.0014 | 0.9483 | 4.9497 |
| 370 | 21.04360 | 0.002215 | 0.0050 | 1844.07 | 386.19 | 2230.26 | 1890.69 | 443.83 | 2334.52 | 4.1112 | 0.6900 | 4.8012 |
| 373.95 | 22.06400 | 0.003106 | 0.0031 | 2015.73 | 0.00 | 2015.73 | 2084.26 | 0.00 | 2084.26 | 4.4070 | 0.0000 | 4.4070 |

II. Saturation Pressure

| $T$ (°C) | $P$ (MPa) | $V^L$ m³/kg | $V^V$ m³/kg | $U^L$ kJ/kg | $\Delta U^{vap}$ kJ/kg | $U^V$ kJ/kg | $H^L$ kJ/kg | $\Delta H^{vap}$ kJ/kg | $H^V$ kJ/kg | $S^L$ kJ/kg-K | $\Delta S^{vap}$ kJ/kg-K | $S^V$ kJ/kg-K |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.97 | 0.001 | 0.001000 | 129.1780 | 29.30 | 2355.19 | 2384.49 | 29.30 | 2484.37 | 2513.67 | 0.1059 | 8.8690 | 8.9749 |
| 17.50 | 0.002 | 0.001001 | 66.9869 | 73.43 | 2325.47 | 2398.90 | 73.43 | 2459.45 | 2532.88 | 0.2606 | 8.4620 | 8.7226 |
| 24.08 | 0.003 | 0.001003 | 45.6532 | 100.98 | 2306.90 | 2407.88 | 100.98 | 2443.86 | 2544.84 | 0.3543 | 8.2221 | 8.5764 |
| 28.96 | 0.004 | 0.001004 | 34.7911 | 121.38 | 2293.12 | 2414.50 | 121.39 | 2432.28 | 2553.67 | 0.4224 | 8.0510 | 8.4734 |
| 32.87 | 0.005 | 0.001005 | 28.1853 | 137.74 | 2282.06 | 2419.80 | 137.75 | 2422.98 | 2560.73 | 0.4762 | 7.9176 | 8.3938 |
| 36.16 | 0.006 | 0.001006 | 23.7334 | 151.47 | 2272.76 | 2424.23 | 151.48 | 2415.15 | 2566.63 | 0.5208 | 7.8082 | 8.3290 |
| 39.00 | 0.007 | 0.001008 | 20.5245 | 163.34 | 2264.71 | 2428.05 | 163.35 | 2408.37 | 2571.72 | 0.5590 | 7.7155 | 8.2745 |
| 41.51 | 0.008 | 0.001008 | 18.0989 | 173.83 | 2257.58 | 2431.41 | 173.84 | 2402.37 | 2576.21 | 0.5925 | 7.6348 | 8.2273 |
| 43.76 | 0.009 | 0.001009 | 16.1992 | 183.24 | 2251.19 | 2434.43 | 183.25 | 2396.97 | 2580.22 | 0.6223 | 7.5635 | 8.1858 |
| 45.81 | 0.01 | 0.001010 | 14.6701 | 191.80 | 2245.36 | 2437.16 | 191.81 | 2392.05 | 2583.86 | 0.6492 | 7.4996 | 8.1488 |
| 60.06 | 0.02 | 0.001017 | 7.6480 | 251.40 | 2204.58 | 2455.98 | 251.42 | 2357.52 | 2608.94 | 0.8320 | 7.0752 | 7.9072 |
| 69.10 | 0.03 | 0.001022 | 5.2284 | 289.24 | 2178.46 | 2467.70 | 289.27 | 2335.28 | 2624.55 | 0.9441 | 6.8234 | 7.7675 |
| 75.86 | 0.04 | 0.001026 | 3.9930 | 317.58 | 2158.75 | 2476.33 | 317.62 | 2318.43 | 2636.05 | 1.0261 | 6.6429 | 7.6690 |
| 81.32 | 0.05 | 0.001030 | 3.2400 | 340.49 | 2142.72 | 2483.21 | 340.54 | 2304.68 | 2645.22 | 1.0912 | 6.5018 | 7.5930 |
| 85.93 | 0.06 | 0.001033 | 2.7317 | 359.85 | 2129.10 | 2488.95 | 359.91 | 2292.95 | 2652.86 | 1.1455 | 6.3856 | 7.5311 |
| 89.93 | 0.07 | 0.001036 | 2.3648 | 376.68 | 2117.20 | 2493.88 | 376.75 | 2282.67 | 2659.42 | 1.1921 | 6.2869 | 7.4790 |
| 93.49 | 0.08 | 0.001039 | 2.0871 | 391.63 | 2106.58 | 2498.21 | 391.71 | 2273.47 | 2665.18 | 1.2330 | 6.2009 | 7.4339 |
| 96.69 | 0.09 | 0.001041 | 1.8694 | 405.10 | 2096.97 | 2502.07 | 405.20 | 2265.11 | 2670.31 | 1.2696 | 6.1247 | 7.3943 |
| 99.61 | 0.1 | 0.001043 | 1.6939 | 417.40 | 2088.15 | 2505.55 | 417.50 | 2257.45 | 2674.95 | 1.3028 | 6.0561 | 7.3589 |
| 120.21 | 0.2 | 0.001061 | 0.8857 | 504.49 | 2024.60 | 2529.09 | 504.70 | 2201.53 | 2706.23 | 1.5302 | 5.5967 | 7.1269 |
| 133.52 | 0.3 | 0.001073 | 0.6058 | 561.11 | 1982.04 | 2543.15 | 561.43 | 2163.45 | 2724.88 | 1.6717 | 5.3199 | 6.9916 |
| 143.61 | 0.4 | 0.001084 | 0.4624 | 604.22 | 1948.88 | 2553.10 | 604.66 | 2133.39 | 2738.05 | 1.7765 | 5.1190 | 6.8955 |
| 151.83 | 0.5 | 0.001093 | 0.3748 | 639.54 | 1921.17 | 2560.71 | 640.09 | 2108.02 | 2748.11 | 1.8604 | 4.9603 | 6.8207 |
| 158.83 | 0.6 | 0.001101 | 0.3156 | 669.72 | 1897.07 | 2566.79 | 670.38 | 2085.76 | 2756.14 | 1.9308 | 4.8285 | 6.7593 |
| 164.95 | 0.7 | 0.001108 | 0.2728 | 696.23 | 1875.58 | 2571.81 | 697.00 | 2065.75 | 2762.75 | 1.9918 | 4.7153 | 6.7071 |
| 170.41 | 0.8 | 0.001115 | 0.2403 | 719.97 | 1856.06 | 2576.03 | 720.86 | 2047.44 | 2768.30 | 2.0457 | 4.6159 | 6.6616 |
| 175.35 | 0.9 | 0.001121 | 0.2149 | 741.55 | 1838.09 | 2579.64 | 742.56 | 2030.47 | 2773.03 | 2.0941 | 4.5272 | 6.6213 |
| 179.88 | 1 | 0.001127 | 0.1944 | 761.39 | 1821.36 | 2582.75 | 762.52 | 2014.59 | 2777.11 | 2.1381 | 4.4469 | 6.5850 |
| 187.96 | 1.2 | 0.001139 | 0.1633 | 796.96 | 1790.87 | 2587.83 | 798.33 | 1985.41 | 2783.74 | 2.2159 | 4.3058 | 6.5217 |
| 195.04 | 1.4 | 0.001149 | 0.1408 | 828.36 | 1763.40 | 2591.76 | 829.97 | 1958.88 | 2788.85 | 2.2835 | 4.1840 | 6.4675 |
| 201.37 | 1.6 | 0.001159 | 0.1237 | 856.60 | 1738.23 | 2594.83 | 858.46 | 1934.36 | 2792.82 | 2.3435 | 4.0764 | 6.4199 |
| 207.11 | 1.8 | 0.001168 | 0.1104 | 882.37 | 1714.87 | 2597.24 | 884.47 | 1911.44 | 2795.91 | 2.3975 | 3.9800 | 6.3775 |
| 212.38 | 2 | 0.001177 | 0.0996 | 906.15 | 1692.97 | 2599.12 | 908.50 | 1889.79 | 2798.29 | 2.4468 | 3.8922 | 6.3390 |
| 223.95 | 2.5 | 0.001197 | 0.0799 | 958.91 | 1643.15 | 2602.06 | 961.91 | 1840.02 | 2801.93 | 2.5543 | 3.7015 | 6.2558 |
| 233.85 | 3 | 0.001217 | 0.0667 | 1004.69 | 1598.47 | 2603.16 | 1008.34 | 1794.81 | 2803.15 | 2.6456 | 3.5400 | 6.1856 |
| 242.56 | 3.5 | 0.001235 | 0.0571 | 1045.47 | 1557.47 | 2602.94 | 1049.80 | 1752.84 | 2802.64 | 2.7254 | 3.3989 | 6.1243 |
| 250.35 | 4 | 0.001253 | 0.0498 | 1082.48 | 1519.24 | 2601.72 | 1087.49 | 1713.33 | 2800.82 | 2.7968 | 3.2728 | 6.0696 |
| 257.44 | 4.5 | 0.001270 | 0.0441 | 1116.53 | 1483.15 | 2599.68 | 1122.25 | 1675.70 | 2797.95 | 2.8615 | 3.1582 | 6.0197 |
| 263.94 | 5 | 0.001286 | 0.0394 | 1148.21 | 1448.77 | 2596.98 | 1154.64 | 1639.57 | 2794.21 | 2.9210 | 3.0527 | 5.9737 |
| 275.59 | 6 | 0.001319 | 0.0324 | 1206.01 | 1383.89 | 2589.90 | 1213.92 | 1570.67 | 2784.59 | 3.0278 | 2.8623 | 5.8901 |
| 285.83 | 7 | 0.001352 | 0.0274 | 1258.20 | 1322.78 | 2580.98 | 1267.66 | 1504.97 | 2772.63 | 3.1224 | 2.6924 | 5.8148 |

| $T$ (°C) | $P$ (MPa) | $V^L$ m$^3$/kg | $V^V$ m$^3$/kg | $U^L$ kJ/kg | $\Delta U^{vap}$ kJ/kg | $U^V$ kJ/kg | $H^L$ kJ/kg | $\Delta H^{vap}$ kJ/kg | $H^V$ kJ/kg | $S^L$ kJ/kg-K | $\Delta S^{vap}$ kJ/kg-K | $S^V$ kJ/kg-K |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 295.01 | 8 | 0.001385 | 0.0235 | 1306.23 | 1264.25 | 2570.48 | 1317.31 | 1441.37 | 2758.68 | 3.2081 | 2.5369 | 5.7450 |
| 303.35 | 9 | 0.001418 | 0.0205 | 1351.11 | 1207.42 | 2558.53 | 1363.87 | 1379.07 | 2742.94 | 3.2870 | 2.3921 | 5.6791 |
| 311.00 | 10 | 0.001453 | 0.0180 | 1393.54 | 1151.65 | 2545.19 | 1408.06 | 1317.43 | 2725.49 | 3.3607 | 2.2553 | 5.6160 |
| 327.81 | 12.5 | 0.001546 | 0.0135 | 1492.26 | 1013.35 | 2505.61 | 1511.58 | 1162.73 | 2674.31 | 3.5290 | 1.9348 | 5.4638 |
| 342.16 | 15 | 0.001657 | 0.0103 | 1585.35 | 870.27 | 2455.62 | 1610.20 | 1000.50 | 2610.70 | 3.6846 | 1.6260 | 5.3106 |
| 354.67 | 17.5 | 0.001803 | 0.0079 | 1679.22 | 711.32 | 2390.54 | 1710.77 | 818.53 | 2529.30 | 3.8394 | 1.3037 | 5.1431 |
| 365.75 | 20 | 0.002040 | 0.0059 | 1786.41 | 508.63 | 2295.04 | 1827.21 | 585.14 | 2412.35 | 4.0156 | 0.9159 | 4.9315 |
| 373.95 | 22.06400 | 0.003106 | 0.0031 | 2015.73 | 0.00 | 2015.73 | 2084.26 | 0.00 | 2084.26 | 4.4070 | 0.0000 | 4.4070 |

III. Superheated Steam

| $P$ = 0.01MPa | (45.8) | | | | $P$ = 0.05MPa | (81.3) | | | | $P$ = 0.10MPa | (99.6) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $T$(°C) | $V$(m$^3$/kg) | $U$(kJ/kg) | $H$(kJ/kg) | $S$(kJ/kg-K) | $T$(°C) | $V$(m$^3$/kg) | $U$(kJ/kg) | $H$(kJ/kg) | $S$(kJ/kg-K) | $T$(°C) | $V$(m$^3$/kg) | $U$(kJ/kg) | $H$(kJ/kg) | $S$(kJ/kg-K) |
| 45.8 | 14.6701 | 2437.2 | 2583.9 | 8.1488 | 81.3 | 3.2400 | 2483.2 | 2645.2 | 7.5930 | 99.6 | 1.6939 | 2505.6 | 2675.0 | 7.3588 |
| 50 | 14.9139 | 2443.3 | 2592.4 | 8.1755 | | | | | | | | | | |
| 100 | 17.1964 | 2515.5 | 2687.5 | 8.4489 | 100 | 3.4187 | 2511.5 | 2682.4 | 7.6953 | 100 | 1.6959 | 2506.2 | 2675.8 | 7.3610 |
| 150 | 19.5132 | 2587.9 | 2783.0 | 8.6892 | 150 | 3.8897 | 2585.7 | 2780.2 | 7.9413 | 150 | 1.9367 | 2582.9 | 2776.6 | 7.6148 |
| 200 | 21.8256 | 2661.3 | 2879.6 | 8.9049 | 200 | 4.3562 | 2660.0 | 2877.8 | 8.1592 | 200 | 2.1724 | 2658.2 | 2875.5 | 7.8356 |
| 250 | 24.1361 | 2736.1 | 2977.4 | 9.1015 | 250 | 4.8206 | 2735.1 | 2976.1 | 8.3568 | 250 | 2.4062 | 2733.9 | 2974.5 | 8.0346 |
| 300 | 26.4456 | 2812.3 | 3076.7 | 9.2827 | 300 | 5.2840 | 2811.6 | 3075.8 | 8.5386 | 300 | 2.6388 | 2810.6 | 3074.5 | 8.2172 |
| 350 | 28.7545 | 2890.0 | 3177.5 | 9.4513 | 350 | 5.7469 | 2889.4 | 3176.8 | 8.7076 | 350 | 2.8710 | 2888.7 | 3175.8 | 8.3866 |
| 400 | 31.0631 | 2969.3 | 3279.9 | 9.6094 | 400 | 6.2094 | 2968.9 | 3279.3 | 8.8659 | 400 | 3.1027 | 2968.3 | 3278.6 | 8.5452 |
| 450 | 33.3714 | 3050.3 | 3384.0 | 9.7584 | 450 | 6.6717 | 3049.9 | 3383.5 | 9.0151 | 450 | 3.3342 | 3049.4 | 3382.8 | 8.6946 |
| 500 | 35.6796 | 3132.9 | 3489.7 | 9.8998 | 500 | 7.1338 | 3132.6 | 3489.3 | 9.1566 | 500 | 3.5655 | 3132.2 | 3488.7 | 8.8361 |
| 550 | 37.9876 | 3217.2 | 3597.1 | 10.0344 | 550 | 7.5957 | 3217.0 | 3596.8 | 9.2913 | 550 | 3.7968 | 3216.6 | 3596.3 | 8.9709 |
| 600 | 40.2956 | 3303.3 | 3706.3 | 10.1631 | 600 | 8.0576 | 3303.1 | 3706.0 | 9.4201 | 600 | 4.0279 | 3302.8 | 3705.6 | 9.0998 |
| 650 | 42.6035 | 3391.2 | 3817.2 | 10.2866 | 650 | 8.5195 | 3391.0 | 3816.9 | 9.5436 | 650 | 4.2590 | 3390.7 | 3816.6 | 9.2234 |
| 700 | 44.9113 | 3480.8 | 3929.9 | 10.4055 | 700 | 8.9812 | 3480.6 | 3929.7 | 9.6625 | 700 | 4.4900 | 3480.4 | 3929.4 | 9.3424 |
| 750 | 47.2191 | 3572.2 | 4044.4 | 10.5202 | 750 | 9.4430 | 3572.0 | 4044.2 | 9.7773 | 750 | 4.7209 | 3571.8 | 4043.9 | 9.4572 |
| 800 | 49.5269 | 3665.3 | 4160.6 | 10.6311 | 800 | 9.9047 | 3665.2 | 4160.4 | 9.8882 | 800 | 4.9519 | 3665.0 | 4160.2 | 9.5681 |
| 850 | 51.8347 | 3760.3 | 4278.6 | 10.7386 | 850 | 10.3663 | 3760.1 | 4278.5 | 9.9957 | 850 | 5.1828 | 3760.0 | 4278.2 | 9.6757 |
| 900 | 54.1424 | 3856.9 | 4398.3 | 10.8429 | 900 | 10.8280 | 3856.8 | 4398.2 | 10.1000 | 900 | 5.4137 | 3856.6 | 4398.0 | 9.7800 |
| 950 | 56.4501 | 3955.2 | 4519.7 | 10.9442 | 950 | 11.2896 | 3955.1 | 4519.6 | 10.2014 | 950 | 5.6446 | 3955.0 | 4519.5 | 9.8813 |
| 1000 | 58.7578 | 4055.2 | 4642.8 | 11.0428 | 1000 | 11.7513 | 4055.1 | 4642.7 | 10.3000 | 1000 | 5.8754 | 4055.0 | 4642.6 | 9.9800 |
| 1050 | 61.0655 | 4156.8 | 4767.5 | 11.1389 | 1050 | 12.2129 | 4156.8 | 4767.4 | 10.3960 | 1050 | 6.1063 | 4156.6 | 4767.3 | 10.0761 |
| 1100 | 63.3732 | 4260.0 | 4893.7 | 11.2325 | 1100 | 12.6745 | 4259.9 | 4893.7 | 10.4897 | 1100 | 6.3371 | 4259.8 | 4893.5 | 10.1697 |
| 1150 | 65.6808 | 4364.7 | 5021.5 | 11.3239 | 1150 | 13.1361 | 4364.6 | 5021.4 | 10.5811 | 1150 | 6.5680 | 4364.5 | 5021.3 | 10.2611 |
| 1200 | 67.9885 | 4470.9 | 5150.7 | 11.4132 | 1200 | 13.5977 | 4470.8 | 5150.7 | 10.6703 | 1200 | 6.7988 | 4470.7 | 5150.6 | 10.3504 |
| 1250 | 70.2961 | 4578.4 | 5281.4 | 11.5004 | 1250 | 14.0592 | 4578.4 | 5281.3 | 10.7576 | 1250 | 7.0296 | 4578.3 | 5281.2 | 10.4376 |
| 1300 | 72.6038 | 4687.4 | 5413.4 | 11.5857 | 1300 | 14.5208 | 4687.3 | 5413.3 | 10.8428 | 1300 | 7.2604 | 4687.2 | 5413.2 | 10.5229 |

$P = 0.20$MPa (120.3)

| T(°C) | V(m³/kg) | U(kJ/kg) | H(kJ/kg) | S(kJ/kg-K) |
|---|---|---|---|---|
| 120.3 | 0.8857 | 2529.1 | 2706.2 | 7.1269 |
| 150 | 0.9599 | 2577.1 | 2769.1 | 7.2810 |
| 200 | 1.0805 | 2654.6 | 2870.7 | 7.5081 |
| 250 | 1.1989 | 2731.4 | 2971.2 | 7.7100 |
| 300 | 1.3162 | 2808.8 | 3072.1 | 7.8941 |
| 350 | 1.4330 | 2887.3 | 3173.9 | 8.0644 |
| 400 | 1.5493 | 2967.1 | 3277.0 | 8.2236 |
| 450 | 1.6655 | 3048.5 | 3381.6 | 8.3734 |
| 500 | 1.7814 | 3131.4 | 3487.7 | 8.5152 |
| 550 | 1.8973 | 3215.9 | 3595.4 | 8.6502 |
| 600 | 2.0130 | 3302.2 | 3704.8 | 8.7792 |
| 650 | 2.1287 | 3390.2 | 3815.9 | 8.9030 |
| 700 | 2.2443 | 3479.9 | 3928.8 | 9.0220 |
| 750 | 2.3599 | 3571.4 | 4043.4 | 9.1369 |
| 800 | 2.4755 | 3664.7 | 4159.8 | 9.2479 |
| 850 | 2.5910 | 3759.6 | 4277.8 | 9.3555 |
| 900 | 2.7066 | 3856.3 | 4397.6 | 9.4598 |
| 950 | 2.8221 | 3954.7 | 4519.1 | 9.5612 |
| 1000 | 2.9375 | 4054.8 | 4642.3 | 9.6599 |
| 1050 | 3.0530 | 4156.4 | 4767.0 | 9.7560 |
| 1100 | 3.1685 | 4259.6 | 4893.3 | 9.8497 |
| 1150 | 3.2839 | 4364.3 | 5021.1 | 9.9411 |
| 1200 | 3.3994 | 4470.5 | 5150.4 | 10.0304 |
| 1250 | 3.5148 | 4578.1 | 5281.1 | 10.1176 |
| 1300 | 3.6302 | 4687.0 | 5413.1 | 10.2029 |

$P = 0.30$MPa (133.5)

| T(°C) | V(m³/kg) | U(kJ/kg) | H(kJ/kg) | S(kJ/kg-K) |
|---|---|---|---|---|
| 133.5 | 0.6058 | 2543.2 | 2724.9 | 6.9916 |
| 150 | 0.6340 | 2571.0 | 2761.2 | 7.0791 |
| 200 | 0.7164 | 2651.0 | 2865.9 | 7.3131 |
| 250 | 0.7964 | 2728.9 | 2967.9 | 7.5180 |
| 300 | 0.8753 | 2807.0 | 3069.6 | 7.7037 |
| 350 | 0.9536 | 2885.9 | 3172.0 | 7.8750 |
| 400 | 1.0315 | 2966.0 | 3275.5 | 8.0347 |
| 450 | 1.1092 | 3047.5 | 3380.3 | 8.1849 |
| 500 | 1.1867 | 3130.6 | 3486.6 | 8.3271 |
| 550 | 1.2641 | 3215.3 | 3594.5 | 8.4623 |
| 600 | 1.3414 | 3301.6 | 3704.0 | 8.5914 |
| 650 | 1.4186 | 3389.7 | 3815.3 | 8.7153 |
| 700 | 1.4958 | 3479.5 | 3928.2 | 8.8344 |
| 750 | 1.5729 | 3571.0 | 4042.9 | 8.9494 |
| 800 | 1.6500 | 3664.3 | 4159.3 | 9.0604 |
| 850 | 1.7271 | 3759.3 | 4277.4 | 9.1680 |
| 900 | 1.8042 | 3856.0 | 4397.3 | 9.2724 |
| 950 | 1.8812 | 3954.4 | 4518.8 | 9.3739 |
| 1000 | 1.9582 | 4054.5 | 4642.0 | 9.4726 |
| 1050 | 2.0352 | 4156.2 | 4766.7 | 9.5687 |
| 1100 | 2.1122 | 4259.4 | 4893.1 | 9.6624 |
| 1150 | 2.1892 | 4364.1 | 5020.9 | 9.7538 |
| 1200 | 2.2662 | 4470.3 | 5150.2 | 9.8431 |
| 1250 | 2.3432 | 4577.9 | 5280.9 | 9.9303 |
| 1300 | 2.4202 | 4686.9 | 5412.9 | 10.0156 |

$P = 0.40$MPa (143.6)

| T(°C) | V(m³/kg) | U(kJ/kg) | H(kJ/kg) | S(kJ/kg-K) |
|---|---|---|---|---|
| 143.6 | 0.4624 | 2553.1 | 2738.1 | 6.8955 |
| 150 | 0.4709 | 2564.4 | 2752.8 | 6.9306 |
| 200 | 0.5343 | 2647.2 | 2860.9 | 7.1723 |
| 250 | 0.5952 | 2726.4 | 2964.5 | 7.3804 |
| 300 | 0.6549 | 2805.1 | 3067.1 | 7.5677 |
| 350 | 0.7140 | 2884.4 | 3170.0 | 7.7399 |
| 400 | 0.7726 | 2964.9 | 3273.9 | 7.9002 |
| 450 | 0.8311 | 3046.6 | 3379.0 | 8.0508 |
| 500 | 0.8894 | 3129.8 | 3485.5 | 8.1933 |
| 550 | 0.9475 | 3214.6 | 3593.6 | 8.3287 |
| 600 | 1.0056 | 3301.0 | 3703.2 | 8.4580 |
| 650 | 1.0636 | 3389.1 | 3814.6 | 8.5820 |
| 700 | 1.1215 | 3479.0 | 3927.6 | 8.7012 |
| 750 | 1.1794 | 3570.6 | 4042.4 | 8.8162 |
| 800 | 1.2373 | 3663.9 | 4158.8 | 8.9273 |
| 850 | 1.2951 | 3759.0 | 4277.0 | 9.0350 |
| 900 | 1.3530 | 3855.7 | 4396.9 | 9.1394 |
| 950 | 1.4108 | 3954.2 | 4518.5 | 9.2409 |
| 1000 | 1.4686 | 4054.3 | 4641.7 | 9.3396 |
| 1050 | 1.5264 | 4155.9 | 4766.5 | 9.4357 |
| 1100 | 1.5841 | 4259.2 | 4892.8 | 9.5295 |
| 1150 | 1.6419 | 4363.9 | 5020.7 | 9.6209 |
| 1200 | 1.6997 | 4470.1 | 5150.0 | 9.7102 |
| 1250 | 1.7574 | 4577.8 | 5280.7 | 9.7975 |
| 1300 | 1.8152 | 4686.7 | 5412.8 | 9.8828 |

$P = 0.50$MPa (151.8)

| T(°C) | V(m³/kg) | U(kJ/kg) | H(kJ/kg) | S(kJ/kg-K) |
|---|---|---|---|---|
| 151.8 | 0.3748 | 2560.7 | 2748.1 | 6.8207 |
| 200 | 0.4250 | 2643.3 | 2855.8 | 7.0610 |
| 250 | 0.4744 | 2723.8 | 2961.0 | 7.2724 |
| 300 | 0.5226 | 2803.2 | 3064.6 | 7.4614 |
| 350 | 0.5702 | 2883.0 | 3168.1 | 7.6346 |
| 400 | 0.6173 | 2963.7 | 3272.3 | 7.7955 |
| 450 | 0.6642 | 3045.6 | 3377.7 | 7.9465 |
| 500 | 0.7109 | 3129.0 | 3484.5 | 8.0892 |
| 550 | 0.7576 | 3213.9 | 3592.7 | 8.2249 |
| 600 | 0.8041 | 3300.4 | 3702.5 | 8.3543 |
| 650 | 0.8505 | 3388.6 | 3813.9 | 8.4784 |
| 700 | 0.8970 | 3478.5 | 3927.0 | 8.5977 |
| 750 | 0.9433 | 3570.2 | 4041.8 | 8.7128 |
| 800 | 0.9897 | 3663.6 | 4158.4 | 8.8240 |
| 850 | 1.0360 | 3758.6 | 4276.6 | 8.9317 |
| 900 | 1.0823 | 3855.4 | 4396.6 | 9.0362 |
| 950 | 1.1285 | 3953.9 | 4518.2 | 9.1377 |

$P = 0.60$MPa (158.8)

| T(°C) | V(m³/kg) | U(kJ/kg) | H(kJ/kg) | S(kJ/kg-K) |
|---|---|---|---|---|
| 158.8 | 0.3156 | 2566.8 | 2756.1 | 6.7593 |
| 200 | 0.3521 | 2639.3 | 2850.6 | 6.9683 |
| 250 | 0.3939 | 2721.2 | 2957.6 | 7.1832 |
| 300 | 0.4344 | 2801.4 | 3062.0 | 7.3740 |
| 350 | 0.4743 | 2881.6 | 3166.1 | 7.5481 |
| 400 | 0.5137 | 2962.5 | 3270.8 | 7.7097 |
| 450 | 0.5530 | 3044.7 | 3376.5 | 7.8611 |
| 500 | 0.5920 | 3128.2 | 3483.4 | 8.0041 |
| 550 | 0.6309 | 3213.2 | 3591.8 | 8.1399 |
| 600 | 0.6698 | 3299.8 | 3701.7 | 8.2695 |
| 650 | 0.7085 | 3388.1 | 3813.2 | 8.3937 |
| 700 | 0.7472 | 3478.1 | 3926.4 | 8.5131 |
| 750 | 0.7859 | 3569.8 | 4041.3 | 8.6283 |
| 800 | 0.8246 | 3663.2 | 4157.9 | 8.7395 |
| 850 | 0.8632 | 3758.3 | 4276.2 | 8.8472 |
| 900 | 0.9018 | 3855.1 | 4396.2 | 8.9518 |
| 950 | 0.9404 | 3953.6 | 4517.8 | 9.0533 |

$P = 0.80$MPa (170.4)

| T(°C) | V(m³/kg) | U(kJ/kg) | H(kJ/kg) | S(kJ/kg-K) |
|---|---|---|---|---|
| 170.4 | 0.2403 | 2576.0 | 2768.3 | 6.6616 |
| 200 | 0.2609 | 2631.0 | 2839.7 | 6.8176 |
| 250 | 0.2932 | 2715.9 | 2950.4 | 7.0401 |
| 300 | 0.3242 | 2797.5 | 3056.9 | 7.2345 |
| 350 | 0.3544 | 2878.6 | 3162.2 | 7.4106 |
| 400 | 0.3843 | 2960.2 | 3267.6 | 7.5734 |
| 450 | 0.4139 | 3042.8 | 3373.9 | 7.7257 |
| 500 | 0.4433 | 3126.6 | 3481.3 | 7.8692 |
| 550 | 0.4726 | 3211.9 | 3590.0 | 8.0054 |
| 600 | 0.5019 | 3298.7 | 3700.1 | 8.1354 |
| 650 | 0.5310 | 3387.1 | 3811.9 | 8.2598 |
| 700 | 0.5601 | 3477.2 | 3925.3 | 8.3794 |
| 750 | 0.5892 | 3569.0 | 4040.3 | 8.4947 |
| 800 | 0.6182 | 3662.4 | 4157.0 | 8.6061 |
| 850 | 0.6472 | 3757.6 | 4275.4 | 8.7139 |
| 900 | 0.6762 | 3854.5 | 4395.5 | 8.8185 |
| 950 | 0.7052 | 3953.1 | 4517.2 | 8.9201 |

| | | | | |
|---|---|---|---|---|
| 1000 | 1.1748 | 4054.0 | 4641.4 | 9.2364 |
| 1050 | 1.2210 | 4155.7 | 4766.2 | 9.3326 |
| 1100 | 1.2673 | 4259.0 | 4892.6 | 9.4263 |
| 1150 | 1.3135 | 4363.7 | 5020.5 | 9.5178 |
| 1200 | 1.3597 | 4470.0 | 5149.8 | 9.6071 |
| 1250 | 1.4059 | 4577.6 | 5280.5 | 9.6944 |
| 1300 | 1.4521 | 4686.6 | 5412.6 | 9.7797 |

$P = 1.00$MPa (179.9)

| T(°C) | V(m³/kg) | U(kJ/kg) | H(kJ/kg) | S(kJ/kg-K) |
|---|---|---|---|---|
| 179.9 | 0.1944 | 2582.8 | 2777.1 | 6.5850 |
| 200 | 0.2060 | 2622.2 | 2828.3 | 6.6955 |
| 250 | 0.2327 | 2710.4 | 2943.1 | 6.9265 |
| 300 | 0.2580 | 2793.6 | 3051.6 | 7.1246 |
| 350 | 0.2825 | 2875.7 | 3158.2 | 7.3029 |
| 400 | 0.3066 | 2957.9 | 3264.5 | 7.4669 |
| 450 | 0.3304 | 3040.9 | 3371.3 | 7.6200 |
| 500 | 0.3541 | 3125.0 | 3479.1 | 7.7641 |
| 550 | 0.3777 | 3210.5 | 3588.1 | 7.9008 |
| 600 | 0.4011 | 3297.5 | 3698.6 | 8.0310 |
| 650 | 0.4245 | 3386.0 | 3810.5 | 8.1557 |
| 700 | 0.4478 | 3476.2 | 3924.1 | 8.2755 |
| 750 | 0.4711 | 3568.1 | 4039.3 | 8.3909 |
| 800 | 0.4944 | 3661.7 | 4156.1 | 8.5024 |
| 850 | 0.5176 | 3757.0 | 4274.6 | 8.6103 |
| 900 | 0.5408 | 3853.9 | 4394.8 | 8.7150 |
| 950 | 0.5640 | 3952.5 | 4516.5 | 8.8166 |
| 1000 | 0.5872 | 4052.7 | 4639.9 | 8.9155 |
| 1050 | 0.6104 | 4154.5 | 4764.9 | 9.0118 |
| 1100 | 0.6335 | 4257.9 | 4891.4 | 9.1056 |
| 1150 | 0.6567 | 4362.7 | 5019.4 | 9.1972 |
| 1200 | 0.6798 | 4469.0 | 5148.9 | 9.2866 |
| 1250 | 0.7030 | 4576.7 | 5279.7 | 9.3739 |
| 1300 | 0.7261 | 4685.8 | 5411.9 | 9.4593 |

$P = 1.60$MPa (201.4)

| T(°C) | V(m³/kg) | U(kJ/kg) | H(kJ/kg) | S(kJ/kg-K) |
|---|---|---|---|---|
| 201.4 | 0.1237 | 2594.8 | 2792.8 | 6.4199 |
| 250 | 0.1419 | 2692.9 | 2919.9 | 6.6753 |
| 300 | 0.1587 | 2781.6 | 3035.4 | 6.8863 |
| 350 | 0.1746 | 2866.6 | 3146.0 | 7.0713 |
| 400 | 0.1901 | 2950.7 | 3254.9 | 7.2394 |
| 450 | 0.2053 | 3035.0 | 3363.5 | 7.3950 |
| 500 | 0.2203 | 3120.1 | 3472.6 | 7.5409 |
| 550 | 0.2352 | 3206.3 | 3582.6 | 7.6788 |
| 600 | 0.2500 | 3293.9 | 3693.9 | 7.8100 |
| 650 | 0.2647 | 3382.9 | 3806.5 | 7.9354 |

| | | | | |
|---|---|---|---|---|
| 1000 | 0.9789 | 4053.7 | 4641.1 | 9.1521 |
| 1050 | 1.0175 | 4155.5 | 4766.0 | 9.2482 |
| 1100 | 1.0560 | 4258.7 | 4892.4 | 9.3420 |
| 1150 | 1.0946 | 4363.5 | 5020.3 | 9.4335 |
| 1200 | 1.1331 | 4469.8 | 5149.6 | 9.5228 |
| 1250 | 1.1716 | 4577.4 | 5280.4 | 9.6101 |
| 1300 | 1.2101 | 4686.4 | 5412.5 | 9.6954 |

$P = 1.20$MPa (188.0)

| T(°C) | V(m³/kg) | U(kJ/kg) | H(kJ/kg) | S(kJ/kg-K) |
|---|---|---|---|---|
| 188.0 | 0.1633 | 2587.8 | 2783.7 | 6.5217 |
| 200 | 0.1693 | 2612.9 | 2816.1 | 6.5909 |
| 250 | 0.1924 | 2704.7 | 2935.6 | 6.8313 |
| 300 | 0.2139 | 2789.7 | 3046.3 | 7.0335 |
| 350 | 0.2346 | 2872.7 | 3154.2 | 7.2139 |
| 400 | 0.2548 | 2955.5 | 3261.3 | 7.3793 |
| 450 | 0.2748 | 3038.9 | 3368.7 | 7.5332 |
| 500 | 0.2946 | 3123.4 | 3476.9 | 7.6779 |
| 550 | 0.3143 | 3209.1 | 3586.3 | 7.8150 |
| 600 | 0.3339 | 3296.3 | 3697.0 | 7.9455 |
| 650 | 0.3535 | 3385.0 | 3809.2 | 8.0704 |
| 700 | 0.3730 | 3475.3 | 3922.9 | 8.1904 |
| 750 | 0.3924 | 3567.3 | 4038.2 | 8.3060 |
| 800 | 0.4118 | 3661.0 | 4155.2 | 8.4176 |
| 850 | 0.4312 | 3756.3 | 4273.8 | 8.5256 |
| 900 | 0.4506 | 3853.3 | 4394.0 | 8.6303 |
| 950 | 0.4699 | 3952.0 | 4515.9 | 8.7320 |
| 1000 | 0.4893 | 4052.2 | 4639.4 | 8.8310 |
| 1050 | 0.5086 | 4154.1 | 4764.4 | 8.9273 |
| 1100 | 0.5279 | 4257.5 | 4891.0 | 9.0212 |
| 1150 | 0.5472 | 4362.3 | 5019.0 | 9.1128 |
| 1200 | 0.5665 | 4468.7 | 5148.5 | 9.2022 |
| 1250 | 0.5858 | 4576.4 | 5279.3 | 9.2895 |
| 1300 | 0.6051 | 4685.4 | 5411.5 | 9.3749 |

$P = 1.80$MPa (207.1)

| T(°C) | V(m³/kg) | U(kJ/kg) | H(kJ/kg) | S(kJ/kg-K) |
|---|---|---|---|---|
| 207.1 | 0.1104 | 2597.2 | 2795.9 | 6.3775 |
| 250 | 0.1250 | 2686.7 | 2911.7 | 6.6087 |
| 300 | 0.1402 | 2777.4 | 3029.9 | 6.8246 |
| 350 | 0.1546 | 2863.6 | 3141.8 | 7.0120 |
| 400 | 0.1685 | 2948.3 | 3251.6 | 7.1814 |
| 450 | 0.1821 | 3033.1 | 3360.9 | 7.3380 |
| 500 | 0.1955 | 3118.5 | 3470.4 | 7.4845 |
| 550 | 0.2088 | 3205.0 | 3580.8 | 7.6228 |
| 600 | 0.2220 | 3292.7 | 3692.3 | 7.7543 |
| 650 | 0.2351 | 3381.9 | 3805.1 | 7.8799 |

| | | | | |
|---|---|---|---|---|
| 1000 | 0.7341 | 4053.2 | 4640.5 | 9.0189 |
| 1050 | 0.7630 | 4155.0 | 4765.4 | 9.1151 |
| 1100 | 0.7920 | 4258.3 | 4891.9 | 9.2089 |
| 1150 | 0.8209 | 4363.1 | 5019.8 | 9.3004 |
| 1200 | 0.8498 | 4469.4 | 5149.2 | 9.3898 |
| 1250 | 0.8787 | 4577.1 | 5280.0 | 9.4771 |
| 1300 | 0.9076 | 4686.1 | 5412.2 | 9.5625 |

$P = 1.40$MPa (195.0)

| T(°C) | V(m³/kg) | U(kJ/kg) | H(kJ/kg) | S(kJ/kg-K) |
|---|---|---|---|---|
| 195.0 | 0.1408 | 2591.8 | 2788.9 | 6.4675 |
| 200 | 0.1430 | 2602.7 | 2803.0 | 6.4975 |
| 250 | 0.1636 | 2698.9 | 2927.9 | 6.7488 |
| 300 | 0.1823 | 2785.7 | 3040.9 | 6.9552 |
| 350 | 0.2003 | 2869.7 | 3150.1 | 7.1379 |
| 400 | 0.2178 | 2953.1 | 3258.1 | 7.3046 |
| 450 | 0.2351 | 3037.0 | 3366.1 | 7.4594 |
| 500 | 0.2522 | 3121.8 | 3474.8 | 7.6047 |
| 550 | 0.2691 | 3207.7 | 3584.5 | 7.7422 |
| 600 | 0.2860 | 3295.1 | 3695.4 | 7.8730 |
| 650 | 0.3028 | 3384.0 | 3807.8 | 7.9982 |
| 700 | 0.3195 | 3474.4 | 3921.7 | 8.1183 |
| 750 | 0.3362 | 3566.5 | 4037.2 | 8.2340 |
| 800 | 0.3529 | 3660.2 | 4154.3 | 8.3457 |
| 850 | 0.3695 | 3755.6 | 4273.0 | 8.4538 |
| 900 | 0.3861 | 3852.7 | 4393.3 | 8.5587 |
| 950 | 0.4027 | 3951.4 | 4515.2 | 8.6604 |
| 1000 | 0.4193 | 4051.7 | 4638.8 | 8.7594 |
| 1050 | 0.4359 | 4153.6 | 4763.9 | 8.8558 |
| 1100 | 0.4525 | 4257.0 | 4890.5 | 8.9497 |
| 1150 | 0.4690 | 4361.9 | 5018.6 | 9.0413 |
| 1200 | 0.4856 | 4468.3 | 5148.1 | 9.1308 |
| 1250 | 0.5021 | 4576.0 | 5279.0 | 9.2182 |
| 1300 | 0.5187 | 4685.1 | 5411.2 | 9.3036 |

$P = 2.00$MPa (212.4)

| T(°C) | V(m³/kg) | U(kJ/kg) | H(kJ/kg) | S(kJ/kg-K) |
|---|---|---|---|---|
| 212.4 | 0.0996 | 2599.1 | 2798.3 | 6.3390 |
| 250 | 0.1115 | 2680.2 | 2903.2 | 6.5475 |
| 300 | 0.1255 | 2773.2 | 3024.2 | 6.7684 |
| 350 | 0.1386 | 2860.5 | 3137.7 | 6.9583 |
| 400 | 0.1512 | 2945.9 | 3248.3 | 7.1292 |
| 450 | 0.1635 | 3031.1 | 3358.2 | 7.2866 |
| 500 | 0.1757 | 3116.9 | 3468.2 | 7.4337 |
| 550 | 0.1877 | 3203.6 | 3579.0 | 7.5725 |
| 600 | 0.1996 | 3291.5 | 3690.7 | 7.7043 |
| 650 | 0.2115 | 3380.8 | 3803.8 | 7.8302 |

| | | | | |
|---|---|---|---|---|
| 700 | 0.2794 | 3473.5 | 3920.5 | 8.0557 |
| 750 | 0.2940 | 3565.7 | 4036.1 | 8.1716 |
| 800 | 0.3087 | 3659.5 | 4153.3 | 8.2834 |
| 850 | 0.3232 | 3755.0 | 4272.2 | 8.3916 |
| 900 | 0.3378 | 3852.1 | 4392.6 | 8.4965 |
| 950 | 0.3523 | 3950.9 | 4514.6 | 8.5984 |
| 1000 | 0.3669 | 4051.2 | 4638.2 | 8.6974 |
| 1050 | 0.3814 | 4153.1 | 4763.4 | 8.7938 |
| 1100 | 0.3959 | 4256.6 | 4890.0 | 8.8878 |
| 1150 | 0.4104 | 4361.5 | 5018.2 | 8.9794 |
| 1200 | 0.4249 | 4467.9 | 5147.7 | 9.0689 |
| 1250 | 0.4394 | 4575.7 | 5278.7 | 9.1563 |
| 1300 | 0.4538 | 4684.8 | 5410.9 | 9.2417 |

| | | | | |
|---|---|---|---|---|
| 700 | 0.2482 | 3472.6 | 3919.4 | 8.0004 |
| 750 | 0.2613 | 3564.9 | 4035.1 | 8.1164 |
| 800 | 0.2743 | 3658.8 | 4152.4 | 8.2284 |
| 850 | 0.2872 | 3754.3 | 4271.3 | 8.3367 |
| 900 | 0.3002 | 3851.5 | 4391.9 | 8.4416 |
| 950 | 0.3131 | 3950.3 | 4514.0 | 8.5435 |
| 1000 | 0.3261 | 4050.7 | 4637.6 | 8.6426 |
| 1050 | 0.3390 | 4152.7 | 4762.8 | 8.7391 |
| 1100 | 0.3519 | 4256.2 | 4889.5 | 8.8331 |
| 1150 | 0.3648 | 4361.1 | 5017.7 | 8.9248 |
| 1200 | 0.3777 | 4467.5 | 5147.3 | 9.0143 |
| 1250 | 0.3905 | 4575.3 | 5278.3 | 9.1017 |
| 1300 | 0.4034 | 4684.5 | 5410.6 | 9.1872 |

| | | | | |
|---|---|---|---|---|
| 700 | 0.2233 | 3471.6 | 3918.2 | 7.9509 |
| 750 | 0.2350 | 3564.0 | 4034.1 | 8.0670 |
| 800 | 0.2467 | 3658.0 | 4151.5 | 8.1790 |
| 850 | 0.2584 | 3753.6 | 4270.5 | 8.2874 |
| 900 | 0.2701 | 3850.9 | 4391.1 | 8.3925 |
| 950 | 0.2818 | 3949.8 | 4513.3 | 8.4945 |
| 1000 | 0.2934 | 4050.2 | 4637.0 | 8.5936 |
| 1050 | 0.3051 | 4152.2 | 4762.3 | 8.6901 |
| 1100 | 0.3167 | 4255.7 | 4889.1 | 8.7842 |
| 1150 | 0.3283 | 4360.7 | 5017.3 | 8.8759 |
| 1200 | 0.3399 | 4467.2 | 5147.0 | 8.9654 |
| 1250 | 0.3515 | 4575.0 | 5278.0 | 9.0529 |
| 1300 | 0.3631 | 4684.1 | 5410.3 | 9.1384 |

$P = 2.50$MPa (224.0)

| T(°C) | V(m³/kg) | U(kJ/kg) | H(kJ/kg) | S(kJ/kg-K) |
|---|---|---|---|---|
| 224.0 | 0.0799 | 2602.1 | 2801.9 | 6.2558 |
| 250 | 0.0871 | 2663.3 | 2880.9 | 6.4107 |
| 300 | 0.0989 | 2762.2 | 3009.6 | 6.6459 |
| 350 | 0.1098 | 2852.5 | 3127.0 | 6.8424 |
| 400 | 0.1201 | 2939.8 | 3240.1 | 7.0170 |
| 450 | 0.1302 | 3026.2 | 3351.6 | 7.1767 |
| 500 | 0.1400 | 3112.8 | 3462.7 | 7.3254 |
| 550 | 0.1497 | 3200.1 | 3574.3 | 7.4653 |
| 600 | 0.1593 | 3288.5 | 3686.8 | 7.5979 |
| 650 | 0.1689 | 3378.2 | 3800.4 | 7.7243 |
| 700 | 0.1783 | 3469.3 | 3915.2 | 7.8455 |
| 750 | 0.1878 | 3562.0 | 4031.5 | 7.9620 |
| 800 | 0.1972 | 3656.2 | 4149.2 | 8.0743 |
| 850 | 0.2066 | 3752.0 | 4268.5 | 8.1830 |
| 900 | 0.2160 | 3849.4 | 4389.3 | 8.2882 |
| 950 | 0.2253 | 3948.4 | 4511.7 | 8.3904 |
| 1000 | 0.2347 | 4048.9 | 4635.6 | 8.4896 |
| 1050 | 0.2440 | 4151.0 | 4761.0 | 8.5863 |
| 1100 | 0.2533 | 4254.7 | 4887.9 | 8.6804 |
| 1150 | 0.2626 | 4359.7 | 5016.2 | 8.7722 |
| 1200 | 0.2719 | 4466.2 | 5146.0 | 8.8618 |
| 1250 | 0.2812 | 4574.1 | 5277.1 | 8.9493 |
| 1300 | 0.2905 | 4683.3 | 5409.5 | 9.0349 |

$P = 3.00$MPa (233.9)

| T(°C) | V(m³/kg) | U(kJ/kg) | H(kJ/kg) | S(kJ/kg-K) |
|---|---|---|---|---|
| 233.9 | 0.0667 | 2603.2 | 2803.2 | 6.1856 |
| 250 | 0.0706 | 2644.7 | 2856.5 | 6.2893 |
| 300 | 0.0812 | 2750.8 | 2994.3 | 6.5412 |
| 350 | 0.0906 | 2844.4 | 3116.1 | 6.7449 |
| 400 | 0.0994 | 2933.5 | 3231.7 | 6.9234 |
| 450 | 0.1079 | 3021.2 | 3344.8 | 7.0856 |
| 500 | 0.1162 | 3108.6 | 3457.2 | 7.2359 |
| 550 | 0.1244 | 3196.6 | 3569.7 | 7.3768 |
| 600 | 0.1324 | 3285.5 | 3682.8 | 7.5103 |
| 650 | 0.1405 | 3375.6 | 3796.9 | 7.6373 |
| 700 | 0.1484 | 3467.0 | 3912.2 | 7.7590 |
| 750 | 0.1563 | 3559.9 | 4028.9 | 7.8758 |
| 800 | 0.1642 | 3654.3 | 4146.9 | 7.9885 |
| 850 | 0.1720 | 3750.3 | 4266.5 | 8.0973 |
| 900 | 0.1799 | 3847.9 | 4387.5 | 8.2028 |
| 950 | 0.1877 | 3947.0 | 4510.1 | 8.3051 |
| 1000 | 0.1955 | 4047.7 | 4634.1 | 8.4045 |
| 1050 | 0.2033 | 4149.9 | 4759.7 | 8.5012 |
| 1100 | 0.2111 | 4253.6 | 4886.7 | 8.5955 |
| 1150 | 0.2188 | 4358.7 | 5015.2 | 8.6874 |
| 1200 | 0.2266 | 4465.3 | 5145.0 | 8.7770 |
| 1250 | 0.2343 | 4573.3 | 5276.2 | 8.8646 |
| 1300 | 0.2421 | 4682.5 | 5408.8 | 8.9502 |

$P = 3.50$MPa (242.6)

| T(°C) | V(m³/kg) | U(kJ/kg) | H(kJ/kg) | S(kJ/kg-K) |
|---|---|---|---|---|
| 242.6 | 0.0571 | 2602.9 | 2802.6 | 6.1243 |
| 250 | 0.0588 | 2624.0 | 2829.7 | 6.1764 |
| 300 | 0.0685 | 2738.8 | 2978.4 | 6.4484 |
| 350 | 0.0768 | 2836.0 | 3104.8 | 6.6601 |
| 400 | 0.0846 | 2927.2 | 3223.2 | 6.8427 |
| 450 | 0.0920 | 3016.1 | 3338.0 | 7.0074 |
| 500 | 0.0992 | 3104.5 | 3451.6 | 7.1593 |
| 550 | 0.1063 | 3193.1 | 3565.0 | 7.3014 |
| 600 | 0.1133 | 3282.5 | 3678.9 | 7.4356 |
| 650 | 0.1202 | 3372.9 | 3793.5 | 7.5633 |
| 700 | 0.1270 | 3464.7 | 3909.3 | 7.6854 |
| 750 | 0.1338 | 3557.8 | 4026.3 | 7.8027 |
| 800 | 0.1406 | 3652.5 | 4144.6 | 7.9156 |
| 850 | 0.1474 | 3748.6 | 4264.4 | 8.0247 |
| 900 | 0.1541 | 3846.4 | 4385.7 | 8.1303 |
| 950 | 0.1608 | 3945.6 | 4508.4 | 8.2328 |
| 1000 | 0.1675 | 4046.4 | 4632.7 | 8.3324 |
| 1050 | 0.1742 | 4148.7 | 4758.4 | 8.4292 |
| 1100 | 0.1809 | 4252.5 | 4885.6 | 8.5235 |
| 1150 | 0.1875 | 4357.7 | 5014.1 | 8.6155 |
| 1200 | 0.1942 | 4464.4 | 5144.1 | 8.7053 |
| 1250 | 0.2009 | 4572.4 | 5275.4 | 8.7929 |
| 1300 | 0.2075 | 4681.7 | 5408.0 | 8.8785 |

$P = 4.00$MPa (250.4)

| T(°C) | V(m³/kg) | U(kJ/kg) | H(kJ/kg) | S(kJ/kg-K) |
|---|---|---|---|---|
| 250.4 | 0.0498 | 2601.7 | 2800.8 | 6.0696 |
| 300 | 0.0589 | 2726.2 | 2961.7 | 6.3639 |
| 350 | 0.0665 | 2827.4 | 3093.3 | 6.5843 |
| 400 | 0.0734 | 2920.7 | 3214.5 | 6.7714 |
| 450 | 0.0800 | 3011.0 | 3331.2 | 6.9386 |

$P = 4.50$MPa (257.4)

| T(°C) | V(m³/kg) | U(kJ/kg) | H(kJ/kg) | S(kJ/kg-K) |
|---|---|---|---|---|
| 257.4 | 0.0441 | 2599.7 | 2798.0 | 6.0197 |
| 300 | 0.0514 | 2713.0 | 2944.2 | 6.2854 |
| 350 | 0.0584 | 2818.6 | 3081.5 | 6.5153 |
| 400 | 0.0648 | 2914.2 | 3205.6 | 6.7070 |
| 450 | 0.0708 | 3005.8 | 3324.2 | 6.8770 |

$P = 5.00$MPa (263.9)

| T(°C) | V(m³/kg) | U(kJ/kg) | H(kJ/kg) | S(kJ/kg-K) |
|---|---|---|---|---|
| 263.9 | 0.0394 | 2597.0 | 2794.2 | 5.9737 |
| 300 | 0.0453 | 2699.0 | 2925.7 | 6.2110 |
| 350 | 0.0520 | 2809.5 | 3069.3 | 6.4516 |
| 400 | 0.0578 | 2907.5 | 3196.7 | 6.6483 |
| 450 | 0.0633 | 3000.6 | 3317.2 | 6.8210 |

| | | | | |
|---|---|---|---|---|
| 500 | 0.0864 | 3100.3 | 3446.0 | 7.0922 |
| 550 | 0.0927 | 3189.5 | 3560.3 | 7.2355 |
| 600 | 0.0989 | 3279.4 | 3674.9 | 7.3705 |
| 650 | 0.1049 | 3370.3 | 3790.1 | 7.4988 |
| 700 | 0.1110 | 3462.4 | 3906.3 | 7.6214 |
| 750 | 0.1170 | 3555.8 | 4023.6 | 7.7390 |
| 800 | 0.1229 | 3650.6 | 4142.3 | 7.8523 |
| 850 | 0.1289 | 3747.0 | 4262.4 | 7.9616 |
| 900 | 0.1348 | 3844.8 | 4383.9 | 8.0674 |
| 950 | 0.1406 | 3944.2 | 4506.8 | 8.1701 |
| 1000 | 0.1465 | 4045.1 | 4631.2 | 8.2697 |
| 1050 | 0.1524 | 4147.5 | 4757.1 | 8.3667 |
| 1100 | 0.1582 | 4251.4 | 4884.4 | 8.4611 |
| 1150 | 0.1641 | 4356.7 | 5013.1 | 8.5532 |
| 1200 | 0.1699 | 4463.5 | 5143.1 | 8.6430 |
| 1250 | 0.1757 | 4571.5 | 5274.5 | 8.7307 |
| 1300 | 0.1816 | 4680.9 | 5407.2 | 8.8164 |

| | | | | |
|---|---|---|---|---|
| 500 | 0.0765 | 3096.0 | 3440.4 | 7.0323 |
| 550 | 0.0821 | 3186.0 | 3555.6 | 7.1767 |
| 600 | 0.0877 | 3276.4 | 3670.9 | 7.3127 |
| 650 | 0.0931 | 3367.7 | 3786.6 | 7.4416 |
| 700 | 0.0985 | 3460.0 | 3903.3 | 7.5646 |
| 750 | 0.1038 | 3553.7 | 4021.0 | 7.6826 |
| 800 | 0.1092 | 3648.8 | 4140.0 | 7.7962 |
| 850 | 0.1145 | 3745.3 | 4260.3 | 7.9057 |
| 900 | 0.1197 | 3843.3 | 4382.1 | 8.0118 |
| 950 | 0.1250 | 3942.8 | 4505.2 | 8.1146 |
| 1000 | 0.1302 | 4043.9 | 4629.8 | 8.2144 |
| 1050 | 0.1354 | 4146.4 | 4755.8 | 8.3115 |
| 1100 | 0.1406 | 4250.4 | 4883.2 | 8.4060 |
| 1150 | 0.1458 | 4355.8 | 5012.0 | 8.4981 |
| 1200 | 0.1510 | 4462.5 | 5142.2 | 8.5880 |
| 1250 | 0.1562 | 4570.7 | 5273.7 | 8.6758 |
| 1300 | 0.1614 | 4680.1 | 5406.4 | 8.7615 |

| | | | | |
|---|---|---|---|---|
| 500 | 0.0686 | 3091.7 | 3434.7 | 6.9781 |
| 550 | 0.0737 | 3182.4 | 3550.9 | 7.1237 |
| 600 | 0.0787 | 3273.3 | 3666.8 | 7.2605 |
| 650 | 0.0836 | 3365.0 | 3783.2 | 7.3901 |
| 700 | 0.0885 | 3457.7 | 3900.3 | 7.5136 |
| 750 | 0.0934 | 3551.6 | 4018.4 | 7.6320 |
| 800 | 0.0982 | 3646.9 | 4137.7 | 7.7458 |
| 850 | 0.1029 | 3743.6 | 4258.3 | 7.8556 |
| 900 | 0.1077 | 3841.8 | 4380.2 | 7.9618 |
| 950 | 0.1124 | 3941.5 | 4503.6 | 8.0648 |
| 1000 | 0.1171 | 4042.6 | 4628.3 | 8.1648 |
| 1050 | 0.1219 | 4145.2 | 4754.5 | 8.2620 |
| 1100 | 0.1266 | 4249.3 | 4882.0 | 8.3566 |
| 1150 | 0.1312 | 4354.8 | 5011.0 | 8.4488 |
| 1200 | 0.1359 | 4461.6 | 5141.2 | 8.5388 |
| 1250 | 0.1406 | 4569.8 | 5272.8 | 8.6266 |
| 1300 | 0.1453 | 4679.3 | 5405.7 | 8.7124 |

$P$ = 6.00MPa (275.6)

| $T$(°C) | $V$(m$^3$/kg) | $U$(kJ/kg) | $H$(kJ/kg) | $S$(kJ/kg-K) |
|---|---|---|---|---|
| 275.6 | 0.0324 | 2589.9 | 2784.6 | 5.8901 |
| 300 | 0.0362 | 2668.4 | 2885.5 | 6.0703 |
| 350 | 0.0423 | 2790.4 | 3043.9 | 6.3357 |
| 400 | 0.0474 | 2893.7 | 3178.2 | 6.5432 |
| 450 | 0.0522 | 2989.9 | 3302.9 | 6.7219 |
| 500 | 0.0567 | 3083.1 | 3423.1 | 6.8826 |
| 550 | 0.0610 | 3175.2 | 3541.3 | 7.0307 |
| 600 | 0.0653 | 3267.2 | 3658.7 | 7.1693 |
| 650 | 0.0694 | 3359.6 | 3776.2 | 7.3001 |
| 700 | 0.0735 | 3453.0 | 3894.3 | 7.4246 |
| 750 | 0.0776 | 3547.5 | 4013.2 | 7.5438 |
| 800 | 0.0816 | 3643.2 | 4133.1 | 7.6582 |
| 850 | 0.0857 | 3740.3 | 4254.2 | 7.7685 |
| 900 | 0.0896 | 3838.8 | 4376.6 | 7.8751 |
| 950 | 0.0936 | 3938.7 | 4500.3 | 7.9784 |
| 1000 | 0.0976 | 4040.1 | 4625.4 | 8.0786 |
| 1050 | 0.1015 | 4142.9 | 4751.9 | 8.1760 |
| 1100 | 0.1054 | 4247.1 | 4879.7 | 8.2709 |
| 1150 | 0.1093 | 4352.8 | 5008.9 | 8.3632 |
| 1200 | 0.1133 | 4459.8 | 5139.3 | 8.4534 |
| 1250 | 0.1172 | 4568.1 | 5271.1 | 8.5413 |
| 1300 | 0.1211 | 4677.7 | 5404.1 | 8.6272 |

$P$ = 7.00MPa (285.8)

| $T$(°C) | $V$(m$^3$/kg) | $U$(kJ/kg) | $H$(kJ/kg) | $S$(kJ/kg-K) |
|---|---|---|---|---|
| 285.8 | 0.0274 | 2581.0 | 2772.6 | 5.8148 |
| 300 | 0.0295 | 2633.5 | 2839.9 | 5.9337 |
| 350 | 0.0353 | 2770.1 | 3016.9 | 6.2304 |
| 400 | 0.0400 | 2879.5 | 3159.2 | 6.4502 |
| 450 | 0.0442 | 2979.0 | 3288.3 | 6.6353 |
| 500 | 0.0482 | 3074.3 | 3411.4 | 6.8000 |
| 550 | 0.0520 | 3167.9 | 3531.6 | 6.9506 |
| 600 | 0.0557 | 3260.9 | 3650.6 | 7.0910 |
| 650 | 0.0593 | 3354.3 | 3769.3 | 7.2231 |
| 700 | 0.0629 | 3448.3 | 3888.2 | 7.3486 |
| 750 | 0.0664 | 3543.3 | 4007.9 | 7.4685 |
| 800 | 0.0699 | 3639.5 | 4128.4 | 7.5836 |
| 850 | 0.0733 | 3736.9 | 4250.1 | 7.6944 |
| 900 | 0.0768 | 3835.7 | 4373.0 | 7.8014 |
| 950 | 0.0802 | 3935.9 | 4497.1 | 7.9050 |
| 1000 | 0.0836 | 4037.5 | 4622.5 | 8.0055 |
| 1050 | 0.0870 | 4140.5 | 4749.3 | 8.1031 |
| 1100 | 0.0903 | 4245.0 | 4877.3 | 8.1981 |
| 1150 | 0.0937 | 4350.8 | 5006.7 | 8.2907 |
| 1200 | 0.0971 | 4457.9 | 5137.4 | 8.3810 |
| 1250 | 0.1004 | 4566.4 | 5269.4 | 8.4690 |
| 1300 | 0.1038 | 4676.1 | 5402.6 | 8.5551 |

$P$ = 8.00MPa (295.0)

| $T$(°C) | $V$(m$^3$/kg) | $U$(kJ/kg) | $H$(kJ/kg) | $S$(kJ/kg-K) |
|---|---|---|---|---|
| 295.0 | 0.0235 | 2570.5 | 2758.7 | 5.7450 |
| 300 | 0.0243 | 2592.3 | 2786.5 | 5.7937 |
| 350 | 0.0300 | 2748.3 | 2988.1 | 6.1321 |
| 400 | 0.0343 | 2864.6 | 3139.4 | 6.3658 |
| 450 | 0.0382 | 2967.8 | 3273.3 | 6.5579 |
| 500 | 0.0418 | 3065.4 | 3399.5 | 6.7266 |
| 550 | 0.0452 | 3160.5 | 3521.8 | 6.8799 |
| 600 | 0.0485 | 3254.7 | 3642.4 | 7.0221 |
| 650 | 0.0517 | 3348.9 | 3762.3 | 7.1556 |
| 700 | 0.0548 | 3443.6 | 3882.2 | 7.2821 |
| 750 | 0.0579 | 3539.1 | 4002.6 | 7.4028 |
| 800 | 0.0610 | 3635.7 | 4123.8 | 7.5184 |
| 850 | 0.0641 | 3733.5 | 4246.0 | 7.6297 |
| 900 | 0.0671 | 3832.6 | 4369.3 | 7.7371 |
| 950 | 0.0701 | 3933.1 | 4493.8 | 7.8411 |
| 1000 | 0.0731 | 4035.0 | 4619.6 | 7.9419 |
| 1050 | 0.0761 | 4138.2 | 4746.7 | 8.0397 |
| 1100 | 0.0790 | 4242.8 | 4875.0 | 8.1350 |
| 1150 | 0.0820 | 4348.8 | 5004.6 | 8.2277 |
| 1200 | 0.0849 | 4456.1 | 5135.5 | 8.3181 |
| 1250 | 0.0879 | 4564.6 | 5267.7 | 8.4063 |
| 1300 | 0.0908 | 4674.5 | 5401.0 | 8.4924 |