39.5 Water at $400psi$ and $700°F$ is in what thermodynamic state?

A. Liquid

B. Saturated Mixture

C. Saturated Vapor

D. Superheated Vapor

Use the Properties of Saturated Water and Steam table and Properties of Superheated Steam table to check where enthalpy values are given for the stated pressure and temperature.

Using the saturated water table by pressure and finding $400psi$, the corresponding temperature is lower than $700°F$.

Therefore, at the stated temperature and pressure, water will be a superheated vapor.

Answer D

39.6 Saturated liquid water at $50psia$ is cooled to $80°F$ at constant pressure. What is the change in enthalpy during cooling?

A. $50\frac{Btu}{lb_m}$

B. $200\frac{Btu}{lb_m}$

C. $660\frac{Btu}{lb_m}$

D. $920\frac{Btu}{lb_m}$

Use the Properties of Saturated Water and Steam table to find the temperature of saturated liquid water at $50psia$: $T_1 = 281°F$

Equate the change in enthalpy to the quantity of heat removed:

$$q = \frac{Q}{m} = \Delta h = c_p \Delta T$$

Substitute and solve using the the specific heat capacity of liquid water, $c_p = 1\frac{Btu}{lb_m^\circ F}$. Note the specific heat capacity of water is a function of temperature which remains nearly constant below about $400°F$, and above which it begins to increase and should no longer be taken as $1\frac{Btu}{lb_m^\circ F}$.

$$\Delta h = c_p \Delta T = \left(1\frac{Btu}{lb_m^\circ F}\right)(281°F - 80°F) = 201\frac{Btu}{lb_m}$$

Answer B

39.7 In a refrigeration cycle, R-134a leaves the evaporator at $20psia$ with $20°F$ of superheat. What is the entropy of the refrigerant entering the compressor?

A. $0.03\frac{Btu}{lb°F}$

B. $0.22\frac{Btu}{lb°F}$

C. $0.24\frac{Btu}{lb°F}$

D. $106\frac{Btu}{lb°F}$

In the Reference Handbook, search for Properties of Refrigerants and use the phrase: Pressure Versus Enthalpy. Find the chart for Refrigerant 134a.

Following a horizontal line at a pressure of $20psia$ to the rightmost edge of the saturation curve, corresponding to a saturated vapor condition. Continue horizontally to the right to account for the additional $20°F$ of superheat. Note that to the right of the saturation curve, lines of constant temperature are curved downward (nearly vertical). This is the compressor entering condition, typically noted as State 1 of the refrigeration cycle.

Once the state point has been identified, read off the entropy from the chart. Note that lines of constant entropy run roughly southwest/northeast on the diagram.

$$s \approx 0.235\frac{Btu}{lb°F}$$

Answer C

39.8 A chiller plant producing a low chilled water supply temperature of $40°F$ uses a glycol/water mixture of 30% glycol by volume. At $40°F$, glycol has a specific heat capacity of $0.56\frac{Btu}{lb_m°F}$ and a specific gravity of 1.15. What is the specific heat capacity of the mixture?

A. $0.86\frac{Btu}{lb_m°F}$

B. $0.87\frac{Btu}{lb_m°F}$

C. $0.88\frac{Btu}{lb_m°F}$

D. $0.89\frac{Btu}{lb_m°F}$

The glycol/water mixture is defined as being 30% glycol by volume, but the specific heat capacity of the mixture will be a function of the relative *mass* of glycol and water, not the volume.

Assume an arbitrary volume of $100ft^3$ of the mixture, comprised of $30ft^3$ of glycol and $70ft^3$ of water.

Find the mass of water:

$$m_{water} = \rho_{water}V_{water} = \left(62.4\frac{lb_m}{ft^3}\right)(70ft^3) = 4368lb_m$$

Find the mass of glycol, by first determining the density of glycol using the specific gravity.