39.4 What is the density of propane at $77°F$ and atmospheric pressure?

A. $0.003 \frac{lb}{ft^3}$

B. $0.02 \frac{lb}{ft^3}$

C. $0.1 \frac{lb}{ft^3}$

D. $60 \frac{lb}{ft^3}$

Treat propane as an Ideal Gas and use the ideal gas law:

$$PV = mRT$$

Divide both sides by volume, V:

$$P = \frac{mRT}{V}$$

Note density is mass per unit volume, $\rho = \frac{m}{V}$:

$$P = \rho RT$$

Rearrange for density:

$$\rho = \frac{P}{RT}$$

Lookup the specific gas constant for propane in the Properties of Ideal Gases table: $R_{propane} = 35.04 \frac{ft \cdot lb_f}{lb_m \cdot R°}$

Substitute and solve for density, being mindful of unit conversions. Make sure to use absolute temperature i.e. Rankine degrees.

$$\rho = \frac{P}{RT} = \frac{\left(14.7 \frac{lb_f}{in^2}\right)\left(\frac{144 in^2}{1 ft^2}\right)}{\left(35.04 \frac{ft \cdot lb_f}{lb_m \cdot R°}\right)(77 + 460R)} = 0.11 \frac{lb_m}{ft^3}$$

Answer C

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