HW – 8: Property Tables for Real Fluids

No need to follow the formal solution procedure for these problems.

i) Answer the following questions.

a) Can quality be expressed as the ratio of the volume occupied by the vapor phase to the total volume? Explain.

b) An ME 200 student is asked to determine the specific volume and internal energy of a compressed liquid at a given P and T. However, no compressed liquid tables exist for the substance. As a result, the student looks up the values for saturated liquid specific volume and internal energy at the given P using the saturation pressure table. Is this a good approximation in general? If not, then what would be a better approach?

c) Water is contained within tank at a temperature of 160°C and volume of 2 m^3. If there are equal volumes of liquid and vapor, then what is the quality?

ii) Complete the table below for R134a. Be sure to show work and indicate where the data came from.

State	T, °C	P, kPa	u, kJ/kg	Phase Description
1	20		95	
2	-12			Saturated Liquid
3		400	300	
4	8	800		

iii) Complete the table below for H_2O. Be sure to show work and indicate where the data came from.

State	T, °C	P, kPa	h, kJ/kg	χ	Phase Description
1		200		0.7	
2	140		1800		
3	80	500			
4		1000	3179.4		

HW – 9: 1st Law for Closed Systems with Real Fluid Properties

i) A mass of 200 g of saturated liquid water contained in a closed system is completely vaporized at a constant pressure of 100 kPa. Show the process on a P-v diagram including the saturation dome with beginning and end states labeled. Determine the volume change (m^3) and heat transfer (kJ). Be sure to follow the formal solution process that includes a sketch, identifying the system, listing all assumptions and basic equations, and showing all steps in the solution.

ii) An American homeowner buys a tank of propane for the outdoor gas grill at the local gas station and puts it on the deck outside his house. The tank can hold 5 gallons, but was charged with 4.3 gallons of liquid propane at 20°C after being evacuated. On a hot summer day, the tank starts out at 20°C at 6 am in the morning and heats up to 48°C by noon due to exposure to the sun. With this information:

a) determine the pressure at 6 am (kPa),
b) determine the pressure at noon (kPa),
c) determine the heat transfer to the propane between 6 am and noon (kJ),
d) show the process for the propane on a P-v diagram with appropriate lines of constant pressure (including the saturation dome).

Follow the formal solution procedure.

iii) A piston-cylinder apparatus contains 0.295 kg of water at a pressure of 0.04 bar that occupies a volume of 0.5 m^3. Initially, the piston is resting on a set of stops. Then, heat transfer occurs and the pressure increases to 1 bar at which point the piston begins to move. The heat transfer continues until the volume expands to 0.75 m^3.

a) Show the process on a P-v diagram (including the saturation dome).
b) Determine the final temperature (°C).
c) Determine the work performed by the water (kJ),
d) Determine the heat transfer to the water (kJ).

HW – 10: More 1st Law with Real Fluid Properties

i) A laboratory technician wishes to charge a small tank that is initially evacuated (zero pressure) with R134a from a larger tank in a room that is at 20°C. The large tank initially contains 125 lb of R134a at a temperature of 20°C and pressure of 6 bar. The small evacuated tank has a volume of 5 gallons and is also at 20°C. The two tanks are connected by a short hose and refrigerant flows from the larger tank to the smaller tank. The technician leaves the room and comes back awhile later and determines through a weight scale that the smaller tank now contains 28 lb of R134a and both tanks are at the initial temperature of 20°C. Based on this data, evaluate the heat transfer to the refrigerant (kJ) that occurred during this process. Provide a plausible explanation for why there was heat transfer. (Hint: choose the combination of the two tanks as the system and neglect the volume of the hose)

ii) A piston-cylinder compressor uses R134a as the working fluid. At the start of a compression process, the R134a is a superheated vapor with P_1 = 1.00 bar and T_1 = –5.0°C. At the end of the compression process P_2 = 7 bar. During the process, the relationship between pressure and specific volume of the R134a satisfies $Pv = \text{constant}$. Determine the heat transfer per unit mass associated with the R134a (kJ/kg). Show the process for the R134a on a P-v diagram (including the saturation dome).