ECHE 260: Intro to Chemical Systems

Homework #4 (50 points).

Conceptual Questions (5 points):

1. (5 points) You calculate the molar volume of a gas twice: (1) using the ideal gas law, you calculate $\widehat{V}_1$ and (2) using the Warburton-Wirth equation of state for non-ideal gasses, you calculate $\widehat{V}_2$. You find that $\widehat{V}_1 \gg \widehat{V}_2$. In your own words, describe what qualities of the gas may contribute to the difference between the two molar volumes. *Justify your answer and be specific.*

Quantitative Questions

2. (25 points) *Note: You do not need to use the FULL general procedure for this problem; however, you should include a fully labeled PFD, clearly outline your calculations with variables and indicate the source of any tabulated data BEFORE calculating anything.*

Consider the same acetylene torch example from class in which oxygen from a pressurized tank and acetylene from a separate pressurized tank are fed to the welding torch nozzle (mixing point). Each stream has a regulating (throttling) valve after the tank before the nozzle that can be used to regulate the flow of each gas. For the following questions, consider the oxygen tank and stream:

a. Initially, the valve in the oxygen line is closed. What is the temperature of the compressed oxygen in the tank if the tank pressure is 600 psi, it contains 24 kg of oxygen and the tank volume is 5.0 ft^3? Provide a numerical answer.

b. When the valve in the oxygen line is open, the oxygen is throttled to 2.0 bar. The temperature of the stream is 401 K and the volumetric flowrate reads 2.0 L/min. What is the molar flowrate of oxygen to nozzle? Provide a numerical answer.

3. (18 points) **Note: You DO need to use the FULL general procedure for this problem.**

In a continuous, steady-state process, hot and humid air at 80^{o}F is pumped through a partial condenser in which only some of the water vapor condenses to form a liquid stream. The water condensate exiting the condenser has a temperature of 50^{o}F and 2 bar. Dehumidified air leaves the condenser at 50^{o}F. The molar flowrate of humid air entering the condenser is 5 mol/hour. The molar flowrate of the condensate is 2 mol/hour.

Provide numerical answers for the questions a & b:

a. (5 points) What is the volumetric flowrate of the condensate? (L/hour)

b. (5 points) What is the volumetric flowrate of the dehumidified air? (L/hour)

c. (5 points) If the dehumidified air exited the condenser at 200 bar – what other information would you need to know to answer part b?

Reflection (2 points)

4. (2 points) We have now concluded units 1-4 which covered unit conversions, dimensional homogeneity and the general procedure for nonreactive single- and multi-unit processes with recycle and bypass AND equations of state for ideal and non-ideal gases.

a. Is there anything about the content that you still find confusing?
b. What (if anything) about the class is prohibiting your learning?
c. What (if anything) about the class is helping your learning?