Spring 2016 CHEE 2331 Practice Set 3

1. A stream enters a 7.50 cm ID pipe at a velocity of 60.0 m/s at 27°C and 1.80 bar (gauge). At a point downstream, the air flows through a 5.00 cm ID pipe at 60°C and 1.53 bar gauge. What is the velocity of gas at this point? Ans: 165 m/s
2. A NH_3 tank was first filled with liquid NH_3, but after use (in fertilizing) the liquid is gone and only vapor is left. The tank volume is 120 ft^3 and its temperature is 125°F. Your calculation indicates that the weight of NH_3 vapor left in the tank is 120 lb (prove this), while your colleague says there is 100 lb because they calculated the specific volume to be 1.20 ft^3/lb. Who is more accurate? Hint – compressibility factor. Ans: Obviously using Z, about a 20% difference…
3. The feed stream to a Claus plant consists of 20.0 mol% H_2S and 80.0% CO_2. 1/3 of the stream is sent to a furnace where the H_2S is burned with a stoichiometric amount of air fed at 1 atm and 25°C. The reaction is $H_2S + 3/2O_2 \rightarrow SO_2 + H_2O$. The product gas from this furnace are then mixed with the remaining 2/3 of the feed stream and sent to a reactor where the H_2S and SO_2 react to form S and H_2O. The gases leave the reactor at a rate of 10.0 m^3/min at 380°C and 205 kPa absolute. Assuming ideal gas behavior, determine the feed rate of air in kmol/min. Ans: 0.114 kmol/min
4. A 5.0 m^3 tank is charged with 75.0 kg of propane gas at 25°C. Use the SRK equation of state to estimate the pressure in the tank, then calculate the percentage error if you would have used the ideal gas law. Ans: 14.4%
5. Using A) the ideal gas law, B) the compressibility charts and C) the SRK equation of state, calculate the pressure that would occur if 5.00 g of CO_2 is put into a 50.0 mL cavity and heated to 1000K. Ans: 186, 190, 198 atm.
6. CO and H_2 react to form CH_3OH in your reactor. The feed ratio of reactants is 2:1 H_2:CO and you compress the gas to 34.5 MPa (abs). A single pass conversion of 25% is attained with the reactor running at 644K. You want to produce 54.5 kmol/h of methanol. Estimate the volumetric flow rate that the compressor must deliver. Ans: 120 m^3/h