The Saylor Foundation's

ME103 Assessment, Unit 2: Guide to Responding

Instructions: Please answer each of the following questions to the best of your ability.

Questions:

1. Estimate the pressure of one kmol of ethylene contained in a 0.6 m^3 volume and at temperature 200^0C using (a) ideal gas law and (b) van der Waal's equation, with a= 453.046 x 10^{-3} Pa$(m^3/mol)^2$ and b= 0.057 x 10^{-3} m^3/mol.

2. Determine the compressibility factor and molar volume for a gas at 500 K and 10 bar, which obeys the truncated viral equation: $PV/RT = 1 + B/V + C/V^2$, with B = - 2.2 x 10^{-4} m^3/ mol; C = - 1.7 x 10^{-8} m^6/mol^2. The critical temperature and pressure of the gas are 515 K and 81 bar.

3. Calculate the volume of one kilo mol of gas at 51.8 bar and 313 K using the van der Waal's equation. The van der Waals constants for the gas are a = 0.365 Nm^4/ mol^2 and b = 4.28 x 10^{-5} m^3/mol.

Solutions:

1. a) According to ideal gas law, PV = RT. Hence, P=RT/V=8.314x 10^3x 473/0.6= 6.5 MPa

b) Van der Waal's equation: P= RT/v-b – a/v^2. This gives P = 6.0 MPa

2. The compressibility factor is defined as $Z = PV/RT = 1 + B/V + C/V^2$. Thus, knowing V will allow us to calculate Z. To calculate Z, we will need to use an iterative procedure to solve

$$V = RT/P(1 + B/V + C/V^2)$$

We can use the ideal gas volume (V= RT/P) as the initial guess. After obtaining V, we solve for Z and obtain Z = 0.94.

3. The Van der Waals equation is $P = RT/ V- b – a/V^2$. We know T and P. To obtain V, use an iterative procedure to solve for V using the ideal gas volume as the initial guess. This will give $V = 0.38\ m^3$.