ECHE 363 – Thermodynamics of Chemical Systems
Homework #9

100 points total. Complete the following problems and upload your solutions to the Canvas assignment dropbox by the due date/time.

You are strongly encouraged to collaborate with your classmates on the homework, but each student is required to come up with a unique solution to the homework problems. For full credit, you must show all work. This includes showing all steps involving algebra and/or calculus. Your calculator can only be used for the final evaluation of numerical answers and may not be used for solving algebraic equations and/or integrals.

1. Determine the fugacity of pure methane at 220K and 77 bar assuming that methane obeys the Van der Waals equation of state.

2. You have a pure gas at 25 bar and 300 K. The compressibility factor (z) under these conditions is 0.9. As best as you can, calculate the fugacity and fugacity coefficient. *Hint:* you may want to assume the gas obeys an equation of state expressed as a perturbation from an ideal gas's compressibility factor.

3. Calculate the fugacity and the fugacity coefficient of steam at (a) 2 MPa and 400 °C, (b) 40 MPa and 400 °C.

4. Consider a ternary system of methane (a), ethane (b), and propane (c) at 25 °C and 15 bar. Assume this system can be represented by the virial equation truncated at the second term:

$$z = 1 + \frac{B_{mix}}{v_m}$$

You can assume that the mixture obeys the following mixing rule for B_{mix}:

$$B_{mix} = y_a^2 B_{aa} + 2y_a y_b B_{ab} + 2y_a y_c B_{ac} + y_b^2 B_{bb} + 2y_b y_c B_{bc} + y_c^2 B_{cc}$$

where $B_{aa} = -42$, $B_{ab} = -93$, $B_{ac} = -139$, $B_{bb} = -185$, $B_{bc} = -274$, $B_{cc} = -399$, all in cm^3/mol.

a) Develop an expression for the fugacity coefficient of methane in the mixture.

b) Estimate the fugacity and the fugacity coefficient of methane for a mixture with 20 mole % methane, 30 mole % ethane, and 50 mole % propane.

c) Repeat (a) and (b) using the Lewis Fugacity Rule.

5. Answer the following reflection questions (5 points):

    a. What about the way this class is taught is helping your learning?

    b. What about the way this class is taught is inhibiting your learning?