ChE 3316 Homework #5

Fall 2022 Due Date: Oct. 14 by 2pm

Submit your assignment as a single PDF file after double checking to ensure that each page is correctly oriented and is clearly legible. Failure to follow these instructions may result in point deductions.

1. Consider the VLE data provided (right).
   a. Prepare a plot of the activity coefficients for components 1 and 2 versus x_1.
   b. Prepare a plot of G^E/RT as a function of x_1.
   c. Are the deviations from ideality positive or negative?
   d. Does the Margules model or the van Laar model better describe (or fit) the data?
   e. Calculate the parameters for your choice in Part d.

x_1	x_2	P [mmHg]
0	0	120
0.1	0.739	415
0.2	0.849	649
0.3	0.892	828
0.4	0.915	959
0.5	0.929	1050
0.6	0.938	1109
0.7	0.944	1150
0.8	0.95	1176
0.9	0.962	1210
1	1	1250

2. Consider a binary system that is described by the two-constant Margules equation. At 55°C, the parameters are A_{12} = 1.25 and A_{21} = 0.85, and the saturation vapor pressures for components 1 and 2 are 1.12 and 0.31 atm, respectively.
   a. Calculate the bubble and dew point pressures of a z_1= 0.6 mixture at 55°C.
   b. This z_1 = 0.6 mixture is flashed in an isothermal drum at 55°C such that one of the product streams contains 80% (by mole) component 2. What is P_{drum}?

3. Consider a pressure-swing distillation process (that is separating components A and B. The process is fed with a 220 kmol/hr saturated liquid feed with z_A = 0.85. The target specifications for the two product streams are 99.2% (by mole) component A and 99% (by mole) component B, respectively. The low-pressure column is run at 2 atm, and the high-pressure column is run at 15 atm. This system forms a homogeneous azeotrope, and you may assume that the streams connecting the two columns have compositions that are equal to the azeotropic compositions:

   @ 2 atm: TAz = 70°C and 48% (by mole) component A

   @ 15 atm: TAz = 160°C and 74% (by mole) component A

   Component A is the more volatile component at compositions below the azeotropic composition.
   a. Draw a flowsheet for this process and label the column pressures as well as the compositions and flow rates of the two product streams and the two streams that connect the two columns.
   b. What (in terms of compositions and/or flow rates) changes if the high pressure azeotropic composition is 55% (by mole) component A as opposed to that given above?