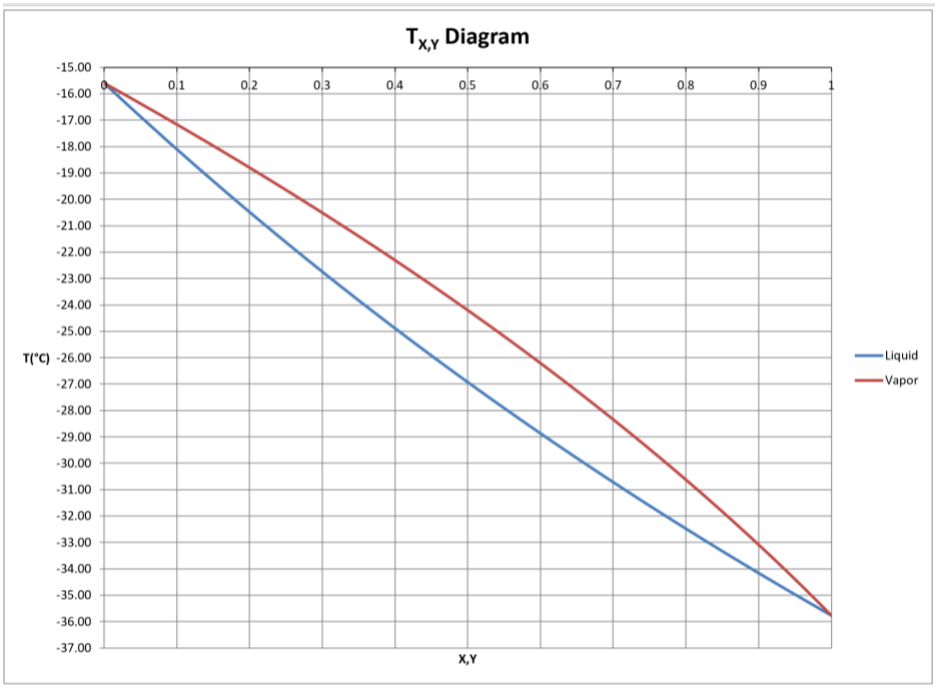
New Problems Chapter 26

26.1-4 ***X-Y diagram using Raoult's law and the Antoine Equation.*** Create an x-y diagram for ethylene and ethane at 12,000 torr using both the Antoine equation and Raoult's Law.

26.2-2 ***Single Stage contact of a Vapor- Liquid System.*** A vapor mixture of 100 mole containing 50% ethylene and 50% ethane is cooled at 12,000 mmHg to -25 °C. Using the $T_{x,y}$ diagram below calculate the composition and amount of the liquid and vapor phases using the level rule.



26.3-6 ***Relative Volatility of a Binary Mixture.*** Using the data below for an ethylene and ethane system, calculate the relative volatility for each concentration and plot α verses the liquid composition x_A.

T	P_1^* (ethylene)	P_2^* (ethane)
-38.83	11000.0	6095.8
-37.83	11320.2	6294.7
-36.83	11646.6	6498.3
-35.83	11979.4	6706.4
-34.83	12318.5	6919.3
-33.83	12664.0	7137.0
-32.83	13015.9	7359.4
-31.83	13374.4	7586.7
-30.83	13739.4	7818.9
-29.83	14111.0	8056.1
-28.83	14489.2	8298.3
-27.83	14874.0	8545.5
-26.83	15265.6	8797.9
-25.83	15664.0	9055.5
-24.83	16069.1	9318.2
-23.83	16481.1	9586.3
-22.83	16900.0	9859.6
-21.83	17325.7	10138.3
-20.83	17758.5	10422.5
-19.83	18198.2	10712.0
-18.85	18633.7	10999.7

26.4-10 ***Distillation Using McCabe–Thiele Method.*** A column is fed 100 kg mol/h of a mixture of 50 mol % ethylene and 50 mol % ethane at 12,000 torr pressure with an α = 1.75. The feed is liquid at the boiling point. The distillate is to contain 95 mol % ethylene and the bottoms 10 mol % ethylene. Using a reflux ratio of 1.5*R_{min}. Calculate the kg mol/h distillate, kg mol/h bottoms, and the number of theoretical trays needed using the McCabe–Thiele method.

26.5-3. ***Murphree Efficiency and Actual Number of Trays.*** For the distillation of ethylene and ethane Problem 26.4-10, the Murphree tray efficiency is estimated as 0.85. Determine the actual number of trays needed by stepping off the trays using the tray efficiency of 0.85. Also, calculate the overall tray efficiency E_O.

26.6-2. ***Estimation of Tower Diameter of Sieve Tray.*** For the distillation of ethylene and ethane Problem 26.4-10. The vapor flow rate at the tower bottom is 7869 kg/hr and the liquid flow rate is 9447 kg/hr. The density of the liquid $\rho_L = 438\ \text{kg/m}^3$ and $\rho_V = 29\ \text{kg/m}^3$. Assume a tray spacing of 24 in. (0.610 m). Calculate the tower diameter assuming the tower operates at 80% of flooding. Assume $\sigma = 5.4$ dyn/cm.

26.7-6 ***Distillation Using A Process Simulator for energy balances*.** A column is fed 100 kg mol/h of a mixture of 50 mol % ethylene and 50 mol % ethane at 12,000 torr pressure. The feed is 50% vaporized. The distillate is to contain 95 mol % ethylene and the bottoms 10 mol % ethylene. Calculate the following using SRK as your thermodynamic model. Use both the Shortcut (A-F) and SCDS (G+H) columns in Chemcad or equivalent models in other simulators.

(a) The molar composition of the D_____ and B_____
(b) The minimum reflux ratio R_{min}_____
(c) The minimum number of stages N_{min}_____
(d) With the optimum reflux ($R_{opt} = 1.5R_{min}$) _____ calculate the actual number of stages N_____ and the feed stage _____
(e) Q_R _____
(f) Q_C _____
(g) Plot the heat curves
(h) Column diameter

26.8-8. **Shortcut Design of Multicomponent Distillation Tower using a Process Simulator.** A feed of part liquid and part vapor $(q = 0.45)$ at 120 psia is fed at the rate of 1000 kmol/h to a distillation tower. The overall composition of the feed is propane ($x_A = 0.05$), *i*-butane ($x_B = 0.17$), *n*-butane ($x_C = 0.23$) *n*-pentane ($x_D = 0.37$), *i*- pentane ($x_E = 0.18$). The feed is distilled so that the heavy key is *n*-butane at 0.94 and the light key is *i*- pentane at 0.1. Calculate the following using Chemcad and the shortcut column with FUG method. Amount and composition of products and top and bottom tower temperatures. Minimum reflux ratio, number of stages at $1.2R_m$, feed-tray location and Q_R plus Qc.