CE407 **Exam 02** **July 25, 2019**

1. **(45 points)** A 300 kg/hr feed stream with composition 42 mass % solute (C) and 58 mass % water (diluent A) is to be contacted with solvent (B) in a countercurrent liquid extraction battery. Entering solvent is pure. The exiting raffinate should contain 16 mass % solute (C) on a solvent free basis. What is the minimum solvent flow rate required to achieve the desired composition of the exiting raffinate (corresponding to an infinite number of stages). A phase diagram is provided.

   Be sure to label points Δ_{min}, V_{N+1}, $V_{1\ min}$, L_N', L_N, and L_0

2. **(45 points)** Feed to a leaching process consists of 1 kg/min $CaCO_3$ (insoluble matrix) which carries in its pores 0.4 kg/min NaOH (solute) and 0.6 kg/min H_2O (solvent). The entering solvent stream is 3 kg/min of pure H_2O. Retention of solution by the $CaCO_3$ is given by the following table. Leaching is carried out with a mixer-settler equivalent to a single equilibrium stage.
   a. **Calculate the NaOH mass fraction of the strong solution (exiting solvent stream with leached NaOH).**
   b. **What is the percent recovery of the NaOH?**

NaOH, wt %	0	5	10	15	20
kg solution/kg $CaCO_3$	1.5	1.75	2.20	2.70	3.60

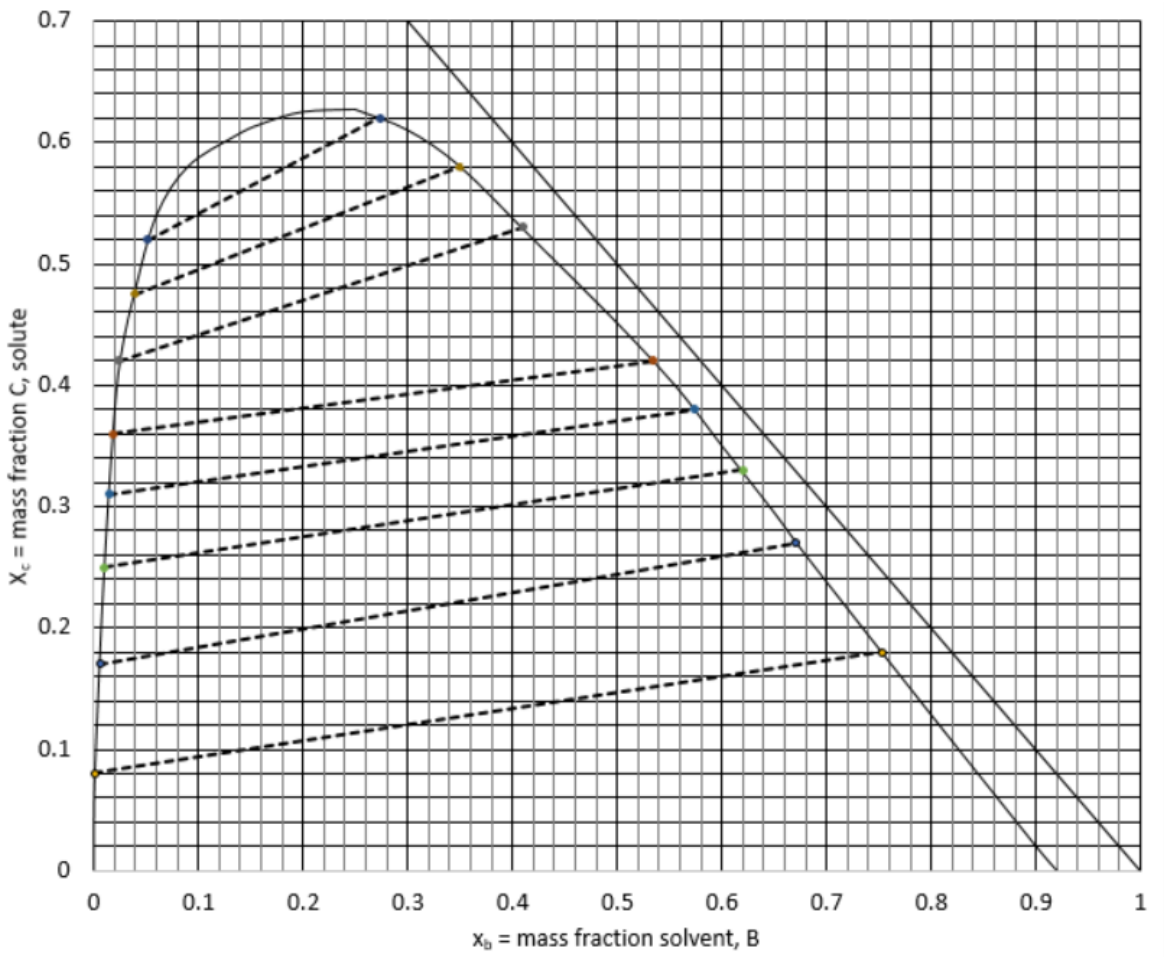
3. **(10 points)** The following mixture will be separated via a train of fractionating columns:

Component	Mole Fraction	Boiling Point (C)
A	0.20	120
B	0.20	125
C	0.20	130
D	0.20	140
E	0.20	190

If the first column is designed with component **B** as the light key and component **E** as the heavy key, where do the various components exit the first column? **Complete the following table describing what fraction of the distillate and bottoms are composed of each component:**

Component	Presence in Distillate	Presence in Bottoms
A		
B		
C		
D		
E		

Label Product mole fraction as: large / small / negligible relative to the feed mole fraction. Negligible means that component is almost undetectable.



Phase Diagram for Problem 1

Tie lines

(0.001, 0.08) and (0.753, 0.18)
(0.006, 0.17) and (0.67, 0.27)
(0.01, 0.25) and (0.62, 0.33)
(0.015, 0.31) and (0.573, 0.38)
(0.019, 0.36) and (0.535, 0.42)
(0.024, 0.42) and (0.41, 0.53)
(0.04, 0.475) and (0.35, 0.58)
(0.052, 0.52) and (0.273, 0.62)