CL 301 Mass Transfer (Total marks 40, total time 90 minutes (11:30 am to 1 pm strictly)

Mid-Sem Exam

1. Draw the triangle diagram for a system for which one of the three liquids is not completely miscible with either of the other two. Show and point raffinate line (for 1 mark), extract line (for 1 mark), and any two tie lines (for 1 mark). Identify the corners of solute (1 mark) and solvent (1 mark). Please note that diagram without identifying the solute and solvent corners will not carry any credit. It is not a drawing exam and hence no beautification is needed. You do not need to show the fraction lines such as 0.1A, 0.2A etc. (Total 5 marks, 5 min)

2. A countercurrent extraction plant is used to extract acetone (C) from its mixture with water by means of MIK (B) (equilibrium diagram was given yesterday. It is also given in the attached sheet). The feed consists of 40% acetone and 60% water (A). The goal is to reduce acetone to 1% as solvent free basis in the final raffinate. Pure solvent equal in mass to the feed is used as the extracting liquid.
   a. Draw the equilibrium x-y diagram. Show the data points.
   b. Using the triangular diagram, find the composition of R_{NP} and E_1.
   c. Draw the operating line on x-y diagram. You may consider it to be a straight line.
   d. How many ideal stages are required to perform this operation?
   e. What will be the extract composition for the same amount of feed to be processed in a single stage extractor to obtain the same raffinate composition?
   f. Find the selectivity for multistage and single stage operation as mentioned above.

   (3+4+1+1+3+3 = 15 marks, 40 min)

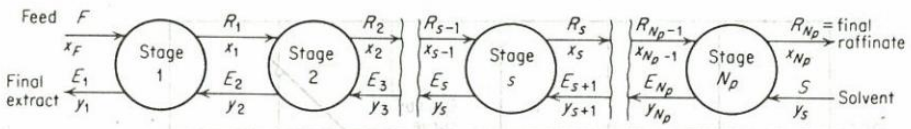


Figure 10.18 Countercurrent multistage extraction.

3. Determine the number of transfer units for the extraction of acetic acid from water using isopropyl ether. Feed flow rate: 8000 kg/hr, solvent flow rate 25000 kg/hr. Feed composition: 30% acid to be reduced to 2% in the raffinate. Consider, raffinate and extract mass flow rate is not changing along the column. Equilibrium values are given in the attached sheet.
   Use $N_{tOR} = \int_{x1}^{x2} \frac{dx}{x-x^*} + \frac{1}{2}\ln\frac{1-x_2}{1-x_1}$

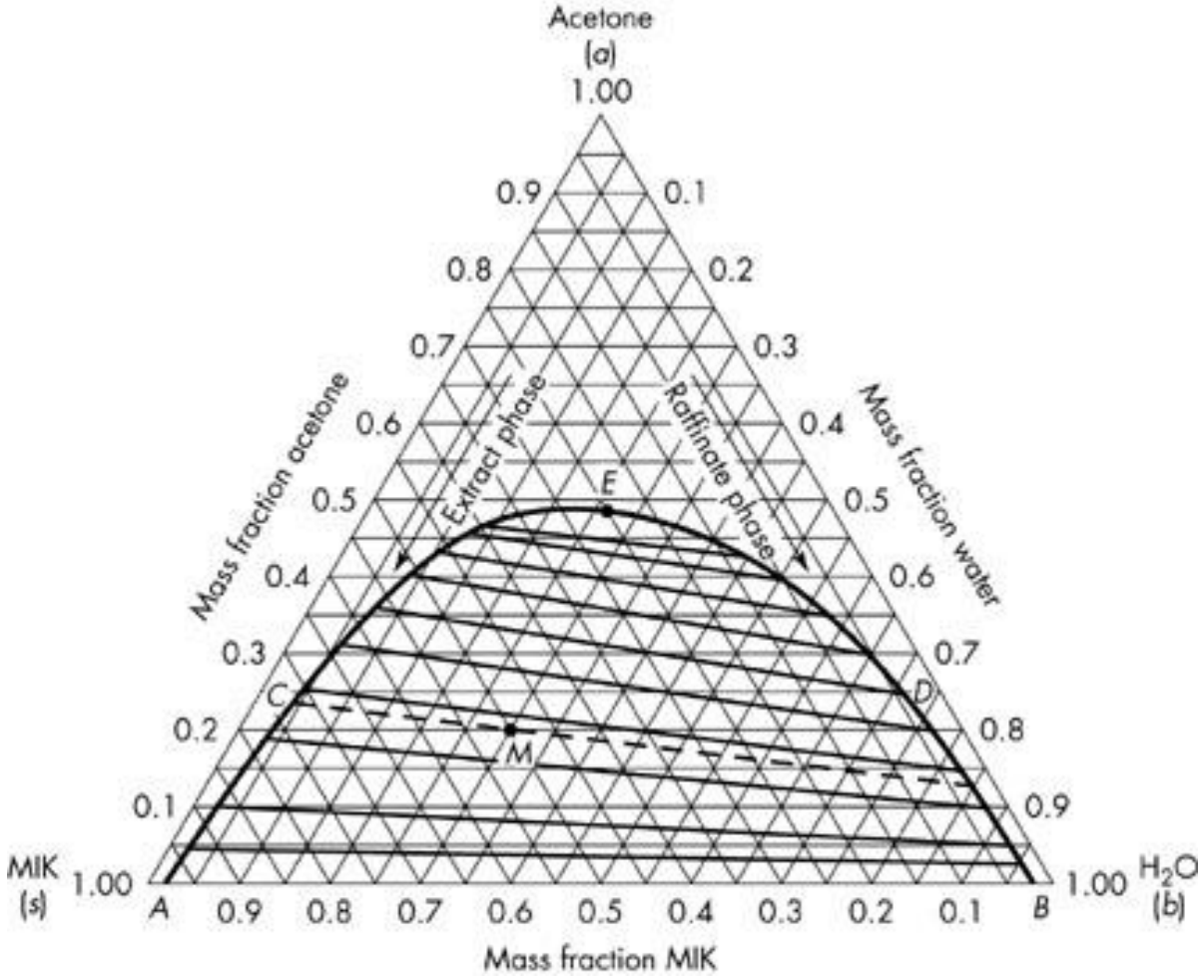
   (15 marks, 30 min)

4. a). What is adsorbate and what is adsorbent?
   b) Give two examples of use of the adsorption process.
   c) I found an adsorption isotherm for methane on carbon by doing a lab experiment. Can the same isotherm be used for an industrial methane-carbon adsorption process? Justify your answer. (1+1+3 = 5 marks, 5 min)

*The time mentioned is indicative. You may need more or less time.

*You should stop writing at 1 pm. The next 30 min are for taking photos and uploading the answer.

*Check the next page for equilibrium data.



Water layer			Isopropyl ether layer		
Wt % acetic acid, $100x$	Water	Isopropyl ether	Acetic acid, $100y^*$	Water	Isopropyl ether
0.69	98.1	1.2	0.18	0.5	99.3
1.41	97.1	1.5	0.37	0.7	98.9
2.89	95.5	1.6	0.79	0.8	98.4
6.42	91.7	1.9	1.93	1.0	97.1
13.30	84.4	2.3	4.82	1.9	93.3
25.50	71.1	3.4	11.40	3.9	84.7
36.70	58.9	4.4	21.60	6.9	71.5
44.30	45.1	10.6	31.10	10.8	58.1
46.40	37.1	16.5	36.20	15.1	48.7