DEPARTMENT OF CHEMICAL ENGINEERING, MNNIT ALLAHABAD

End Semester Examination

B. Tech. V Semester Examination, 2018-19

Mass Transfer-II (CL- 1502)

Time: 3.00 h Total Marks: 60

Note:

1. *Attempt all questions.*
2. *Make suitable assumptions wherever necessary.*
3. *Figures to the right indicate full marks.*

Q.1 (a) Attempt any two of the following: [2x2 = 4]

(i) Show that the relative volatility of an ideal binary mixture is equal to the ratio of vapour pressure of components.

(ii) What are the advantages of valve plate over sieve plate in tray column?

(iii) Differentiate between Packed Towers and Tray Towers.

(b) Explain briefly the triangular diagram for the system of three liquids with one pair partially soluble with suitable example. [4]

(c) Derive the mixture rule. [4]

Q.2 (a) Show that the minimum reflux ratio required to distil a binary mixture of constant relative volatility at its bubble point in a continuous fractionating column is given by: [5]

$$R_m = \frac{1}{(\alpha-1)}\left[\frac{x_D}{x_F} - \frac{\alpha(1-x_D)}{(1-x_F)}\right]$$

Where α = Relative volatility

x_F, x_D = mole fractions of more volatile component in feed and distillate, respectively.

(b) A mixture of 35 mole % A and 65 mole % B is to be separated in a fractionating column. The concentration of A in the distillate is 93 mole % and 96 % of all product A in the distillate. The feed is half vapour and the reflux ratio is to be 4.0. The relative volatility of A to B is 2.0. Calculate the number of theoretical plates in the column and locate the feed plate.

Data given: values of x (mole fraction) in equilibrium with y (mole fraction) on equilibrium curve as: 0, 0.10, 0.20, 0.40, 0.50, 0.70, 0.90, 1.0 [7]

Q.3 (a) A solution of nicotine in water containing 1% nicotine is to be extracted with kerosene at 293 K. Water and kerosene are essentially immiscible with each other. Assume equilibrium relationship as: $Y = 0.9\,X$ [5]

Y = kg of nicotine/kg kerosene and X = kg of nicotine/kg water

(i) Determine the percentage extraction of nicotine if 100 kg of feed solution is extracted with 150 kg of solvent.

(ii) Repeat for three theoretical stages using 50 kg solvent in each stage. Determine the amount of nicotine removed after each stage.

P.T.

(b) 100 kg/h of a nicotine-water solution containing 0.01 weight fraction nicotine is extracted with 150 kg/h of kerosene containing 0.0006 weight fraction nicotine in multistage countercurrent extraction. The nicotine content of exit water stream is 0.0010 weight fraction. Determine the number of theoretical stages required for this separation. Water and Kerosene are essentially immiscible solvents. The equilibrium data for above system is: [7]

X= kg nicotine/ kg water	0	0.001011	0.00246	0.00502	0.00750	0.00998	0.02040
Y= kg nicotine/ kg kerosene	0	0.00807	0.00196	0.00456	0.00686	0.00913	0.01870

Q.4 (a) Discuss the various techniques for achieving super saturation with suitable example. [3]

(b) Describe the construction and working of Oslo krystal evaporative crystallizer OR Swenson Walker crystallizer with the help of a neat sketch. [4]

(c) A crystallizer is charged with 100 kg of a solution containing 25% $Ba(NO3)_2$ in water. On cooling 10% of the original water present evaporates. Calculate the yield of crystals when the solution is cooled to 283 K. The solubility at 283 K is 7 kg $Ba(NO3)_2$ /100 kg total water. [5]

Atomic weight: Ba = 137

Q.5 (a) Outline the industrial applications of leaching. [1]

(b) Classify the equipments used for leaching. Explain the working of any one of the following:

(i) Rotocel Extractor (ii) Dorr Agitator and Thickener [4]

(c) Seeds containing 20% by weight oil are to be extracted in a counter current plant and 90% of the oil is recovered in a solution containing 50% by weight oil. If the seeds are contacted with fresh solvent and 1 kg of solution is removed in the underflow in association with every 2 kg of insoluble matter (no adsorption of solute), determine the theoretical stages required. [7]

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