Thapar Institute of Engineering and Technology
Department of Chemical Engineering
End Semester Examination (December 4, 2006)
CH-013: Mass Transfer – II

Time	Attempt All questions	Max Marks
3 Hr.	Assume missing information, if any, with justification	36

1. Draw the enthalpy concentration diagram of a binary mixture of components A and B (A is more volatile), and hence find the heat required to bring one mole of a mixture containing 0.25 mole fraction A from 90°C to its bubble point. Specific heat capacity of both A and B are 35 kJ/kmole, and latent heat of vaporization of A and B are 100 and 200 kJ/kmole, respectively. The vapor-liquid equilibrium data is given below. (Assume solution to be ideal, and reference temperature at 50°C). (9)

T (°C)	100	98	95	93	90
x (mole fraction)	0	0.15	0.42	0.65	1.0
y (mole fraction)	0	0.37	0.70	0.85	1.0

2. A binary mixture of components A and B having mole fraction 0.4, has to be continuously distilled to produce distillate and residue with 95-mole% purity. The feed is 30% vaporized while entering the column. Find the minimum reflux ratio for the distillation operation and the number of stages if reflux ratio is 1.5 times that of minimum value. Equilibrium mole fraction of component A is given below.

x	0.02	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
y	0.1	0.4	0.56	0.66	0.74	0.8	0.85	0.89	0.93	0.96

(9)

3. (a) Starting from material balance equation, derive a correlation to estimate height of packing for a binary distillation column. (5)
   (b) In a packed column Raschig ring is used as packing material. The specific surface aria, *a*, for this packing material is 328 m^2/m^3. It was observed that the concentrations of more volatile component at the two ends of a 15.0m high packed bed are 0.95 and 0.45 mole fractions. If the difference in the interface concentration and the bulk concentration (y_i-y) is constant throughout the bed, find the number of transfer units (N_{tG}) and height of transfer unit (H_{tG}) of the packed bed. The value of (y_i-y) is 0.08. Also, estimate the mass transfer coefficient (mole/m^2.sec). (4)

4. (a) What is Plait point? (1)
   (b) What factors would you consider while selecting a solvent for liquid-liquid extraction process? (3)
   (c) Following are the equilibrium data (on mass basis) of the ternary system water(A)–acetone(C)–chlorobenzene(B).

Raffinate	Water	99.89	89.79	79.69	69.42	58.64	46.28	27.41	25.66
	Acetone	0	10	20	30	40	50	60	60.58
	Chlorobenzene	0.11	0.21	0.31	0.58	1.36	3.72	12.59	13.76
Extract	Water	0.18	0.49	0.79	1.72	3.05	7.24	22.85	25.66
	Acetone	0	10.79	22.23	37.48	49.44	59.19	61.07	60.58
	Chlorobenzene	99.82	88.72	76.98	60.80	47.51	33.57	16.08	13.76

Calculate the selectivity of chlorobenzene for acetone at each tie-line. (5)