Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- Vth SEMESTER–EXAMINATION – MAY/JUNE - 2012

Subject code: 150501 **Date: 01/06/2012**

Subject Name: Mass Transfer Operations -I

Time: 02:30 pm – 05:00 pm **Total Marks: 70**

Instructions:

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

Q.1 A slurry consisting of insoluble particles of $CaCO_3$ in 10% NaOH solution, having solids concentration of 0.125 kg $CaCO_3$ / kg solution. The slurry is allowed to settle and the clear NaOH solution is withdrawn and replaced by an equal weight of water. The mixture is vigorously agitated. After repetition of this procedure (a total of two fresh water washes), what fraction of the original NaOH in the slurry remains unrecovered and therefore lost in the sludge? **14**

The equilibrium data are as follows:

x = wt. fraction NaOH in clear solution	N = kg $CaCO_3$ / kg solution in settled sludge	y* = wt. fraction NaOH in solution of the settled sludge
0.0900	0.495	0.0917
0.0700	0.525	0.0762
0.0473	0.568	0.0608
0.0330	0.600	0.0452
0.0208	0.620	0.0295
0.01187	0.650	0.0204
0.00710	0.659	0.01435
0.00450	0.666	0.01015

Q.2 **(a)** Discuss classification of mass transfer operations in detail. **07**

(b) Explain Penetration theory for mass transfer co-efficient. **07**

OR

(b) Oxygen (A) is diffusing through carbon monoxide (B) under steady state condition with carbon monoxide non-diffusing. The total pressure is $1*10^5$ N/m^2 and temperature is 0°C. The partial pressure of oxygen at two planes 3.0 mm apart is respectively 12500 and 7000 N/m^2. The diffusivity for the mixture is $1.87*10^{-5}$ m^2/s. Calculate the rate of diffusion of oxygen in kmol/s through each square meter of the two planes. **07**

Q.3 A coal gas is to be freed of its light oil by scrubbing with wash oil as an absorbent and the light oil recovered by stripping the resulting solution with steam. The circumstances are as follows: **14**

Absorber: Gas in, 0.250 m^3/s at 26°C, p_t = $1.07*10^5$ N/m^2, containing 2.0% by volume of light oil vapors. The light oil will be assumed to be entirely benzene, and a 95% removal is required. The wash oil is to enter at 26°C, containing 0.005 mole fraction benzene and has an average molecular weight 260. An oil circulation rate of 1.5 times the minimum is to be used. Wash oil-benzene solutions are ideal. The temperature will be constant at 26°C.

At 26°C, the vapor pressure of benzene is p = 13330 N/m^2.

Compute the oil circulation rate.

OR

Q.3 **(a)** Name the equipments used in leaching. Discuss any one in detail. **07**

(b) What is leaching? What are the industrial applications of leaching? Discuss the different types of equilibrium diagram for leaching. **07**

Q.4 **(a)** Discuss the criteria for choice of solvent for liquid-liquid extraction. **07**

(b) Explain with a neat sketch the material balance for multi-stage liquid-liquid extraction. **07**

OR

Q.4 **(a)** The equilibrium tie-line data for the system water (A) – chlorobenzene (B) – pyridine (C) at 25°C are given in weight %. **07**

Plot the equilibrium data on the following co-ordinate system:

(i) x and y against weight fraction B

(ii) x against y

Chlorobenzene layer			Water layer		
Pyridine	Chlorobenzene	Water	Pyridine	Chlorobenzene	Water
0	99.95	0.05	0	0.08	99.92
11.05	88.28	0.67	5.02	0.16	94.82
18.95	79.9	1.15	11.05	0.24	88.71
24.1	74.28	1.62	18.9	0.38	80.72
28.6	69.15	2.25	25.5	0.58	73.92
31.55	65.58	2.87	36.1	1.85	62.05
35.05	61	3.95	44.95	4.18	50.87
40.60	53	6.4	53.2	8.9	37.90
49.0	37.8	13.2	49	37.8	13.2

(b) Explain minimum gas-liquid ratio for absorbers. **07**

Q.5 **(a)** Explain the following terms with respect to tray towers: **07**

(i) Flooding

(ii) Priming

(iii) Coning

(iv) Weeping

(v) Dumping

(vi) Tray Spacing

(vii) Theoretical Tray

(b) Differentiate between Packed Tower and Tray Tower. **07**

OR

Q.5 **(a)** Explain construction and working Swenson-Walker Crystallizer with the help of a neat sketch. **07**

(b) Explain mass, heat and momentum transfer analogies. **07**

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