BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
First Semester 2016-2017
CHE F313 Separation Processes – II
Mid-Semester Test

Date: 04.10.2016 **Maximum Marks: 90**

***Note*:** The question paper consists of two parts: Part A (Closed-Book) and Part B (Open Book). Part B question paper can be collected only after submission of Part A answer sheet.

PART – A

Time: 11:00 – 11:30 A.M. **(Closed-Book)** **Marks: 40**

1. Give precise answers to the following questions.

a. Define humid volume and derive its expression.
b. Define the number of transfer units in a dryer? In case of air-water system and high liquid content in solid during drying, derive the expression for number of transfer unit. What is its range for an economic operation?
c. Draw and explain the drying curve for non-porous solids with proper justification.
d. What are the parameters kept constants during the scale up of an adsorber from laboratory scale to large scale? Justify.
e. Describe the mechanism for the transport of gases through dense polymer membranes. How will you achieve the high membrane selectivity?

[5x3 = 15 Marks]

2. (a) Derive the expression for total drying time.
(b) Consider a drying operation for solid loading (dry basis) of 50 kg/m^2 with a constant drying rate of 5 kg/m^2 h. The falling rate of drying is linear with moisture content. Calculate the drying time (in hrs.) required to reduce an initial moisture content of 25% (wet basis) to a final moisture content of 2% (wet basis). The critical moisture and equilibrium moisture contents on dry basis are 0.1 and 0.005 respectively.

[10+5 = 15 Marks]

3. Dialysis is being considered to recover a product A with molecular weight 150 from a dilute aqueous stream. Predict the initial flux of A (in g/cm^2.s) if the membrane has a porosity of 45%, a mean pore size of 0.05μm, molecular size 7.81Å and a thickness of 30μm. The concentration of A in feed solution is 0.01g/cm^3. Neglect boundary layer resistances and assume pure water on the product side. Given diffusivity, D_A = 6.93x10^{-6} cm^2/s; τ =2.0; factor F = 0.94.

[10 Marks]

~

Time: 11.30 – 12.30 P.M.	**PART – B (OPEN BOOK)**	**Marks: 50**

Note: 1. Answer in separate answer book.
2. Only Text Book and Hand-written Class-Notes are allowed.
3. Photocopy (Xerox) of Class-Notes is not allowed.

1. A continuous counter-current dryer is used to dry 425.6 kg dry solid/h containing 0.035 kg total moisture/kg dry solid to a value of 0.0017 kg total moisture/kg dry solid. The granular solid enters at 25^{o}C and leaves at 60^{o}C. The heating medium is air which enters at 84.2^{o}C, has a humidity of 0.0175 kg H_2O/kg dry air and leaves at 32.8^{o}C. Calculate the air flow rate and the outlet humidity, assuming the heat losses from the dryer to be 9300 kJ/h. The constant heat capacity of dry solid is 1.465 kJ/kg K. The value of latent heat of water at 0^{o}C is 2501 kJ/kg. The specific heat of dry air and water vapor are 1.00 and 2.01 kJ/kg K respectively. [25 Marks]

2. Using molecular sieves, moisture was removed from N_2 gas in a packed bed at 301 K. The column height was 26.8 cm, with the bulk density of the solid being equal to 712.8 kg/m^3. The initial water concentration of the solid was 0.01 kg/kg of dry solid and the mass velocity of nitrogen gas was 4052 kg/m^2.h. The initial moisture concentration of the gas was $c_0 = 926 \times 10^{-6}$ kg per kg of dry gas. The breakthrough data are as follows:

Time (h)	0	9	9.2	9.6	10	10.4	10.8	11.25	11.5	12	12.5	12.8
Concentration (c), $\frac{\text{kg } H_2O(v)}{\text{kg } N_2} \times 10^6$	<0.6	0.6	2.6	21	91	235	418	630	717	855	906	926

A value of $c/c_0 = 0.02$ is desired at the break point. Find the break point, the fraction of total capacity used up to the break point, the length of unused bed and the saturation loading capacity of the solid. For a proposed column length of 40 cm, calculate the break point time and the fraction of total capacity used.

[25 Marks]

~