BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
First Semester 2015-2016
CHE F313 Separation Processes – II
Comprehensive Examination

Date: 01.12.2015 **Maximum Marks: 120**

***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: 08.00 –10.00 A.M. **(Closed-Book)** **Marks: 70**

1. (a) Define sphericity and derive the expression for sphericity for non-spherical particle. [2]

(b) For the given analysis, find out the specific surface area and number of particles in the mixture. Volume shape factor a = 2, density of particle ρ_p = 2.65 g/cc and sphericity Φ_s = 0.571.

Mesh	Average diameter of particle (cm)	Mass of particles (g)
- 10 + 14	0.1410	21
- 14 + 20	0.1001	30
Pan		20

[5]

(c) Differentiate between cake filters and clarifying filters. [2]

(d) What are the requirements that the filter medium (septum) must meet? [5]

(e) What is the function of precoating? Is it a part of filter medium of cake? [2]

(f) Differentiate between differential analysis and cumulative analysis? Which analysis is more precise and why? [5]

(g) What is the clear opening in 3 Mesh screen having wire diameter 0.07 in.? [2]

(h) What are the different ways in which the average particle size is defined? Write their expressions. In which case all of these may be same? [5]

(i) In a crystallization process how can you know that whether heat will be added to the system or evolved from the system? [2]

(j) What is supersaturation? Outline the methods for generation of supersaturation. [5]

(k) What is nucleation? Describe the mechanism of homogeneous nucleation. [5]

2. Oxalic acid is to be crystallized from a saturated aqueous solution (solubility = 85 g/100 g water) by cooling from 100^{o}C. What will be the final solubility of anhydrous oxalic acid in g per 100 g water if 90% of the acid is crystallized as the dehydrate ($C_2O_4H_2.2H_2O$)? [10]

3. Slurry of $CaCO_3$ in water is to be filtered in a press having a total area of 8 m^2 and operated at a constant pressure drop of 2 atm. The frames are 36 mm thick. The experimental result is tabulated below. Given, concentration of slurry = 175 kg/m^3 density of cake =1170 kg/m^3, Viscosity of filtrate = 0.98 cP.

Filtrate (L)	2.27	4.54	6.81	9.08	11.35	13.62	15.89
Time, s	26	98	211	361	555	788	1083

(a) Obtain the specific cake resistance and filter medium resistance in appropriate units.

(b) Calculate the filtration time required and the volume of filtrate obtained in one cycle.

[20]

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Time: 10.00 – 11.00 A.M. **PART – B** **Marks: 50**

(OPEN BOOK)

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.

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1. Activated carbon impregnated with sulphur is used to remove mercury vapor from natural gas and air. The adsorption is irreversible and the capacity is as high as 30%. (a) Assuming that the adsorption rate for removal of mercury from air is controlled by external mass transfer, calculate the overall coefficient for a bed of 4x6 –mesh carbon at 25^{o}C and a superficial velocity of 80 cm/s. (b) It the inlet concentration is 10 microgram/Nm^3 and the treated gas must contain less than 0.001 microgram/Nm^3, what is the minimum bed length? (c) For a bed of 50 cm deep, what is the predicted time to breakthrough? [20]

2. 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. [20]

3. A rotary vacuum drum filter having a 33% submergence of the drum in the slurry is to be used to filter a $CaCO_3$ slurry using a pressure drop of 67.0 kPa. The solid concentration in the slurry is 0.191 kg solid/kg slurry and the filter cake is such that the kg wet cake/kg dry cake = 2.0. The density and viscosity of the filtrate can be assumed as that of water at 298.2 K. Calculate the filter area needed to filter 0.778 kg slurry/s. The filter cycle time is 250 s. The specific cake resistance can be represented by $\alpha = (4.37 \times 10^9)(-\Delta p)^{0.3}$, where $-\Delta p$ is in Pa and α in m/kg. Take density of water 996.9 kg/m^3, and viscosity is 0.8937 x 10^{-3} Pa. s. [10]

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