Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

III SEMESTER B.TECH (CHEMICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOVEMBER 2017

SUBJECT: MECHANICAL OPERATIONS [CHE 2103]

REVISED CREDIT SYSTEM

Time: 3 Hours (25/11/2017 FN) Max. Marks: 50

Instructions to Candidates:

- **Answer all the questions.**
- **Each questions carry equal marks (5 X 10 = 50).**
- **Missing data, if any, may be suitably assumed.**
- **Write specific and precise answers, Usual notations shall apply.**

1A. State the difference between Grizzlies and Trommels. Derive an expression to determine the overall effectiveness (E) of the screen with its graphical representation. **[01] [04]**

1B. Pyrite ore is used for the production of sulfur dioxide which is used in the manufacture of sulfuric acid in industries. The sphericity and specific gravity of pyrite are 0.6 and 5 respectively. Assume that the volume shape factor is 1.992. The sample mixture is screened and the screen analysis data is given below. **[05]**

A	4	8	14	28	48	65	100	150	200
B	4.699	2.362	1.168	0.589	0.295	0.208	0.147	0.104	0.074
C	0	11.2	29.6	27.4	17.2	6.0	3.8	2.8	2

Where A = Mesh no; B = Screen opening (mm); C = Percentage retained (wt%)

Calculate the specific surface area and specific number of pyrite particles present in the sample mixture using differential analysis.

2A. (i) Explain the principle, construction and working operation of fluid energy mill with neat sketch. **[03]**

(ii) Derive an equation to determine the power (P) required for crushing based on crushing efficiency (η_c). **[03]**

2B. A certain Jaw crusher takes rock whose average particle diameter is 0.025 m and crusher is to give a product whose average particle diameter is 0.018 m at the rate of 20,000 kg/hr. At this rate, the mill takes 684 kgf-m/sec of power and 35 kgf-m/sec power is required to run it empty. (1) What would be the power consumption in terms of HP for same capacity if the average particle diameter in the product is 0.008 m. (2) How much power would be required in terms of HP under same conditions by Kick's law? If the rate of crushing is 20 tons /hr. **[04]**

3A. State the difference between free and hindered settling. Draw a neat sketch, explain the construction and working operation of Elutriator with its uses. **[01] [03]**

3B. The data given below are obtained from a single batch sedimentation test in a calcium carbonate ($CaCO_3$) slurry. Determine the maximum cross sectional area of continuous thickener to handle 224 m^3/hr. If the solids from a feed concentration is 16.68% by wt. and the under flow concentration is to be 68.82% by wt. of solids. The density of the solids was 2.63 g/cc. **[06]**

Z (cm)	90	60	42	27	19	7.5	6	5.5	4.5	4.0	4.0
Θ (hr)	0	0.1	0.25	0.50	0.75	2.0	2.6	3.0	3.4	3.8	4.2

where Z= Height of settling interface (cm); Θ = settling time (hr).

4A. Derive an equation to determine the speed (N) of rotary drum vacuum filter for the formation of compression cake. Write the importance of filter aids during filtration operation with its examples **[05]**

4B. Feed slurry of crystals is filtered at constant pressure through a filtration medium consisting of a screen support mounted across the end of a Pyrex pipe. The resistance of the filter medium is negligible and the following data in a laboratory test is given **[05]**

Weight of crystals	: 62 gm
Pressure of filtration	: 15 psi
Filter diameter	: 5.08 cm
Cake volume	: 253 cm^3
Filtration time	: 163 min

Calculate $\frac{\mu\alpha}{2\rho_0}$ in the laboratory test data?. The cake is essentially incompressible. On the basis of the laboratory test data, predict the number of frames (30 inch x 30 inch x 1 inch thickness) needed for a plate and frame filter press. Estimate the time required to filter the slurry for 63 kg crystal formed on the filter medium. In this calculations, assume that the feed pump will deliver 10 psi and that the filtrate from the press is to be reduced to 6.5 psi. (1 psi = 6.894 x 10^3 N/m^2)

5A. Describe in detail about the following with neat sketch **[02]**

(i) Muller mixer.

(ii) Flow patterns in an agitated vessel. **[03]**

5B. (i) Write the significance of centrifugation coefficient and 'Z' factor during the separation of fine particles in a centrifugation operation. **[01]**

(ii) A pilot scale disc-stack centrifuge is tested for recovery of fine particles. The centrifuge contains 25 discs with inner and outer diameters 2 cm and 10 cm respectively. The cone angle is 35˚,when operated at a speed of 3000 rpm with a feed rate of 3.5 lit/min, 80 % of the fine particles are recovered. If the same type of bigger centrifuge is to be used for industrial treatment of 80 lit/min. What operating speed is required to achieve the same sedimentation performance if the larger centrifuge contains 55 discs with outer diameter 15 cm, inner diameter 4.7 cm and cone angle 45˚?. **[04]**

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