Question Paper

Exam Date & Time: 26-Jun-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

IV SEMESTER B.TECH END SEMESTER MAKEUP EXAMINATIONS, JUNE 2024

PARTICLE TECHNOLOGY [CHE 2221]

Marks: 50 **Duration: 180 mins.**

Answer all the questions.

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1) A) What is meant by the Sphericity of solid particles with an appropriate mathematical expression? Briefly explain the various methods of sampling in screen analysis. (4)

B) Differentiate (a) ideal and actual screen (any 4 points) and (b) capacity and binding of the screen. (2)

C) 3 tons/hr of dolomite is produced by crushing and screening through a 20-mesh screen from the screen analysis data shown below (4)

Mesh No		4	8	14	28	48	100	150
Screen size opening, cm		0.4699	0.2362	0.1170	0.0589	0.0295	0.0147	0.0104
Weight retained (%)	Feed	14.3	20	20	28.5	8.6	5.7	2.9
	Overflow	20	28	28	24	---	---	---
	Underflow	---	---	10.5	29.5	30	20	10

Calculate the overall effectiveness (E) of the screen and total feed of the crushed material.

2) A) The iron ore (hematite) crushed materials are obtained using a pilot-scale Jaw crusher. Explain the principle, construction, and working operation of the same equipment with a suitable sketch. (3)

B) Briefly explain the various laws of size reduction and derive an equation to determine the power required for crushing. (4)

C) A certain set of crushing rolls of 150 cm diameter by 50 cm width face. They are set so that the crushing surfaces are 1.25 cm apart at the narrowest point. The manufacturer recommends that it run at 100 rpm to crush a rock having a specific gravity of 2.35 with an angle of nip is 30˚. What are the maximum (a) permissible size of the feed and the actual (3)

capacity of the roll crusher in tons/hr, if the actual capacity is 65% of the theoretical capacity?

3) A) State the difference between free and hindered settling of solid particles in a fluid medium. Develop an expression to calculate the ratio of the size of the particle in the feed mixture in various regions with appropriate graphical representation, if the particles are settled in equal settling velocity. (4)

B) With a neat sketch, explain the construction, and working operation of an Elutriator. (2)

C) The particles of galena are settled under the force of gravity in water at 30˚C. The galena particles are cubic in shape and have a density of 468.21 lb/ft^3 and a dimension of 0.000582 cm. The void fraction of galena particles in water is 0.75. The drag coefficient is given from the equation $C_D = 5.31 - 4.184\ \phi_S$. where ϕ_S is the sphericity of solid particles. The density of water is 1 g/cc. A 2,50,000-lit cylindrical stirred tank is used to separate galena particles. The stirrer is stopped and then the galena particles are allowed to settle. The tank has a liquid height-to-diameter ratio of 2.5. Estimate the settling time of galena particles in the cylindrical tank by assuming that these particles settle under hindered settling condition with the constant n = 4.2. (4)

4) A) Explain the principle, construction, working operation, and advantages of continuous rotary drum vacuum filter with a neat sketch. (3)

B) For a plate and frame filter press, operated at constant pressure the relation between the volume of filtrate 'V_f' and the time in filtration operation 'θ_f' is as follows $V_f^2 = 6.25 \times 10^4\ (\theta_f + 0.11)$. Where '$V_f$' is a cubic meter of filtrate delivered in filtering time 'θ_f' hours. Rate of filtration can be taken as $dV_f/d\theta_f$. The cake formed in each cycle must be washed with an amount of water equal to one-sixteenth times the volume of filtrate delivered per cycle. The washing rate remains constant and is equal to one-fourth of the filtrate delivery rate at the end of filtration. The time required per cycle for dismantling, dumping, and reassembling the press is 6 hours. Under the conditions where the proceeding information applies, determine the total cycle time necessary to permit maximum output of filtrate during each 24 hours. (5)

C) Write the (a) significance of filter aids and (b) characteristics of filter medium during filtration operation. (2)

5) A) Develop an equation to determine the time required for separating the fine particles from a feed slurry using a tubular bowl centrifuge with an appropriate sketch. (2)

B) A pilot scale disc stack centrifuge is tested for recovery of fine particles. The centrifuge contains 25 discs with inner and outer diameters of 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, 70 % of the fine particles are recovered. If the same type of bigger centrifuge is to be used for industrial treatment of 80 lit/min same feed slurry. What operating speed is required to achieve the same settling performance if the larger centrifuge contains 55 discs with an outer diameter of 15 cm, inner diameter of 4.7 cm, and cone angle of 45˚? (3)

C) Briefly explain the theory of sedimentation with suitable assumptions and deduce the relationship between the concentration of solids in the rate-limiting layer (C_L) and the initial concentration of solids in slurry (C_0). Write the various steps with an appropriate plot to determine the maximum cross-sectional area of the continuous thickener. (5)

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