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Answer scheme - Regular Exam

III Semester- B. Tech Chemical Engineering
Particle Technology [CHE 2154]
End semester Examination – December 2022

Type: Des

Q1. What is meant by the 'sphericity' of a solid particle with appropriate mathematical expression? Develop an expression to determine the specific surface area of solid particles in the mixture. (3)

Q2. Compare and contrast between Grizzlies and Trommels. Briefly explain the various methods of sampling in screen analysis. (2)

Q3. Finely divided spherical particle of activated carbon (1500 gm) is used as an adsorbent for the removal of emerging pollutants from aqueous solutions. The adsorbent particle has a density of 2.1 g/cc and the screen analysis data is given below. Assume that the volume shape factor is 1.992. Calculate the specific surface area of adsorbent particles in cm^2 per gm and a specific number of particles present in the sample mixture using the differential analysis method. The screen analysis data is given below (5)

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	168	444	411	258	90	57	42	30

Where A = Mesh no; B = Screen opening (mm); C = Mass of particle retained (gm)

Q4. State the difference between open and closed-circuit grinding. Derive an equation to determine the power required for crushing based on crushing efficiency. (3)

Q5. The commercial pigment fine powders are produced by a pilot-scale fluid energy mill. Explain the principle, construction, and working operation of the same equipment with a suitable sketch. (3)

Q6. Calculate the operating speed of the ball mill if the critical speed is 40% more than the operating speed. The diameter of the ball mill and balls are 800 mm and 60 mm, respectively.

Cement clinker having a mean particle size of 5 mm goes through the grinder with a capacity of 3 tons/hr. The screen analysis data are as follows:

Screen opening (mm)	3.5	1.75	0.88	0.45	0.23
Cumulative weight fraction retained (%)	20	50	80	95	100

What is the power consumed in a grinder according to Bonds' law? Given that the work index for limestone is 13.45 kw-hr-/ton. (4)

Q7. Obtain an entire expression to determine the terminal settling velocity of a solid particle in a low viscous medium with suitable assumptions. (4)

Q8. With a neat sketch, explain the principle, construction, and working operation of an electrostatic precipitator with its advantages. (3)

Q9. It is desired to separate quartz particles from galena particles by taking advantage of their different density. A hydraulic classifier is used under free settling conditions, separation is to be carried out in the water. The density of quarts and galena are 2.65 and 7.5 g/cc, respectively. The original mixture of particles has a size range of 0.00052 to 0.0025 cm. The density of water is 1 g/cc and the viscosity is 1 mpa sec. (i) What is the size range of products? Assume that the settling velocity of both particles is the same. (ii) What velocity of water flow will give to separate larger-size galena and smaller-size silica? (3)

Q10. Explain the significance of (i) filter aids during filtration operation with its examples (ii) cake compressibility factor and (iii) 'r' factor during cake washing in a rotary drum vacuum filter with the necessary equation. (3)

Q11. A slurry of 2.33% by weight calcium carbonate ($CaCO_3$) is filtered at a constant pressure drop in a laboratory-scale leaf filter. The filter area was 0.25 m^2 and the ratio of the mass of wet cake to dry cake was 1.639. The pressure drop across the filter is 360 mm Hg and the filtrate viscosity is 1 mN-sec/m^2. At the end of 20 minutes, 30.24 liters of the filtrate were collected. (i) Calculate the specific cake resistance (ii). What size filter is required to process 4000 liters of feed slurry in 30 min at a pressure drop of 360 mm Hg. Assume that filter medium resistance is negligible. The density of calcium carbonate and water is 2.63 and 1 g/cc, respectively. (4)

Q12. Explain the various factors affecting the rate of filtration? Develop an equation to determine the time required for separating the particle from an aqueous solution using a tubular bowl centrifuge with an appropriate sketch. (3)

Q13. To determine the maximum diameter of continuous thickener to produce an underflow concentration of 40% by weight from a feed containing calcium carbonate ($CaCO_3$) concentration of 1.9083 lb/ft^3. The flow to the continuous thickener is to be 4133.783 m^3 per hr. The density of $CaCO_3$ was 2.63 g/cc. Assume that the density of water is 1 g/cc. The batch sedimentation test data is given below.

Z (cm)	32.4	26	18.5	8	4.5	3.6	3.4	3.2	3.1	3.0
θ (sec)	0	120	240	420	600	780	900	1020	1140	1260

- Where Z= Height of settling zone at the interface (cm); θ = settling time (sec). (5)

Q14. A very fine particles are to be separated from a feed solution using a pilot scale disc stack centrifuge at 20°C. Assume that the particles are spherical with a diameter of 5 μm, and a density 1.06 g/cc. At the temperature of separation, the density of the suspending fluid is 0.997 g/cc and the viscosity of the feed solution is 1.36 mpa-sec. 500 liters of feed solution must be treated every hour for a suitably sized disc stack centrifuge. The small size and low density of fine particles are disadvantages in centrifugation. If instead of fine particles, silica particles of diameter 0.1 mm and specific gravity 2.0 are separated from the liquid, by how much percentage (%) of the centrifugation coefficient is reduced? (3)

Q15. Compare and contrast between classifier and clarifier. List out the possible ways to increase the settling velocity of a particle in a centrifugal separation. (2)