

CHL-331 : Major Examination:

Fluid Particle Mechanics

Time: 2 hour; Full Marks: 40. Answer All the Questions. Use necessary assumptions if required and state clearly in answer booklet. Do not ask questions to invigilators.

1. Discuss how viscosity of slurries varies with shear rate at different concentration of solid spherical particles. 2
2. Write down the various processes by which size enlargement of particles are done. 2
3. Particles of A (40 % by weight) and B (60%) of two different materials are mixed in a mixer. Devise an experimental methodology to find out the optimum time of mixing operation. 2
4. What are critically loaded and overloaded thickeners? Outline the procedure of determination of area of critically loaded thickener from a given the flux plot and feed rate. 4

5. Air containing 18 g/m^3 of gas at NTP is fed into a cyclone at a rate of $0.3 \text{ m}^3/\text{s}$. The size distributions by mass of the dust carried in the gas, the grade efficiency of the cyclone used are shown below. Find out the overall efficiency of cyclone. Also find out the mass flow rate of particles of size $20 \mu\text{m}$ in the gas outlet. 6

Size range (μm)	0-5	5-10	10-20	20-40	40-80	80-160
Mass percent	10	15	35	20	10	10
Grade efficiency	20	40	80	90	95	100

6. If crushing rolls 1 m diameter are set so that the crushing surfaces are 12.5 mm apart, what is the maximum size of particle which should be fed to the rolls? Given, the friction co-efficient between the particles and roll is 0.25.

If the actual capacity of the machine is 12 per cent of the theoretical, calculate the throughput in kg/s when running at 2.0 Hz if the working face of the rolls is 0.4 m long, and the feed density is 2500 kg/m^3 . 6

7. Slurry containing 0.1 kg of solid/kg of water is being filtered with a plate and frame filter press with number of frames and plates 40 each. The filter area of each side of the filter is 0.5 m^2 . This unit delivers 4500 kg of filtrate during the first 2 hours of the filtration starting with clean unit and maintaining a constant pressure drop of 0.7 kg/cm^2 . The resistance of the filter medium is negligible. The time required for washing and dumping is 3 hours per cycle. The filter press is to be replaced by a rotary vacuum-drum filter with negligible filter medium resistance. This rotary filter can deliver the filtrate at a rate of 450 kg/h at the drum speed of 0.6 rpm. Assuming the fraction submerged and the pressure drop are unchanged, what drum speed in rpm is necessary to make the amount of filtrate delivered in 24 hours from the rotary filter exactly equal to the maximum amount of filtrate obtainable per 24 hours from the plate and frame filter? 8

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8. Derive the relation to determine Critical Particle Diameter for Settling in a Continuous Solid Bowl Centrifuge in terms of volumetric flow rate of liquid through centrifuge, radial distance from the axis of rotation to the centrifuge wall, R.L. radial distance from the axis of rotation to the liquid pool.
9. Estimate the amount of time that each of the suspension of 200 nm dia alumina (density = 3980 kg/m³) in water will remain stabilized against sedimentation due to Brownian motion at room temperature (300K). Density of water 1 gm/cc, viscosity 1cp, Boltzmann constant $K = 1.3806488 \times 10^{-23}$ J.molecule⁻¹ K⁻¹