

**III B.Tech. I Semester Supplementary Examinations, May -2005**  
**MECHANICAL UNIT OPERATIONS**  
**(Chemical Engineering)**

**Time: 3 hours**

**Max Marks: 80**

**Answer any FIVE Questions**  
**All Questions carry equal marks**

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1. (a) State the similarities and differences between the properties of solid particles and fluids.  
(b) How are particulate solids classified depending on their flow properties? Give examples.  
(c) Write in detail about bin storage and bulk storage.
2. Discuss about mixers for powders, viscous materials and pastes.
3. A material is crushed in a Blake jaw crusher such that the average size of particle is reduced from 50 mm to 10 mm with a consumption of energy at the rate of 13 kJ/kg. What will be the consumption of energy needed to crush the same material of average size of 75 mm to an average size of 25 mm?  
(a) Assuming Rittinger's law applies?  
(b) Assuming Kick's law applies?  
(c) Which of these results would be regarded as being more reliable and why?
4. Explain the theory and principle of centrifugal filtration and describe any one equipment with a neat diagram.
5. Write short notes on.  
(a) Partial rejection of solutes.  
(b) Microfiltration
6. (a) Write about separation of dust from gases in cyclones.  
(b) What is the effect of parameters like particle size, flow rate and density on the collection efficiency in a cyclone?
7. Write the purpose of agitation of liquids. Draw neat sketches of various impellers and explain their specific features.
8. What is a crystal? Write about invariant crystals and about crystal size and shape factors?

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1. (a) What are the distinctive properties of particulate masses?  
(b) Explain how free flowing solids flow out of bins.
2. (a) Explain the significance of the equilibrium standard deviation for mixing of granular solids.  
(b) How do you calculate the time required for degree of mixing of granular solids.
3. (a) Define the term 'Work Index'. Obtain an expression for relating power consumption of a size-reducing machine with feed rate, work Index and size of feed and product  
(b) What will be the power required to crush 150 tonnes per hour of limestone if 80% of the feed passes 50 mm screen and 80% of the product passes through a 3.125 mm screen? The work index is 12.74.  
(c) Discuss various variables, which affect power requirement of a crusher.
4. (a) Derive an expression for determining the specific resistance of the cake during filtration.  
(b) A rotary filter, operating at 3 rpm, filters 30 m<sup>3</sup>/hr of a slurry. At what speed the filter must be rotated if it operates under the same vacuum to ensure a filtration rate of 50 m<sup>3</sup>/hr. Assume that filter cloth resistance is negligible.
5. Write short notes on.
  - (a) Partial rejection of solutes.
  - (b) Microfiltration
6. (a) Write about the sink-and-float method for separation of differing density particles.  
(b) Explain heavy media separation method of cleaning coal.
7. Write the purpose of agitation of liquids. Draw neat sketches of various impellers and explain their specific features.
8. (a) Explain the phenomena of crystallization from melts.  
(b) Describe Brodie purifier counter current cooling crystallizer.

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1. (a) What are the distinctive properties of particulate masses?  
(b) Explain how free flowing solids flow out of bins.
2. Discuss in detail about:
  - (a) kneaders, dispersers and masticators
  - (b) mixer-extruders.
3. (a) Give general considerations for the selection of a machine for size reduction of a feed to a product of desired size.  
(b) Discuss the effect of moisture content and size of feed particles on comminution.  
(c) Suggest machine for comminution of
  - i. big lumps of hard rock ,and
  - ii. fibrous materials
4. (a) Define filtration.  
(b) Name the broad classifications of liquid-solid filters and discuss them in detail.
5. A tubular membrane with a diameter of 2 cm and a water permeability of 250 L/m<sup>2</sup>-h-atm is being used for UF of cheese whey. The whey proteins have an average diffusivity of  $4 \times 10^{-7}$  cm<sup>2</sup>/s and the osmotic pressure in atmospheres is given by Jonsson's equation:
$$\pi = 4.4 \times 10^{-3}c - 1.7 \times 10^{-6}c^2 + 7.9 \times 10^{-8}c^3$$
where c is the protein concentration in grams per liter. Calculate the effect of  $\Delta p$  on the flux for a clean membrane if the solution velocity is 1.5 m/s and the protein concentration is 10, 20 or 40 g/L. Assume the gel concentration is 400 g/L and the rejection is 100 percent. Assume the bulk solutions have the same density and viscosity as water:
$$\rho=1 \text{ g/cm}^3 \quad \mu=0.01 \text{ g/cm-s}$$
6. (a) Explain the principle and operation of centrifugal separators.  
(b) A slurry containing 5 kg of water per kg of solids is to be thickened to a sludge containing 1.5 kg of water per kg of solids in a continuous operation. Sedimentation tests yielded the following results.

Concentration (kg water/kg solid)	5	4.2	3.7	3.1	2.5
Rate of sedimentation (mm/sec)	0.17	0.1	0.08	0.06	0.042

Calculate the minimum area of a thickener to effect the separation of 0.6 kg of solids per second.

7. (a) Sketch and explain briefly the different designs of turbines.  
(b) Discuss the importance of Froude number in determining the power consumption of an agitator.  
(c) Describe a suitable equipment for mixing miscible liquids.
8. (a) Write about the heat of crystallization and enthalpy-concentration diagram.  
(b) Write a note on supersaturation.

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1. Discuss in detail about
  - (a) Pressures in masses of particles
  - (b) Pressures in bins and silos
2.
  - (a) Distinguish between kneaders, dispersers and masticators.
  - (b) Describe with figures double-motion paste mixers.
3.
  - (a) Draw a diagram of a Blake jaw crusher and mention its construction and operation.
  - (b) State the type and size of material, which can be crushed in a Blake jaw crusher.
  - (c) Differentiate between Blake jaw crusher and a gyratory crusher.
4.
  - (a) Distinguish between compressible and incompressible sludges.
  - (b) Explain the terms specific cake resistance and filter-medium resistance.
5.
  - (a) Discuss about the types of membranes and the material of construction.
  - (b) Discuss about the rejection curve for some membranes based on molecular weight of membranes.
6.
  - (a) Derive an expression for calculating the minimum thickener area required for a gravity thickener.
  - (b) Quartz particles (density =  $2650 \text{ kg/m}^3$ ) are settling in water at room temperature. What will be the maximum particle diameter so that stoke's formula can hold good in this case?  
Viscosity =  $1004 \times 10^{-6} \text{ kg/m.s}$
7. Write the purpose of agitation of liquids. Draw neat sketches of various impellers and explain their specific features.
8.
  - (a) Describe the particle size distribution of the crystals and explain the coefficient of variation.
  - (b) Explain the ' $\Delta L$ ' law of crystal growth.

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