Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH(CHE-OLD)/SEM-4/CHE-402/2012

2012

MECHANICAL OPERATION

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :

$10 \times 1 = 10$

i) Sauter diameter of a particle is the diameter of the sphere having the same

a) ratio of surface to volume as the actual volume

b) ratio of volume to surface as the particle

c) volume as the particle

d) none of these.

ii) Soft and non-abrasive material can be made into fines by

a) attrition b) compression

c) cutting d) none of these.

iii) The operating speed of a Ball mill should be ..... the critical speed.

a) less than b) much more than

c) at least equal to d) slightly more than.

iv) 200 mesh screen means 200 openings per

a) cm^2 b) cm

c) inch d) $inch^2$.

v) Which is the most suitable conveyor for transportation of sticky material ?

a) Apron conveyor b) Belt conveyor

c) Screw conveyor d) Pneumatic conveyor.

vi) The energy consumed by a ball mill depends on

a) its speed

b) its ball load

c) the density of the material being ground

d) all of these.

vii) For laminar flow of filtrate through the cake deposited on septum, which of the following will be valid ?

a) Kozeny-Carman equation

b) Leva's equation

c) Blake Plummer equation

d) None of these.

viii) The unit of specific cake resistance is

a) gm/cm^2 b) cm/gm

c) cm/gm^2 d) gm/gm.

ix) Which of the following gives the crushing energy required to create new surface ?

a) Taggart's rule b) Fick's law

c) Rittinger's law d) None of these.

x) Diatomaceous earth is a/an

a) explosive b) filter aid

c) filter media d) catalyst.

xi) A fluid energy mill is used for

a) cutting b) grinding

c) ultra-grinding d) crushing.

xii) The baffle width of any mixing tank is generally maintained at ..... of the tank diameter.

a) equal b) half

c) one fourth d) one twelfth.

xiii) Hindered settling velocity is

a) equal to free settling velocity

b) greater than free settling velocity

c) less than free settling velocity

d) none of these.

xiv) For storage of non-homogeneous solids in open piles, it is practised to keep the angle of repose

a) equal to angle of friction

b) greater than angle of friction

c) less than angle of friction.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Define screen capacity. What are the factors on which it depends ? 2 + 3
3. A crushing machine has been fed with the solids having volume-surface mean diameter of 2·0 cm and generates products of 0·4 cm diameter. The power required to crush 10000 kg/hr is 5 kW. If the capacity is reduced to 8000 kg/hr and the volume surface mean diameter of product is to be 0·35 cm (from the same feed), estimate the power required.
4. Explain critically about close circuit and open circuit operations with pictorial representation.
5. What is terminal settling velocity ? Distinguish between free settling and hindered settling. 2 + 3
6. What are the requirements to be fulfilled for selecting a filtering septum in any filter ? Mention the necessary condition for incompressible cakes. 4 + 1

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Differentiate between ideal screen and actual screen. What do you mean by 'screening error' ? 3

   b) A salt is being screened through a series of vibrating screen assembly. The desired product is – 30 + 20 mesh fraction. In this case 30 mesh and 20 mesh screens are used as double deck and feed is introduced on 30 mesh

screen. During operation, it was observed that the over size of 30 mesh : over size of 20 mesh : under size of 20 mesh = 2 : 1·5 : 1. Calculate this double deck screen efficiency when mass fraction of feed on 30 mesh screen = 0·281 and mass fraction of over size from 20 mesh screen = 0·526. 6

c) Mention the factors on which power consumption of a belt conveyor depends. 2

d) Ammonium nitrate having bulk density 720 kg/m^3 is to be conveyed by a flat belt running at a speed of 1·5 m/s at a rate of 10 kg/sec along an incline of 18°. If the product has angle of surcharge of 25°, determine the minimum belt width. [slope factor = 0·85] 4

8. a) What is Rittinger's number ? Explain its significance. 3

b) If crushing rolls of 1 mm diameter are set so that the crushing surfaces are 12·5 mm apart and the angle of nip is 31°, what is the maximum size of particle which should be fed to the rolls ?

If the actual capacity of the machine is 12% of the theoretical, calculate the throughput in kg/s when running at 2 m/s if the working face of the rolls is 0·4 m long and the bulk density of the feed is 2500 kg/m^3. 6

c) Discuss the situations that occur from low to high speed of rotation for a ball mill. 3

d) Explain briefly about the principle of Fluid Energy mill. 3

9. a) Define different settling regimes obtained during sedimentation test with respect to solid concentration. 4

   b) A spherical lead particle of diameter 0·1 mm is allowed to settle in a medium of density 1000 kg/m^3. Calculate the distance it will move before it reaches 99% of its terminal settling velocity. Assume Stokes' law applicable under the prevailing condition. [Dynamic viscosity of the medium = 0·001 Pascal-second. Density of lead = 11400 kg/m^3] 7

   c) Explain the working principles of a classifier and a clarifier. 4

10. a) How does flow of granular solids differ from liquid flow ? How solid flow can be measured ? 3 + 1

   b) Deduce an expression for power consumption by an impeller in a mixing tank. Name at least one mixing device each for solid-solid mixing and mixing of viscous material. 4 + 2

   c) Write a note on cyclone separator. 5

11. a) A rotary drum filter having a 33% submergence of the drum in the slurry is to be used to filter a $CaCO_3$ slurry using a pressure drop of 67·0 kPa. The solid concentration in the slurry is C_s = 0·191 kg solid/kg slurry and the filter cake is such that kg wet cake/kg dry cake = 2·0. The density and viscosity of the filtrate can be assumed as that of water at 298·2 K. Calculate the filter area needed to filter 0·778 kg slurry/s. The filter cycle time is 250 s.

The specific cake resistance can be represented by $\alpha = (4 \cdot 37 \times 10^{9})(\Delta P)^{0 \cdot 3}$, where ΔP is in P_a and α in m/kg, $\rho = 996 \cdot 9$ kg/m^3, $\mu = 0 \cdot 8937 \times 10^{-3} P_a$ - S. 8

b) Give a comparative study of pressure filter and vacuum filter. 4

c) What is the significance of critical speed for centrifugation ? 3

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