Name : …………………………………………………………

Roll No. : …………………………………………………………

Invigilator's Signature : …………………………………….…

CS/B.TECH (CHE/OLD)/SEM-4/CHE-402/2013
2013
MECHANICAL OPERATIONS

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

      a) attriion   b) compression

      c) cutting   d) none of these.

   ii) Solid particles of different densities are separated by

      a) filters   b) thickness

      c) cyclones   d) sorting classifier.

4010 (O)   [Turn over

iii) The inlet pressure in a constant rate filtration

   a)   increases continuously

   b)   decreases gradually

   c)   remains constant

   d)   none of these.

iv) The most common filter aid is

   a)   diatomaceous earth

   b)   calcium silicate

   c)   sodium carbonate

   d)   silica gel.

v) To remove very small amount of tiny solid impurities from liquid we use

   a)   pressure filter

   b)   vacuum filter

   c)   centrifugal filter

   d)   coagulant.

vi) Balls for ball mills are never made of

   a)   forged / cast steel

   b)   lead

   c)   cast iron

   d)   alloy steel.

vii) Cumulative analysis for determining surface is more precise than differential analysis because of the

    a)   assumption that all particles in a single fraction are equal in size

    b)   fact that screening is more effective

    c)   assumption that all particles in a single fraction are equal in size, is not needed

    d)   none of these.

viii) Equivalent 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.

ix) Screw conveyors are

    a)   run at very high r.m.p.

    b)   suitable for sticky material

    c)   suitable for highly abrasive materials

    d)   all of these.

x) Sedimentation on commercial scale occurs in

    a) classifiers   b) rotary drum filters

    c) thickeners   d) cyclones.

xi) Sphericity of Raching ring (whose length and diameter are equal) is

    a) > 1   b) < 1

    c) 1   d) 2.

xii) Which of the following is not categorized as mechanical operation ?

    a) Agitation   b) Filtration

    c) Size enlargement   d) Humidification.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.   3 × 5 = 15

2. a) What is sphericity ?

    b) What is differential and cumulative screen analysis ?

                                  2 + 3

3. a) What is terminal velocity ?

    b) What are Stokes' law and Newton's law regimes of settling ?   2 + 3

4. What is crushing efficiency ? Derive the equation for critical speed of a ball mill.   2 + 3

5. a) What is separation factor of a cyclone separator ?

    b) If for a cyclone diameter is 1 ft (0·3 m) and tangential velocity is 50 ft/s (15 m/s), what will be the separation factor ?   2 + 3

6. Describe the vacuum drum filter.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following.   3 × 15 = 45

7. a) What is Screen effectiveness ? What is actual and ideal screening ? Mention material balance over screen.   7

   b) A quartz mixture having the screen analysis shown in Table 1 is screened through a standard 10-mesh screen. The cumulative screen analysis of overflow and underflow are given in Table 1. Calculate the mass ratios of the overflow and underflow to feed and the overflow effectiveness of the screen.   8

Table 1 : Screen analysis

Mesh	Dp, mm	Feed	Overflow	Underflow
4	4·699	0	0	—
6	3·327	0·025	0·071	—
8	2·362	0·15	0·43	0
10	1·651	0·47	0·85	0·195
14	1·168	0·73	0·97	0·58
20	0·833	0·885	0·99	0·83
28	0·589	0·94	1·00	0·91
35	0·417	0·96	—	0·94
65	0·208	0·98	—	0·975
Pan	—	1·00	—	1·00
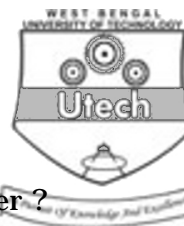
8. a) What are the advantages of ball mill ? 4

   b) Find angle of nip for a double roll crusher ? 4

   c) What should be the diameter of a set of rolls to take feed of a size equivalent to 1·5 in. spheres and crush to 0·5 in., if the coefficient of friction is 0·35 ? 4

   d) Distinguish between free crushing and choke crushing. 3

9. a) What is free and hindered settling ? What is the criterion for settling regime ? 5

   b) Practicles of sphalerite (specific gravity 4·00) are settling under the force of gravity in carbon tetrachloride at 20°C (specific gravity 1·594). Viscosity is 1·03 Cp. The diameter of the sphalerite particle is 0·004 m (0·10 mm). The volume fraction of sphalerite in carbon tetrachloride is 0·20. What is the terminal velocity ? In which law regime it is fallen ? If the calculated Reynolds number range, $n = 4·1$. What will be the settling velocity ? 7

   c) What is mixing effectiveness and mixing index ? 3

10. a) A flat-blade turbine with six blades is installed centrally in a vertical tank. The tank is 6 ft (1·83 m) in diameter ; the turbine is 2 ft (0·61 m) in diameter and is positioned 2 ft (0·61 m) from the bottom of the tank. The turbine blades are 5 in. (127 mm) wide. The tank is filled to a depth of 6 ft (1·83 m) with a solution of 50 percent caustic soda, at 65·5°C, which has a viscosity of 12 cP and a density of 93·5 lb/ft^3 (1498 km/m^3). The turbine is operated at 90 r/min. The tank is baffled. What power will be required to operate the mixer, if $N_p = 5·8$ at a calculated Reynolds number ? 7
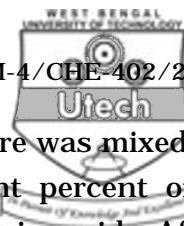
b) A silty soil containing 14 percent moisture was mixed in a large muller mixer with 10·00 weight percent of a tracer consisting of dextrose and picric acid. After 3 min of mixing, 12 random samples were taken from the mix and analysed colorimetrically for tracer material. The measured concentrations in the sample were, in weight percent tracer, 10·24, 9·30, 7·94, 10·24, 11·08, 10·03, 11·91, 9·72, 9·20, 10·76, 10·97, 10·55. Calculate the mixing index I_p and the standard deviations.   5

c) What is power number, flow number and Froud number ?   3

11. a) What is filter aid ?   3

b) Data for the laboratory filtration of $CaCO_3$ slurry in water at 298·2 K are reported as follows at a constant pressure of 338 kN/m^2. The filter area of the plate-and frame press was 0·0439 m^2 and the slurry concentration was 23·47 kg/m^3. Calculate specific cake resistance and filter medium resistance from the experimental data given, where t is time is s and V is filtrate volume collected in m^3.   12

t	4·4	9·5	16·3	24·6	34·7
$V/10^{-3}$	0·498	1	1·501	2	2·498

46·1	59	73·6	89·4	107·3
3·002	3·506	4·004	4·502	5·009

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