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B.TECH
PCE31103

3rd Semester Regular Examination 2016 - 17

MECHANICAL OPERATIONS

BRANCH : Chemical

Time : 3 Hours

Max Marks : 100

Question Code : Y595

Answer Part-A which is compulsory and any four from Part-B.

The figures in the right-hand margin indicate marks.

Assume suitable notations and any missing data wherever necessary.

Answer all parts of a question at a place.

Part – A (Answer all the questions)

1. Answer the following questions : 2 x 10

(a) The value of coefficient of flowability (K) for free-flowing granular materials varies between _____ to _____.

- i. 0.0 to 0.3
- ii. 0.3 to 0.6
- iii. 0.6 to 0.9
- iv. 0.9 to 1.2

(b) Bond's law is applicable for feed size between ____ to ____ mm.

- i. 0.05 to 0.5
- ii. 0.5 to 50
- iii. 0.05 to 50
- iv. 5 to 50

(c) For effective grinding, the ball mills are usually operated between _____ to _____ % of the critical speed.

- i. 20 to 45
- ii. 30 to 55
- iii. 40 to 65
- iv. 50 to 75

(d) The Tyler Standard sieve scale series is based on a _____ screen.

- i. 200 mesh
- ii. 200 μm
- iii. 200 mm
- iv. 200 cm

(e) Triboelectrostatic separators are used to separate _____ materials.

- i. conductive
- ii. non-conductive

- iii. polar
- iv. non-polar
- (f) Pine oil is used in a floatation cell as a _____.
 - i. pH regulator
 - ii. collector
 - iii. coagulant
 - iv. frother
- (g) When two solid particles having different densities but the same size are separated using a fluid, the method is known as _____.
 - i. elutriation
 - ii. coagulation
 - iii. flocculation
 - iv. sedimentation
- (h) For handling corrosive liquids _____ filters are selected.
 - i. rotary drum
 - ii. leaf
 - iii. rotary disk
 - iv. none of these
- (i) The angle of inclination of the belt in a belt conveyor is _____ the angle of repose of solid particles to be transported.
 - i. greater than
 - ii. equal to
 - iii. less than
 - iv. none of these
- (j) During liquid mixing, Froude number affects power consumption only if _____.
 - i. Reynolds number < 300
 - ii. baffles are present
 - iii. vortex is present
 - iv. viscosity > 10³cP

2. Answer the following questions : 2 x 10

- (a) What are dynamic angle of repose and static angle of repose ?
- (b) For a set of crushing rolls, under what condition there will be little or no crushing ?
- (c) Write the operating principle of a fine impact mill.
- (d) Mention the types of screening surfaces.
- (e) Mention the factors which affect the magnetic characteristics of a material.
- (f) What are the various zones of a mechanical classifier ?
- (g) What do you understand by Stokes' law region ?
- (h) What should be the characteristics of filter aids ?
- (i) Write the applications of screw conveyors.
- (j) Mention the objectives of size enlargement operations.

Part – B (Answer any four questions)

3. (a) Finely divided clay is used as a catalyst in the petroleum industry. It has a density of 1.2 g/cm³ and a sphericity of 0.5.

The size analysis is as follows:

Average diameter, $D_{pi\ avg}$ (cm)	0.0252	0.0178	0.0126	0.0089	0.0038
Mass fraction, ξ (g/g)	0.088	0.178	0.293	0.194	0.247

Find the specific surface area and the Sauter mean diameter of the clay material. 06

(b) Discuss in brief the three types of flow patterns of bulk solids. 09

4. (a) A crusher takes rock whose average particle diameter is 0.025 m and crushes it to a product whose average particle diameter is 0.018 m, at a rate of 20,000 kg/hr. At this rate, the mill takes 684 kg_f.m/s of power and 35kg_f.m/s power is required to run it empty.
- i. What would be the power consumption for same capacity, if the average particle diameter in the product is 0.008 m ?
 - ii. How much power would be required under conditions (i) by Kick's law ? 10

(b) Discuss in brief the factors affecting the size of the product in a ball mill. 05

5. (a) Discuss in detail the theory of vibrational separation with neat diagrams. 10

(b) Describe the operation of an induced roll magnetic separator with a neat diagram. 05

6. (a) Mention the laws of classification. Briefly discuss the construction and operation of a gravity settling classifier with a neat diagram. 4+6

(b) A sample of bauxite ore is to be cleaned using water in a classifier. The ore particles have a size range of 10 to 500 microns. The mixture is being separated into three parts: pure bauxite (specific gravity 2.2), pure silica (specific gravity 2.8), and the third fraction is the middling which is recycled. Assuming the flow to be laminar and neglecting any wall effect, estimate the size range of the three fractions. 05

7. (a) A sludge filtered in a washing plate and frame filter press is of such nature that the filtration equation is $V^2 = K t$ where V is the volume of filtrate obtained in time t, when the pressure is constant. 30 m³ of filtrate is produced in 10 hours. 3 m³ of wash water is forced through the cake at the end of filtration.
- i. What is the length of the washing time?
 - ii. If the filtering surface of the press is doubled, all other conditions remaining constant, how long would it take to produce 30 m³ of filtrate? 10

(b) Briefly discuss the construction and operation of a rotary drum filter with a neat diagram. 05

8. Briefly discuss about the construction and operation of the following equipments with their neat diagram.
- i. Electrostatic precipitator 07
 - ii. Screw conveyor 08

9. (a) A flat blade turbine with six blades is installed centrally in a vertical tank. The tank is 1.83 m in diameter, the turbine is 0.61 m in diameter, and is positioned 0.61 m from the bottom of the tank. The tank is filled to a depth of 1.83 m with a solution of 50 % caustic soda which has a viscosity of 12 cP and a density of 1.5 gm/cm³. The turbine is operated at 90 rpm. The tank is fitted with four baffles, each having a width of 19 cm. what will be the power consumption for the operation of the baffled mixture ? Data:

N_{Re}	10,000	60,000	80,000
P_o	5.8	6.0	6.0

- (b) Discuss briefly about the construction and operation of a V-blender with a neat diagram. 07
- (c) Discuss briefly about the nucleation and crystal growth steps of crystallization operation. 04
