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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

August 2024 Semester End Main Examinations

Programme: B.E. **Semester: III**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 22CH3PCMOP **Max Marks: 100**
Course: Mechanical Operations

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

UNIT - I

1 a) Table salt is fed to a vibrating screen at the rate of 100 kg/h. The desired product is -30 + 20 mesh fraction. The mass fraction data for oversize 30 mesh, oversize & undersize of 20 mesh is tabulated below. It is observed that oversize is 30 mesh, oversize from mesh 20 and undersize from mesh 20 are in the ratio 2:1.5:1. Estimate the effectiveness of the screen for the desired product. **10**

Mesh no.	-85+60	-60+40	-40+30	-30+20	-20+15	-15+10
Feed	0.097	0.186	0.258	0.281	0.091	0.087
Over Size 30 mesh	0.197	0.389	0.337	0.066	0.005	0.006
Oversize 20 mesh	0.026	0.039	0.322	0.526	0.061	0.026
Undersize 20 mesh	0.0005	0.0009	0.0036	0.3490	0.2990	0.3470

b) Differentiate between differential and cumulative screen analysis. **05**

c) Explain the working principle of gizzlies. **05**

UNIT - II

2 a) With a neat diagram, explain the construction and working principle of jaw crusher. **10**

b) Trap rock is crushed in a gyratory crusher. The feed size is 5.08 cm. The differential screen analysis data of the product is given in the table below. The power required to crush this material is 400 kWh/ton, out of this 10 kW power is required to operate the empty crusher. **10**
Design changes were made in the crusher for better performance. The crusher was used to crush the feed second time of same size. The differential screen analysis of the product is tabulated below. Apply Rittinger's and Kick's law to estimate the power required for the second operation. The feed rate after the design changes was considered as 110 ton/h.

Particle size Dp (mm)	Mass of product retained in g	
	First crush	Second crush
3.327	3.1	0
2.362	10.3	3.3
1.651	20.0	8.2
1.168	18.6	11.2
0.1590	15.2	12.3
0.0538	12.0	13.0
0.0210	9.5	19.5
0.0138	6.5	13.5
0.0082	4.3	8.5
0.0067	0.5	6.2
0.0049	0	4.0
0.0029	0	0.3

UNIT - III

3 a) Explain the working principle of rotary drum filter with a neat diagram. **08**

b) Consider a cylindrical column packed with berl saddles. The water is allowed to flow into the column against the gravity.The velocity of the water is maintained very low. The pressure of the water drops as it flows through the column. Estimate the pressure drop in the column with the help of relevant derivation from basic assumptions. **12**

OR

4 a) Cylindrical tower of diameter 0.6 m is packed with activated alumina. The packing height is 3.0 m. The tower is used to refine the naphtha flowing downwards from the tower. The operating condition of the tower is given below. **10**

Temperature = 27 °C, Density of naphtha = 700 $\frac{kg}{m^3}$, Viscosity of naphtha = 0.916 cP , Porosity of the bed = 0.4, Flow rate of naphtha = 7.0 $\frac{m^3}{h}$, Pressure drop in the bed = 2.38 atm. Estimate the diameter of the packing material.

b) A plate and frame filtration in operated at constant pressure. Derive the relevant equations to calculate specific cake and filter medium resistance for constant pressure condition. **10**

UNIT - IV

5 a) Show the range for settling criteria for a spherical particle in Stoke's and Newton's regime. **05**

b) Derive an expression to determine the one-dimensional motion of particles through a fluid if centrifugal force acts as external force. **10**

c) Explain the working of hydro cyclone separator with neat sketch. **05**

OR

6 a) Derive an expression to determine the minimum cross-sectional area required for a continuous thickener using a batch sedimentation data. **08**

b) A slurry of 10 % solids was subjected to a batch sedimentation test. The results of the test are tabulated below. **12**

Time (min)	0	10	20	30	40	50	60	70	80	90	100
Interface Height (cm)	32	29	25	20	15	13	10	8	7	6	5.5

Design a continuous thickener with a minimum area required to concentrate the given slurry solution to 50% solids using the batch test data. The feed to the continuous thickener is 100 ton/day of dry solids. Density of solids are 3200 kg/m^3.

UNIT – V

7 a) Explain the principle of electrostatic separation and froth floatation. **10**

b) A geometrically similar baffled stirred tanks, the power number is constant at high Reynolds number. Let P = power supplied per unit volume of the fluid, N = No of revolutions per second of agitator, ρ = density of the fluid, μ = viscosity of the fluid, and D = diameter of the impeller. The power is related to the parameters as shown in the expression below **10**

$$P = N^{\propto} \times \rho^{\beta} \times \mu^{\gamma} \times D^{\delta}$$

Determine values of $\alpha, \beta, \gamma, and\ \delta$ using dimensional analysis.

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