Q. Code: 939010

Reg. No. | | | | | | | | | | | | | |

B.E / B.TECH. DEGREE EXAMINATIONS, MAY 2024

Fourth Semester

CH18401 – MECHANICAL OPERATIONS

(Chemical Engineering)

(Regulation 2018 /2018A)

TIME: 3 HOURS **MAX. MARKS: 100**

CO 1 Impart the basic knowledge on the solid handling characteristics and mixed particle size analysis through screening.

CO 2 Estimate the power requirement for various comminution through the Laws of size reduction; along with the design of size reduction equipments.

CO 3 Classify various solid separation techniques through settling and basic knowledge on such equipment design.

CO 4 Apply the principles of filtration, mixing, conveying and storage of solids with related calculations for design of such equipments.

CO 5 Select the mechanical operation equipments with and without involving fluid mechanics principles.

PART- A (10 x 2 = 20 Marks)

(Answer all Questions)

		CO	RBT LEVEL
1.	List the specific properties of particulate solids that has significance at industry.	**1**	**2**
2.	Give reason why the solids have to be crushed and characterized at cement industry.	**1**	**3**
3.	Write the particulate solids sizes which to be called as Coarse, Medium and Fine particles.	**2**	**2**
4.	List the forces involved in size reduction in a ball mill?	**2**	**2**
5.	Mention the importance of hindered settling at the waste water treatment plant.	**3**	**3**
6.	Distinguish between settling and sedimentation.	**3**	**2**
7.	Mention some examples for filer aids and filter medium.	**4**	**2**
8.	Distinguish between cake filtration and deep bed filtration.	**4**	**2**
9.	Write the significance of mixing index for pastes and granular materials?	**5**	**2**

			Marks	CO	RBT LEVEL
10.	Suggest some equipment for dispersion of gas in liquids and liquids in liquids for petrochemical industry.		**5**	**3**	

PART- B (5 x 14 = 70 Marks)

			Marks	CO	RBT LEVEL
11. (a)	**(i)**	Elaborate the reason on how cumulative analysis is accurate than differential analysis with example.	**(10)**	**1**	**3**
	(ii)	Differentiate Ideal screens and Actual screens used at laboratory sampling at industries.	**(4)**	**1**	**3**

(OR)

(b)		Calculate the volume surface mean diameter and volume mean diameter for the -4 to +200 mesh fractions of the material analysed given in table below. From the results how does volume mean diameter differ qualitatively from the volume surface mean diameter.	**(14)**	**1**	**3**

Mesh	Screen Opening, mm	Mass fraction retained
4	4.699	0
6	3.327	0.025
8	2.362	0.125
10	1.651	0.321
14	1.168	0.257
20	0.833	0.159
28	0.589	0.054
35	0.417	0.021
48	0.295	0.010
65	0.208	0.008
100	0.147	0.006
150	0.104	0.004
200	0.074	0.003
Pan	-	0.008

12. (a)		Describe the working principle and salient features of any one Coarse crusher and any one Fine crusher with neat sketches.	**(14)**	**2**	**3**

(OR)

(b)		A material is to be crushed in a Blake Jaw Crusher and the average size of the particles is reduced from 60mm to 20mm with the energy consumption rate if 12 kW/kg.s. Investigate the energy needed to crush the same material of average size from 100mm to 25mm if Kick's law is applicable. Also comment what would be the significance of using Dodge Jaw Crusher.	**(14)**	**2**	**3**

13. (a)		Explain with neat sketch the principle and construction of Decker thickener used at ore processing industries.	**(14)**	**3**	**3**

(OR)

(b)	List the ratio of diameter of the particles if the Newton's region settling prevails in the cases of lead (density is 7800 kg/m^3) and quartz (density is 2650 kg/m^3) particles, settling separately in water at 20^{0}C with the identical settling velocity. Data as follows: Viscosity of water at 20^{0}C = 104 x 10^{-6} kg/ms Density of water at 20^{0}C = 1000 kg/m^3	**(14)**	**3**	**3**

14. (a)	Elaborate the description with neat sketch about a Continuous Filter used at process industry and compare with a batch filter used at same industry.	**(14)**	**4**	**3**

(OR)

(b)	A slurry containing 25.7 kg dry solids/m^3 of filtrate across the filter medium area 2.15 m^2 at a constant rate of 0.00118 m^3/s. The pressure drop was observed 4,000 and 8,500 Pa after 150 and 450 seconds of filtration, respectively. The viscosity of filtrate was 0.001 Pa.s. Determine the specific cake resistance and filter medium resistance.	**(14)**	**4**	**3**

15. (a)	A flat-blade turbine with six blades is installed centrally in a vertical tank. The tank is 1.5m in dia, the turbine is 0.68 m in dia and is positioned 0.68m from the bottom of the tank. The turbine blades are 12cm wide. The tank is filled to a depth of 1.8 m with a solution of 50 % caustic soda at 150^{0}C and its μ is 12 cP and its ρ is 1200 kg/m^3. The turbine operates at 90 r/min. the tank is baffled. What power will be required to operate the mixer? Assume power number 5.8 for NRe ≤ 70000 and 1.5 for NRe ≥ 70000.	**(14)**	**5**	**2**

(OR)

(b)	Explain with neat sketch the principle of Twin V mixer and mixing of liquids using pipe blender.	**(14)**	**5**	**2**

PART- C (1 x 10 = 10 Marks)

(Q.No.16 is compulsory)

		Marks	CO	RBT LEVEL
16.	An aqueous slurry containing 1.2% by weight solids (sp.gr = 2.0) is to be clarified by continuous sedimentation. Feed to the thickener is 3600 m^3 per day and the underflow from the unit analyses 8% solids. Design the diameter of the thickener, using the batch sedimentation test on the feed material gave the following information.	**(10)**	**3**	**5**

Time (min)	0	5	10	20	40	60	180	240	∞

Height of interface (cm)	31	21	10	3.2	2.2	2.1	2.0	1.96	1.94

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