Ex/FTBE/PC/B/T/226/2022

B. E. Food Technology and Bio-Chemical Engineering Examination, 2022

(2nd Year, 2nd Semester)

Mechanical Operation

Time : Three hours | Full Marks : 100

(50 Marksd for each Part

Use separate Answer Script for each Part

PART - I (50 Marks)

GROUP A

Answer any two questions **10×2 = 20**

1. What are the different types of sedimentation processes? Derive the expression for free settling velocity. 4+6 = 10
2. Derive the equation for the filtration process operating in a constant pressure system.
3. What is filter aid? Briefly describe on flocculation process. Write the role of different flocculating agents. 2+4+4 = 10

Group B

Answer any two questions **15×2 = 30**

4. (a) Differentiate sedimentation and flocculation process.
   (b) In a Type-I sedimentation process following data were obtained:

t (min)	0	60	80	100	130	200	240	420
C (mg/L)	300	189	180	168	156	111	78	27

Column height = 1.8m; loading rate = 25 m^3/day-m^2. Calculate overall removal efficiency. 3+12 = 15

5. (a) What are the different types of filtration processes?
   (b) The following data were obtained in a constant filtration unit for filtration of a yeast suspension.

t (min)	4	20	48	76	120
V (l filtrate)	115	365	680	850	1130

Characteristics of the filter as follows:

$A = 0.28 m^2$; $C = 1920$ kg/m^3; $\mu = 2.9 \times 10^{-3}$ kg/m-s; $\alpha = 4$ m/kg

(i) Determine the pressure drop across the filter, (ii) Determine the filter medium resistance, (iii) determine the size of filter for the same pressure drop to process 4000 l of cell suspension in 20 min. 3+12 = 15

6. (a) What is centrifugation coefficient? Derive the correlation between centrifugation coefficient and flow rate.
   (b) Yeast cells are recovered from a fermentation broth by using a tubular centrifuge. Sixty percent (60%) of the cells are recovered at a flow rate of 12 l/min with a rotational speed of 4000 rpm. Recovery is inversely proportional to flow rate.
   (i) To increase the recovery of cells to 95% at the same flow rate, what should be the rpm of the centrifuge?
   (ii) At a constant rpm of 4000 rpm, what should be the flow rate to result in 95% cell recovery? 5+10 = 15

[Turn over

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PART - II (50 Marks)

Q.1 is compulsory & answer any two from the following questions:

1. (i) If a non-spherical particle with sphericity 0.875 is to be compared with a spherical particle of diameter 0.2 inch in diameter. Estimate the surface area to volume ratio of the non-spherical particle?
(ii) What information is carried by the symbol 12/14 mesh screening analysis, technically?
(iii) In a screening operation, the following data is obtained for a particle with sphericity 0.92 and density 19,500 kg/m^3 in a Tyler Standard Screen as follows:

Mesh	Screen opening D_{pi} (mm)	Mass fraction retained(x_i)
4	4.699	0.000
6	3.327	0.615
8	2.362	0.278
10	1.653	0.024
Pan	_-	0.083

For the material between 6 and 8 mesh size, estimate A_w in mm^2/gm
(iv) In the above problem, estimate the volume-surface mean diameter.
(v) In the above problem, estimate the average particle diameter between 6 and 8 mesh size and between 8 and 10 mesh size. **5×2 = 10**

2. Write short notes on **4×5=20**
(i) cut-off diameter (ii) Sphericity (iii) Difference between toothed-roll crusher and smooth-roll crusher (iv) Difference between Ideal Screen and Actual Screen
3. In a crushing operation, 125 kW is required to reduce the size from 3.5 inch to 1 inch @ feed rate of 120 tons /hr. Estimate the work index of the material, (ii) How much power is required for the same material to be reduced from a size of 1.75 inch to 0.25 inch in diameter @ feed rate of 120 tons/hr? (iii) what would be the final dimension of the particle of the same material if the same power is applied to crush the material from initial dimension of 2.5 inch? **20**
4. The screen analysis shown in the following table applies to a sample of crushed quartz with density 2,650 kg/m^3 and the sphericity $\Phi s = 0.571$. For the material between 14-mesh and 35-mesh in particle size, calculate (i) A_w in m^2/gm (ii) volume mean diameter (iii) volume-surface mean diameter (iv) mass mean diameter **20**

Mesh	Avg. particle dia. (mm)	Mass fraction retained (x_i)
14	1.409	0.000
20	1.001	0.257
28	0.711	0.159
35	0.503	0.054
Pan	_-	0.53