BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE

Department of Chemical Engineering
Course Title: Separation Processes II (CHE F313)
SECOND SEMESTER 2022-2023
Comprehensive Exam(Closed Book)

Max. Marks: 70 **Weightage:35%**
Date: 27/12/22 *Answer all questions* **Time: 9:30 a.m-12:30 p.m.**
Please ensure that you receive the Annexure containing formulae
Please ensure that all the steps leading to the solution are given
Answer to the point only for all the answers

1 (a)A material has to be crushed in a jaw crusher and the average size of the particle is reduced from 10cm to 4cm with consumption of energy of 45 Watts /metric ton What will be consumption of energy necessary to crush the material from 12 cms to 3cms.The mass flow rate of the material is one kg/hr. The mechanical efficiency remains same using Kicks law and Rittingers law. **(3M+3M)**

(b) Write the mechanism of size reduction for jaw crusher and ball mill. **(4M)**

2.(a)0.5 tonnes of dolomite is produced by ball mill in closed circuit grinding with 100 mesh. The screen analysis is given below. Calculate the following
(a) amount of feed and overflow
(b) Effectiveness of the screen

Mesh	Feed	Oversize	Undersize
35	16.60	13.67	0
48	7.07	32.09	0
65	9.07	27.12	0
100	14.02	20.70	2.32
150	11.82	4.35	14.32
200 on	7.62	2.07	13.34
200 through	33.8	0	70.02

(6M)

(b) A company uses has powdery material which is proposed to be stored in bin or silo. During the discharge of this product company faces issues related to flowability and complete removal of the material from the bin. What could be the problems encountered explain with help of diagram and give possible suggestions to overcome this problem. **(4M)**

3(a)Fines have to be removed from gas stream to meet the environmental pollution norms. Suggest one equipment to do this and give reasons for the choice of this equipment along with working principle of this equipment. Please mention the design variables and operating variables for this equipment. **(5M)**

(b)If a particle is settling in stokes law range in centrifugal sedimentation. Along with a neat diagram derive a relation to find the time taken for the sedimentation. **(5M)**

4(a) Define the following (i) slimes (ii) sand (iii) cutpoint diameter in centrifugal sedimentation. **(3M)**
(b) What is the principle of measurement of wet bulb temperature? **(2M)**
(c) Write how the experiment is carried out in lab to design a thickener and what are important parameters to design a thickener. **(5M)**

5.(a) Sheet material, measuring $1m^2$ and 5 cm thick, is to be dried from 50% to 5% moisture under constant drying conditions. The dry density of the material is 500 kg per cubic meter and its equilibrium moisture content is 2%. The available drying surface is 1 m^2. Experiments showed that the rate of drying was constant at 5.1 kg/(hr)(m^2) between moisture contents of 50% and 20% and thereafter the rate decreased non linearly

according to the equation Nc=25 X^2-0.2X. What is critical moisture content and Calculate the total time required to dry the material from 50% to 5%. All moisture contents are on wet basis. **(6M)**

(b) Take example of silica gel used in bottles and drying of wood. One phase is common in both the cases. What is that phase and what is the desired operation for the transfer of this phase in both cases(direction of mass transfer). Explain **(4M)**

6. (a)The following data was obtained using a chromatograph

compound	t_r (min)	w (min)
A	8.04	0.15
B	8.26	0.15
C	8.43	0.16

Where" t "is the retention time and w is the peak width.Calculate the following

I. N for each compound
II. Average N for the column **(6M)**

(b) Does Raoult's law have any significance in the design of chromatograph if so how?please explain with justification for your answer. **(4M)**

7. (a)From ore purification of uranium to making of uranium rod with help of flow sheet show the various unit operation involved and reasons for your answer. **(5M)**

(b) Name at least five areas of separations where membranes can be used. **(5M)**

Annexure

$$\frac{W}{m} = \frac{6e_s}{\eta_c \eta_m \rho_p}\left(\frac{1}{\phi_b \overline{D}_{sb}} - \frac{1}{\phi_a \overline{D}_{sa}}\right)$$

$$sin\alpha_m \ \frac{p_V - p_L}{p_V + p_L}$$

$$q_c = \frac{\pi b \omega^2 (\rho_p - \rho) D_p^2 (r_2^2 - r_1^2)}{18\mu \ln(\frac{r_B}{r_A})}$$

$$t_T = \frac{18\mu \ln(r_B / r_{A)}}{\omega^2 (\rho_p - \rho) D_p^2}$$

$$q_c = \frac{\pi b \omega^2 (\rho_p - \rho) D_{pc}^2 (r_2^2 - r_1^2)}{18\mu \ln(2r_2(r_2 + r_1))}$$

$$q_s = 2Vu_T / s = 2VDp^2(\rho p - \rho)\omega^2 r_2 / 18\mu$$

$$u_{tB} = \frac{g D_{pB}^2 (\rho_p - \rho)}{18\mu}$$

$$t^* = \frac{L\rho_p (W_{sat} - W_o)}{u_o c_o}$$

$$\frac{q_T}{\dot{m}_s} = C_{pv}(T_{sb} - T_{sa}) + X_c C_{pL}(T_v - T_{sa}) + (X_a - X_b)\lambda + X_b C_{pL}(T_{sb} - T_v) + (X_a - X_b) C_{pv}(T_{va} - T_v)$$

$$m_A = \varepsilon c_{A,g} + \left(\rho_b s \frac{P}{\gamma_A P'_A} \frac{\rho_{M,l}}{\rho_{M,g}}\right) c_{A,g}$$