BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI, K. K. BIRLA GOA CAMPUS Comprehensive Examination CHE F313, Separation Processes II 1st Semester, 2022-2023 Date: 17-12-22 Max. Time: 180 min, Max. marks: 80

PART– A (15 marks, 30 minutes) Close Book ID #:

		Name	
Q1) Fill in the blanks (0.5 x 8= 4 ma	rks)		
a) Combustion is a unit			
b) The area of the opening in any one	screen in the Tyler standa	d screen series is exactly	that
of the opening in the next smaller scre	en.		
c) In ball mill the speed at which		occurs is called the critical speed.	
d) In	filters the only resista	nce is filter medium resistance.	
e) In	the filtration is	s carried using rotating basket in a perfor	rated bowl.
f) In crystallization the particle which	is just smaller than the crit	ical size is called	·
g)ca	n be minimized by coating	g crystals with an inert dust.	
h)	nucleation is restricted	to the formation of new particles within	a phase
uninfluenced by solids of any sort, inc	luding the walls of the con	tainer.	

Q2) Choose the correct option (put Tick mark) (0.5 x 6= 3 marks)

(i) A generic term f	or size reduction is			
(a) compression	(b) comminution	(c) agglomeration	(d) segregation	
(ii) Talc powder is	obtained from its granu	les by using		
(a) a roll crusher	(b) a jaw crusher	(c) a ball mill	(d) a gyratory crusher	•
(iii) The unit of Rittin	ger's number is			
(a) m^2/l	(b) $1/m^2$	$(c) J/(ton.m^2)$	(d) (ton.m ²) /J	
		(-,-, (,	(2) (22)	
(iv) Which of the fo	llowing is not commor	ly used as filter aid?		
(a) Perlite (b)) Diatomaceous earth	(c) Purified v	vood cellulose	(d) Rice husk
(,	(-)		(*)
(v) Which equipme	nt may be used for both	purposes ie to separa	te mixture of solid and	liquid, and also to separate
mixture of two diffe	erent liquids?			
(a) Centrifuge	(b) Plate and	frame filter press	(c) Leaf filter	(d) Rotary drum vacuum
filter				
(vi)	can be used to	estimate the number	of critical sized particle	s in the parent phase
(a) Kozeny Carman e	can be used to	Roltzmann statistics	(c) colligative properties	(d) viscosity measurement
(a) isozony Carman c	quantin (0) maxwell-	Donzinann statistics	c) comganite properties	(u) viscosity measurement

Q3) State True or False (0.5 x 8= 4 marks)

- a) Dodge- Jaw Crusher has a tendency to choke.
- b) Size reduction is one of the most energy efficient of all the unit operations.
- c) Screen capacity and efficiency are opposing factors.
- d) Use of small balls are peferred in ball mills for grinding.
- e) Pressure filters are usually continuous, while vacuum filters are usually discontinuous.
- f) A crystal formed from an impure solution is itself pure.
- g) Crystallization is a physical change.
- h) Low boiling point or volatile materials at operating temperature can be filtered using rotary drum vacuum filter.

Q4) For a cyclone if diameter =1 ft, u_{tan} =50 ft/s, what is the separation factor? (2 marks)

Q5) Show derivation to prove that for a critical sized particle the radius $r^* = -\frac{2\gamma}{\Delta g}$ (2 marks)

Where, Δg is the Gibbs free energy change per unit volume and γ is the surface energy per unit area of the interface separating the parent and the product phase.

Comprehensive Exam FOR CHE 313 (Separation Processes II) 17-12-2022 PART (B) CLOSED BOOK TOTAL 15 Marks (Each Question = 1 Mark) Time: 30 minutes

PART-B (Prof. Bawa's Portion) Write in supplementary sheet

- 1) What does the term EVA stand for?
- 2) What fabrication method was used for creating EVA membranes for drug delivery?
- 3) What was the fluid used to create the EVA membranes?
- 4) Write the algebraic equation that defines tortuosity.
- 5) Draw a sketch with clear labels that explains the tortuosity of pores.
- 6) Expand the term MWCO and Explain what it means.
- 7) Define t* in adsorption.
- 8) Define:
 - (a) MTZ
 - (b) LUB
- 9) For a cationic ion exchange resin what is the charge on the resin sites?
- 10) Explain the operative principles of:
 - (a) A dense membrane.
 - (b) A porous membrane.
- 11) Explain the term "Breakthrough Concentration" in adsorption.
- 12) Explain the terms thermal and pressure swings in the regeneration of an adsorbent.
- 13) Sketch diagram(s) that illustrate dead end vs. crossflow in membrane usage.
- 14) Explain the term osmotic pressure and osmotic energy.
- 15) Sketch a plot that describes a favourable vs. an unfavourable adsorption isotherm.

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PART – C (25 marks, 1 hr) Open Book

(Answer in supplementary answer sheet)

Q1) Trap rock is crushed in a gyratory crusher. The feed is nearly uniform 2" spheres. The differential screen analysis of the product is given below. The feed rate is 110 tons /h. Construct a table similar to that shown in Table 3. Using the data given in Table 1 and Table 2, fill the Table 3. Using Bond's method, estimate the power consumed (in kW). Given $W_i = 19.32$ kWh/ton for trap rock. (9 marks)

Table 1		Table 2		
			Mesh	Aperture size
Mesh	Product (kg)			Opening mm
4/6	3.1		4	<u>1 699</u>
6/8	10.3		T	4.077
0/10	20.0	-	6	3.327
8/10	20.0	-	8	2.362
10/14	18.6		10	1 651
14/20	15.2		10	1.051
20/28	12.0		14	1.100
20/20	12.0	-	20	0.833
28/35	9.5	-	28	0.589
35/48	6.5		25	0.202
10/65	1.2		35	0.417
48/03	4.5	-	48	0.295
-65	0.5		65	0.208
			05	0.200

Table 3	Mesh	Aperture size D _{pi} , mm	Mass retained kg	Mass fraction	Cumulative mass fraction smaller
			_	Xi	than D _{pi}
	4	4.699			
	6	3.327			
	8	2.362			
	10	1.651			
	14	1.168			
	20	0.833			
	28	0.589			
	35	0.417			
	48	0.295			
	65	0.208			
	Pan	pan			

Q2) An air stream with a flow rate of 7 m^3/s is passed through a cyclone of standard proportions. The diameter of the cyclone is 2m and the air temperature is 77°C.

(a) Determine the removal efficiency η for a particle with a density of 1.5 g/cm^3 and a diameter of 10 $\mu m.$

(b) Hence find the cut diameter $d_{0.5}$ (in μ m).

Given the viscosity of air at 77°C is 2.1×10^{-5} kg/m.s and N = 6 (number of turns the gas makes) Hint: Write formula, and show stepwise calculation. (5+3=8 marks)

Q3(a) What is the theoretical yield of crystals which may be obtained by cooling a solution containing 1000 kg of sodium sulphate (molecular mass = 142 kg/kmol) in 5000 kg water to 283 K? The solubility of sodium sulphate at 283 K is 9 kg anhydrous salt/100 kg water and the deposited crystals will consist of the deca-hydrate. It may be assumed that 2 percent of the water will be lost by evaporation during cooling.

Q3(b) For a measurable homogeneous nucleation rate of $10^6 \text{ m}^{-3}\text{s}^{-1}$, calculate the value of ($\Delta f^* + \Delta H_d$) in kJ/mol at temperature of 27 °C. (4 +4= 8 marks)

Part-D (Prof. Bawa's portion) Write in Main answer booklet PLEASE SHOW INTERMEDIATE STEPS FOR YOUR ANSWERS

- What is the osmotic pressure at 27 degrees C of a 1 L solution containing 50g of NaCl R = 0.0821 L atm/mol. K (5 points)
- 2) A centrifuge having a radius of 0.5 m is rotating at N = 1200 rev/min.
 (a) Calculate the centrifugal force developed in terms of gravity forces.
 (b) Compare this force to that for a bowl with a radius of 1 m rotating at the same rev/min (5 points)
- 3) Calculate the settling velocity of glass spheres having a diameter of 1.554 X 10^{-4} m in water at 293.2 K (20°C). The slurry contains 70 wt. % solids. The density of the glass spheres is $\rho_p = 2467 \text{ kg/m}^3$ Density of water $\rho = 998 \text{ kg/m}^3$, and viscosity of water $\mu = 1.005 \times 10^{-3} \text{ Pa} \cdot \text{s}$ Check your answer by providing the Reynold's number (5 points)
- 4) Find the terminal settling velocity of a spherical discrete particle with diameter 0.6 mm and specific gravity of 2.8 settling through water at 20 °C. $\rho_w = 998.2 \ kg \ m^{-3} \ \mu = 1.002 \times 10^{-3} \ Nsm^{-2}$ Check your answer by providing the Reynold's number. **(10 points)**