**BITS PILANI - DUBAI CAMPUS**

Dubai International Academic City, Dubai, U.A.E.

III Year Chemical Engineering, II Semester 2010-11

Course Code: CHE C431 **COMPREHENSIVE EXAM** Date: 02.06.11

Course Title: Selected Chemical Engineering Operations Max Marks: 70

Duration: 3 hr (Closed Book) Weightage: 35%

Note: Attempt ALL questions. Draw a labeled flow diagram wherever necessary, mentioning therein all the known and unknown variables. Write all assumptions and steps clearly.

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1. (a) Mention the situations when the batch kneaders and continuous kneaders can be used to mix in any industrial processes. (2 m)

1. (b) Mention the difference for the following (8 m)
(i) Jaw crusher and Gyratory crusher (4)
(ii) Hammer mill and Impactors (4)

1. (c) What are the factors which influences the performances of any size reduction mills? (4 m)

2. (a) A quartz mixture is screened through a 10-mesh screen. The cumulative screen analysis of feed, overflow and underflow are given in the table. Calculate the mass ratios of the overflow and underflow to feed. (2.5 m)

| Mesh | Dp(mm) | Feed | Overflow | Underflow |
|---|---|---|---|---|
| 4 | 4.699 | 0 | 0 | 0 |
| 6 | 3.327 | 0.025 | 0.071 | 0 |
| 8 | 2.362 | 0.15 | 0.43 | 0 |
| 10 | 1.651 | 0.47 | 0.85 | 0.195 |
| 14 | 1.168 | 0.73 | 0.97 | 0.58 |
| 20 | 0.833 | 0.885 | 0.99 | 0.83 |
| 28 | 0.589 | 0.94 | 1.0 | 0.91 |
| 35 | 0.417 | 0.96 | | 0.94 |
| 65 | 0.208 | 0.98 | | 0.975 |
| Pan | | 1.0 | | 1.0 |

2. (b) Discuss step by step procedure for designing a thickener using batch sedimentation data. (4 m)

2. (c) Discuss in detail the working principle and significance for the following separation equipments (7.5 m)
(i) Continuous vacuum filter (2.5)
(ii) Disk centrifuge (2.5)
(iii) Nozzle discharge centrifuge (2.5)

3. (a) A continuous countercurrent dryer is to be designed to dry 800 kg of wet porous solid per hour from 140 percent moisture to 20 percent, both on the dry basis. The average equilibrium moisture content is 5 percent of the dry weight. The total moisture content (dry basis) at the critical point is 40 percent and the constant rate of drying period is 0.297 kg/$m^2$ hour. The area exposed to the air is 1.1 $m^2$ per kg of dry solids. Determine the time required to retain the solids in the drier. (8 m)

3. (b) Sketch the temperature patterns of batch and continuous countercurrent adiabatic dryer. (4 m)

3. (c) What are adiabatic and non adiabatic dryers. (2 m)

4. (a) Equilibrium isotherm data for adsorption of glucose from an aqueous solution to activated alumina are as follows: (6 m)

| C (g/$cm^3$) | 0.0087 | 0.019 | 0.027 | 0.094 | 0.195 |
|---|---|---|---|---|---|
| Q (g solute/g alumina) | 0.053 | 0.075 | 0.082 | 0.123 | 0.129 |

Determine constants and max adsorption capacity from the Langmuir plot

4. (b) Using molecular sieves, water vapor was removed from nitrogen gas in a packed bed at 28°C. The column height is 0.268 m, with the bulk density of the solid bed being equal to 712 kg/$m^3$. The initial water concentration in the solid was 0.01 kg water / kg solid. The initial water concentration in the gas is $C_0 = 926 \times 10^{-6}$ kg water/kg nitrogen. The break through data is as follows

| t (hr) | 0 | 9 | 9.2 | 9.6 | 10 | 10.4 | 10.8 | 11.25 | 11.5 | 12 | 12.5 | 12.8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C (kg $H_2O$ /Kg $N_2 \times 10^6$) | 0.5 | 0.6 | 2.6 | 21 | 91 | 235 | 418 | 630 | 717 | 855 | 906 | 926 |

A value of C/Co = 0.02 is desired at the break point. Determine the break point time and total capacity used up to the break point. (3 + 3 m)

4. (c) Answer the following: (1.5 + 1.5 m)
i) What are the factors which influences the membrane coefficient?
ii) Define membrane selectivity

5. (a) Mention the classification of crystals on the basis of interfacial angles and discuss briefly. (3 + 3 m)

5. (b) Discuss in detail about circulating liquid evaporator crystallizer with its working principle and significance. (3 m)

5. (c) A salt solution weighing 10 tons with 30 wt % $Na_2CO_3$ (MW: 106) is cooled to 20°C. The salt crystallizers as the decahydrate. What will be the yield of $Na_2CO_3.10H_2O$ crystals if the solubility is 21.5 kg anhydrous $NaCO_3$/100 kg of total water? Assume 3 % of the total weight of the solution is lost by evaporation of water in cooling. (4 m)

**BITS PILANI - DUBAI CAMPUS**

Dubai International Academic City, Dubai, U.A.E.

III Year Chemical Engineering, II Semester 2010-11

Course Code: CHE C431 **TEST 2** Date: 17.04.11

Course Title: Selected Chemical Engineering Operations Max Marks: 15

Duration: 50 minutes (Open Book) Weightage: 15%

**Note : only prescribed text book and own handwritten notes are allowed, physical and chemical property tables are allowed**

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1. Discuss how the settling velocity is measured experimentally for designing a thickener. (2 m)

2. Mention the forces act upon a particle while free settling occurs. (2 m)

3. Granular carbon is used to remove phenol with an initial concentration of 50 ppm from an aqueous waste. Mesh size of 10 × 20 carbon and 100 ml of volume content for each batch is used at 30°C. Determine maximum adsorption capacity and constants of the following isotherms;
   a) Freundlich or Langmuir isotherm (4 m)
   b) Any other isotherm (other than above isotherms) (4 m)
   The equilibrium data:

| Mass, mg | 5 | 10 | 15 | 20 | 25 | 30 |
|---|---|---|---|---|---|---|
| Equilibrium Conc, ppm | 54 | 35 | 17 | 7 | 3 | 1 |

4. Determine the internal pressure drop for an oxygen-nitrogen hollow fiber separator that has 600 μm outside and 400 μm inside diameter fibers 1 m long. The permeate flux is 2 L/min $m^2$. What would be internal pressure drop for L = 10 m? (Data: $\mu = 1.8 \times 10^{-5}$ Pa –s, assume flux is constant along the length of the fiber) (3 m)

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III Year Chemical Engineering, II Semester 2010-11

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|---|---|---|
| Course Code: CHE C431 | **TEST 1** | Date: 27.02.11 |
| Course Title: Selected Chemical Engineering Operations | | Max Marks: 15 |
| Duration: 50 minutes | (Closed Book) | Weightage: 15% |

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1. Define sphericity for irregular particles. (1 m)

2. Explain how cohesive solids flow out of bins. (1.5 m)

3. How the degree of axial mixing is measured. (1.5 m)

4. Mention the significance of filter aids. (1.5 m)

5. Mention the significance of adding dry ice along with feed for crushing. (1 m)

6. Define septum (1 m)

7. Discuss in detail about the working principles and applications for the following equipments. (2.5 + 2.5 + 2.5 m)
   a. Centrifugal Filters
   b. Suspended batch centrifuges
   c. Roller mill

**BITS PILANI - DUBAI CAMPUS**

Dubai International Academic City, Dubai, U.A.E.

III Year Chemical Engineering, II Semester 2010-11

Course Code: CHE C431 **QUIZ 2** Date: 04.05.11

Course Title: Selected Chemical Engineering Operations Max Marks: 07

Duration: 20 minutes (Closed Book) Weightage: 07%

Each question carries one mark

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1. What is inverted solubility?

2. Solubility _____ as the temperature is raised for sodium chloride. (increases, decreases, changes slightly, has no change)

3. Calcium carbonate occurs commonly in nature in the orthorhombic form as _____

4. How supersaturation may be generated if the solubility of the solute increases strongly with increase in temperature?

5. Express the pretreatments which can increase the permeate quality in the membrane separation process.

6. Mention the significance of mixed matrix membranes with an example.

7. What are the process alternatives for oxygen production from air separation?

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III Year Chemical Engineering, II Semester 2010-11

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|---|---|---|
| Course Code: CHE C431 | **QUIZ 1** | Date: 23.03.11 |
| Course Title: Selected Chemical Engineering Operations | | Max Marks: 08 |
| Duration: 20 minutes | (Closed Book) | Weightage: 08% |

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1. How the surface fouling/gel layer of the membrane can be cleaned in the membrane separation operations. How it can be prolonged the period of satisfactory operation. (1.5 m)

2. How the membrane pore size distribution is determined. (1 m)

3. Mention the significance of pendulum blades and in which dryer it is used? (2 m)

4. Fluid bed dryer (1 m)

   a) Can be operated only horizontally
   b) Can be operated only vertically
   c) Can be operated either ways
   d) None

5. The feed for flash dryers are (1 m)

a) Wet pulverized solids
b) Solution and slurries
c) Pastes
d) Wet granules
e) Any wet materials

6. Mention the kinds of polymers used for ultra filtration membranes. (1.5 m)