BITS, PILANI – DUBAI

SECOND SEMESTER 2009 – 2010

THIRD YEAR – CHEMICAL

Course Code: CHE C431 **COMPREHENSIVE EXAM** Date: 23.05.10

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.

1.(a) Define the open-circuit and closed-circuit operation in the size reduction mills.(4 m).

(b) Mention the difference between agitated mill and colloid mill. (4 m)

(c) Discuss the various methods to calculate the average particle size of the crushed materials. (6 m)

2.(a) Discuss in detail about the various zones in the settling of flocculates suspension. (4 m)

(b) When the filter press is said to be jammed? (2 m)

(c) Sketch the various motions of the screens. (6 m)

(d) Mention the significance of precoat in rotary filter? (2 m)

3.(a) A batch drier is used to dry the wet solids under constant drying conditions. Ten hours are required to reduce the moisture content from 25 to 5%. The equilibrium moisture was found to be 3 % and the critical moisture 15%. All moisture contents are on the dry basis. Assuming that the rate of drying during the falling rate period is proportional to free moisture content, how long should it take to dry a sample of the same solid from 45 to 5 % under the same drying conditions? (10 m)

(b) Define the following: (1× 4 = 4 m)

(i) Critical moisture content

(ii) Equilibrium moisture

(iii) Bone dry

(iv) Examples of sweep gas

4.(a) Discuss the significance of the following; (2× 4 = 8 m)

(i) Narrow mass transfer zones in breakthrough curves

(ii) Wide mass transfer zones in breakthrough curves

(iii) Length of unused bed

(iv) Langmuir Isotherm

(b) A certain ion-exchange resin used ofr treating wastewater contains a finite quantity of charges groups. Therefore, the equilibrium can be expressed in the same way that adsorption equilibrium is described with an isotherm. Laboratory analysis of this resin shows that it follows the Langmuir isotherm

$$Y = \frac{aX}{b + X}$$

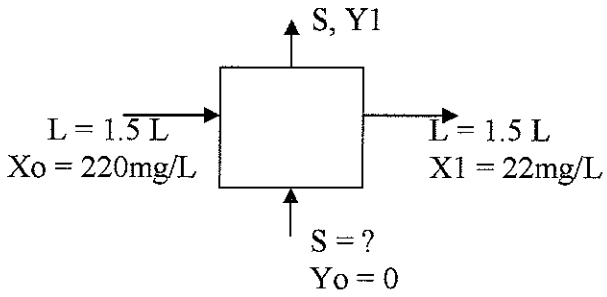
Where Y = amount exchanged (mass contaminant/volume resin)

X = concentration in solution (mass contaminant/volume water)

a = 70 mg/cm^3

b = 50 mg/L

If 1.5 L of an aqueous waste stream containing 220 mg/L contaminant, how much fresh resin is necessary to adsorb 90% of the contaminant? (10 m)



5.(a) Discuss in detail about the operation of draft tube baffle crystallizer with a neat sketch. (6 m)

(b) Sketch the flow arrangements for hollow fiber membranes (4 m)

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SECOND SEMESTER 2009 – 2010

THIRD YEAR – CHEMICAL

Course Code: CHE C431 **TEST 2** Date: 18.04.10

Course Title: Selected Chemical Engineering Operations Max Marks: 15

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

Note: only prescribed txt book and own handwritten notes are allowed

1. Mention the factors influence the effective diffusion coefficient for the adsorption operation. (2 m)

2. Granular activated carbon impregnated with sulfur is used to remove mercury vapor from natural gas and from air. Because chemical reaction converts the mercury to mercuric sulfide, the adsorption is irrervesible, and the capacity is as high as 20 weight percent. Assuming that the adsorption rate for removal of mearcury (A) from air (B) is controlled by external mass transfer, calculate the overall coefficient for a bed of 4×6 mesh carbon at 20°C, and superficial velocity of 75 cm/s. The adsorption carried out at 1 atm pressure. (6 m)
   Data: for air at 20°C, 1 atm, $\mu = 0.0179$ cp, $\rho = 1.206 \times 10^{-3}$ g/cm^3
   For Hg, mw = 200.59, boiling point = 357 °C

3. Specify the equipments for the following operations; (one mark each)
   a) The drying capacity is proportional to the active drying area.
   b) Moisture is rapidly vaporized from the droplets, leaving residual particles of dry solids.
   c) The particles are fluidized by gas in a boiling bed unit. Mixing and heat transfer are very rapid.
   d) The production rate is small, drying by circulation of air across stationary layers of solid is slow and drying cycles are long.

4. Air carrying particles of density 1800 kg/m^3 and an average diameter of 20 μm enters a cyclone at a tangential velocity of 18m/s. The diameter of the cyclone is 600 mm. What is the approximate separation factor for this cyclone? (3 m)

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SECOND SEMESTER 2009 – 2010

THIRD YEAR – CHEMICAL

Course Code: CHE C413 **TEST 1** Date: 07.03.10

Course Title: Selected Chemical Engineering Operations Max Marks: 08

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

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1. How the particle sizes are expressed from coarse to ultra fine particles. (2 m)

2. Sketch the particle size distribution for powders for differential and cumulative analysis. (2 m)

3. Classify the particulate solids with respect to their flow properties. Explain with examples. (2 m)

4. Data on the rate of mixing of sand and salt particles in an air-fluidized bed are given in table. The number of particles in each spot sample was about 100. Calculate the estimated standard deviation s. Data on mixing of 35/48 mesh salt in sand in a 2in air-fluidized mixer with mixing time of 45 seconds. (3 m)

0.64	0.68	0.74	0.63	0.73
0.66	0.64	0.77	0.7	0.67
0.49	0.52	0.49	0.54	0.64
0.25	0.32	0.33	0.35	0.48
0.26	0.26	0.21	0.32	0.38

5. Sketch the fluid energy mill and smooth roll crusher and mention its feed and product sizes. (3 m)

6. Define screen capacity. (1 m)

7. What is under size and over size particles? (1 m)

8. Mention the materials by which the industrial screens are made. (1 m)

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SECOND SEMESTER 2009 – 2010

THIRD YEAR – CHEMICAL

Course Code: CHE C431 **QUIZ 2** Date: 10.05.10

Course Title: Selected Chemical Engineering Operations Max Marks: 07

Duration : 20 minutes (Closed Book) Weightage: 7%

Name: ..... **ID No:** ..... **Sec / Prog:** .....

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1. The sequence of stages in the evolution of a crystal is (1 m)
   a) embryo - cluster – nucleus – crystal
   b) cluster – embryo – nucleus – crystal
   c) nucleus - embryo - cluster – crystal
   d) none

2. Solubility _____ with increase in temperature for $MnSO_4.H_2O$ (1 m)
   a) decreases
   b) increases
   c) no effect
   d) increases and then decreases

3. Mention the reasons for slow growth rate of the crystals.(1 m)

4. Mention the difference between salting and precipitation in the generation of super saturation solution. (2 m)

5. Match the following; (2 m)

birth of the new particles	- permeability
Invariant crystals	- concentration polarisation
Removal of VOC	- dialysis
Polymer membranes	- embryo
	- none
	- geometrically similar
	- geometrically dissimilar
	- pervaporation
	- nucleation
	- none
	- reverse osmosis
	- none
	- solution diffusion
	- none

BITS, PILANI – DUBAI

SECOND SEMESTER 2009 – 2010

THIRD YEAR – CHEMICAL

Course Code: CHE C431 **QUIZ 1** Date: 29.03.10

Course Title: Selected Chemical Engineering Operations Max Marks: 08

Duration : 20 minutes (Closed Book) Weightage: 8%

Each question carries 0.5 marks

Name: ..... **ID No:** ..... **Sec / Prog:** .....

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1. In constant pressure filtration,
   a) Resistance decreases with time
   b) Rate of filtration is constant
   c) Rate of filtration increases with time
   d) Rate of filtration decreases with time

2. At the beginning of filtration, the cake resistance is
   a) maximum, b) optimum
   c) minimum and greater than zero d) zero

3. A rotary drum filter is –
   a) a continuous vacuum filter b) a discontinuous pressure filter
   c) a continuous pressure filter d) none of the above

4. The thickness of cakes formed on industrial rotary vacuum filters is usually between
   a) 0.5 and 2 mm b) 3.2 and 38 mm
   c) 80 and 100 mm d) 200 and 400 mm

5. Filter aids are added to the slurry prior to filtration in order to form
   b) compact cakes of low porosity b) cakes of increased porosity

c) crystalline cakes d) none of the above ;

6. In a filter bed, the liquid flow
   a) is laminar
   b) is turbulent
   c) is between laminar and turbulent
   d) cannot be predicted, information on process conditions and filter medium is necessary.

7. The speed of rotation of an industrial rotary – drum filter is
   a) 0.1 to 2 RPM b) 25 to 50 RPM
   c) 50 to 100 RPM d) 100 to 200 RPM

8. The rate of hindered settling is
   a) more than that of free settling b) less than that of free settling
   c) equal to that of free settling

9. Cyclones are usually employed to separate
   a) solids from gases b) solids of two different substances
   c) solids from liquids d) all (a), (b), (c)

10. Wet classifier is
    a) sharples supercentrifuge b) hydrocyclone
    b) door Oliver rake classifier c) all of the above

11. Batch filter can be operated by
    a) pressure is to be kept constant b) flow rate is to be kept constant
    c) either (a) or (b) above d) none of the above

12. The unit of filter medium resistance is
    a) $kg.m^{-1}$ b) m^{-1} c) $m.kg^{-1}$ d) kg^{-1}

13. Filters used for separation of sugar solution from settled out mud is

a) sparkler filter b) plate and frame filter

c) centrifugal filter d) rotary drum vacuum filter

14. Moisture can be removed from lubricating oil using

a) tubular centrifuge b) clarifier

c) sparkler d) vacuum leaf filter

15. Diatomaceous earth is

a) explosive b) filter aid

c) filter medium d) none of the above

16. In plate and frame press, the slurry is introduced through a pot in

a) in the centre of the press b) one side of press

b) each frame d) none of the above