BACHELOR OF TECHNOLOGY (C.B.C.S.) (2014 COURSE)
B.Tech.Sem - V CHEMICAL : WINTER- 2022
SUBJECT : MASS TRANSFER OPERATION

Day : Thursday | Time : 02:30 PM-05:30 PM

Date : 8/12/2022 | **W-13501-2022** | Max. Marks : 60

N.B.:

1) All questions are **COMPULSORY**.
2) Figures to the right indicate **FULL** marks.
3) Use of non-programmable **CALCULATOR** is allowed.
4) Assume suitable data if necessary.

Q.1 Calculate the rate of diffusion of NaCl at 18^0C through a stagnant film of NaCl-water mixture 1 mm thick when the concentrations are 20% and 10% (by weight) respectively on either side of the film. Diffusivity of NaCl in water is 1.26×10^{-9} m^2/s. The densities of 20% and 10% NaCl solutions are 1149 and 1067 kg/m^3 respectively. **[10]**

OR

a) Derive the expression of molar flux, N_A for the case of equimolar counter diffusion. **[05]**

b) Describe steady state diffusion in solids. **[05]**

Q.2 a) What are the assumptions of film theory? Describe the said theory with a neat sketch. **[05]**

b) What is two resistance concept in interphase mass transfer? **[05]**

OR

Draw a schematic diagrams and describe the material balances for steady state co-current and counter-current processes of interphase mass transfer. **[10]**

Q.3 Describe the HTU, NTU calculations for absorption operation. **[10]**

OR

An air – NH_3 mixture containing 5% NH_3 is being scrubbed with water in a packed tower to recover 95% NH_3, G_1 = 3000 kg/hm^2, L_s = 2500 kg/hm^2. Tower is maintained at 25^0C and 1 atmosphere pressure. Find NTU and height of tower. The equilibrium relation is given by $y = 0.98x$, where x and y are mole fraction units. $K_G.9 = 65$ kmol/h m^3 atmosphere. **[10]**

Q.4 a) Derive a relation between Wet Bulb temperature and humidity. **[05]**

b) In a vessel at 101.3 kN/m^2 and 300 K the percentage relative humidity of water vapour in air is 25. If the vapour pressure of air at 300K is 3.6 kN/m^2 calculate: **[05]**

i) the partial pressure of water vapour in the vessel.
ii) the specific volumes of air and water vapour.
iii) the humidity of air and humid volume.
iv) the percentage humidity.

OR

Design a cooling tower to obtain the height of a cooling tower. **[10]**

P.T.O.

Q.5 a) Give the classification of dryers. [04]

b) Describe in detail rotary dryers with a neat sketch. [06]

OR

a) A wet solid is dried from 40 to 8% moisture in 5.55 hrs. If the critical and equilibrium moisture contents are 15 and 4 percent respectively, how long will it take to dry the solid to 5% moisture under the same conditions. All moisture contents are on dry basis. [06]

b) With a neat sketch explain spray dryers. [04]

Q.6 a) Explain Mier's super saturation theory with diagram. [05]

b) Sodium acetate solution is available at 70^0 C with a solute content of 58%. Find out percentage saturation, yield of crystals and percentage yield if 2000 kg of this solution is cooled to 10^0C. [05]
Solubility at 70^0C = 146 gms of sodium acetate / 100 gms of water
Solubility at 10^0C = 121 gms of sodium acetate / 100 gms of water

OR

A Swenson-Walker crystallizer has to produce 800 kg/h of $FeSO_4.7H_2O$ crystals. The saturated solution enters the crystallizer at 49^0C and the slurry leaves at 27^0C. Cooling water is circulated which enters the jacket at 15^0C and leaves at 21^0C. The overall heat transfer coefficient is 175 cal/hr. m^2 ^{0}C. There are 1.3 m^2 of cooling surface per meter of crystallizer length. [10]

i) Estimate the cooling water requirement in kg/h.

ii) Determine the number of crystallizer sections, each section being 3 m long.

Data:

1) At 49^0C saturated solution contains 140 parts of $FeSO_4.7H_2O$ per 100 parts of water.
2) At 27^0C saturated solution contains 74 parts of $FeSO_4.7H_2O$ per 100 parts of water.
3) Average specific heat of the initial solution is 0.7 kcal/kg^{0}C and the heat of crystallization is 15.8 kcal/kg.

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