B.TECH SEM - V (2007 COURSE) (CHEMICAL ENGG.) : WINTER - 2017

SUBJECT: MASS TRANSFER – I

Day : **Thursday**
Date : **18/01/2018**

Time **02.30 PM TO 05.30 PM**
Max. Marks : 80

W-2017-2446

N.B.

1) **Q.1** and **Q.5** are **COMPULSORY.** Out of the remaining attempt any **TWO** questions from each Section.
2) Figures to the right indicate **FULL** marks.
3) Answers to both the sections should be written in **SEPARATE** answer book.
4) Use of non-programmable calculator is allowed.

SECTION – I

Q.1 **a)** Describe in detail about local overall mass transfer coefficient. **(05)**

b) Explain in brief about absorption and stripping factors. **(05)**

c) Explain in brief about any one analogy of mass, heat and momentum transfer **(04)**

Q.2 **a)** In an oxygen-nitrogen mixture at 10 atm and 25^0C, the concentration of oxygen at two places of 0.2 cm apart are 10 and 20 volume percent respectively. Calculate the rate of diffusion of oxygen expressed as gm/cm^2. hr for the case of steady state diffusion of oxygen through non diffusing nitrogen. **(09)**

b) Explain in brief Fick's and Maxwell's law of diffusion. **(04)**

Q.3 **a)** Describe material balance for steady state counter current mass transfer processes. **(07)**

b) Discuss in brief about the two resistance concept in interphase mass transfer. **(06)**

Q.4 5000 kg/hr of a SO_2 air mixture containing 5% by volume SO_2 is to be scrubbed with 200,000 kg/hr of water in a packed tower. The exist concentration of SO_2 is reduced to 0.15%. The tower operates at 1 atm. The equilibrium relationship is **(13)**

$$Y=30X \quad \text{Where } Y=\frac{\text{moles of } SO_2}{\text{moles of air}}$$

$$X=\frac{\text{moles of } SO_2}{\text{moles of water}}$$

If the packed height of the tower is 420 cm, estimate the height of transfer unit (HTU).

P.T.O.

SECTION – II

Q.5 **a)** Discuss typical equilibrium diagrams used in leaching operation. **(05)**

b) Describe Mier's super saturation theory in brief. **(05)**

c) Discuss about the vortex formation and prevention in mechanically agitated vessel **(04)**

Q.6 **a)** Explain the operation of packed towers and describe the various types of packings used in packed towers. **(07)**

b) Explain with neat sketch the operation of Venturi scrubbers. **(06)**

Q.7 **a)** Discuss in brief about the rate of nucleation in crystallization. **(04)**

b) A Swenson Walker crystallizer is to cool a 23% solution of $Na_3 PO_4$ from a temperature of 40 °C to 25 °C. During the cooling $Na_3PO_4.12H_2O$ is crystallized. It is desired to produce 225 kg product per hour. The solubility of Na_3PO_4 at 25^0C is 15.5 parts anhydrous salts per 100 parts total water. The specific heat of the solution can be taken as 0.77 kcal/ kg °C and the heat crystallization of 1kg product is 35 kcal/kg. Cooling water is to enter the crystallizer jacket at 15^0C and is to leave at 20^0C. The over all heat transfer coefficient is 120 kcal/h m^2 °C. What length of crystallizer should be used? **(09)**
Atomic weight of P = 31, effective heat transfer area is $1m^2$ per running metre of crystallizer.

Q.8 **a)** Describe with neat sketch single stage leaching operation. Mention the solute and solvent balances in single stage leaching. **(04)**

b) Crushed oil seeds containing 55% oil (by wt.) is to be extracted at the rate of 4000 kg/hr using 100 kg/min of n-hexane containing 5% oil (by weight) as the solvent. A counter current two stage extraction system is employed. The oil seeds will retain 1 kg of solution per kg of oil free cake. Estimate the percent recovery of oil (based on original feed) obtained under the above conditions. **(09)**

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