B.Tech. SEM -V (Chemical 2014 Course (CBCS) : WINTER - 2018

SUBJECT: MASS TRANSFER OPERATION

Day: Thursday
Date: 22/11/2018

W-2018-2374

Time: 02.30 PM TO 05.30 PM
Max Marks. : 60

N.B. :

1) All questions are **COMPULSORY**.
2) Figures to the right indicate **FULL** marks.
3) Assume suitable data, if necessary.
4) Draw neat diagrams wherever necessary.

Q. 1 In the oxygen – nitrogen mixture at 10 atmosphere and 25^0 C, 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 nitrogen non-diffusing. Value of diffusivity is $0.181 cm^2/sec$. **(10)**

OR

Q. 1 Calculate the rate of diffusion of water vapor from a thin layer of water at the bottom of well 6 cm in height to dry air flowing over the top of the well. Assume the entire system is at 298 K and atmospheric pressure. If the well diameter is 3m, find out the total weight of the water diffused per second from surface of water in the well. The diffusion coefficient of water vapor in dry air at 298 K and atmospheric pressure is 0.256×10^{-4} m^2/sec. The partial pressure of water vapor at 298 K is 0.0323×10^{-4} Kg/m^2. **(10)**

Q. 2 **a)** Describe film theory in brief and draw the concentration distribution diagram **(05)**

b) Derive the relationship between individual and overall mass transfer coefficient. **(05)**

OR

Q. 2 **a)** Draw a schematic diagram for a counter-current process in interphase mass transfer. State the component balance for solute and derive the generalized equation representing the operating lines. Also show graphically the operating lines and equilibrium curve for the said process. **(05)**

b) Describe the Chilton – Colburn Analogy in brief. **(05)**

Q. 3 A packed tower is designed to recover 98% CO_2 from a gas mixture containing 10% CO_2 and 90% air using water. **(10)**

A relation y = 14x can be used for equilibrium conditions where

$$y = \frac{\text{kg } CO_2}{\text{kg dry air}}, x = \frac{kg\, CO_2}{\text{kg water}}$$

The water to gas rate is kept 30% more than the minimum value. Calculate the height of the tower if HTU is 1 meter.

OR

Q. 3 Describe in detail the HTU and NTU calculations in absorption process. **(10)**

Q. 4 **a)** Describe the adiabatic saturation curves. **(06)**

b) Define absolute humidity, relative humidity and vapor pressure **(04)**

OR

Q. 4 A mixture of nitrogen and acetone vapor at 800 mm of Hg at 25°C has a saturation of 80%. Calculate the (a) absolute molal humidity, (b) Partial pressure of acetone, (c) Mass absolute humidity and (d) Volume percent of acetone. Assume vapor pressure of acetone at 25°C as 190 mmHg **(10)**

P.T.O.

Q. 5 **a)** Explain with neat diagram, bound and unbound moisture. **(05)**

b) Derive an equation for time required for drying in falling rate period. **(05)**

OR

Q. 5 A filter cake is dried for 5 hours from an initial moisture content of 30% to 10% on wet basis. Calculate the time required to dry the filter cake from 30% to 6% on wet basis. Equilibrium moisture content = 4% on dry basis, Critical moisture content = 14% on dry basis. Assume that the rate of drying in falling rate period is proportional to free moisture content. **(10)**

Q. 6 **a)** Explain the rate of crystal growth and derive the relevant equation. **(05)**

b) Describe the Mier's super saturation Theory. **(05)**

OR

Q. 6 A Swenson walker Crystallizer is used to produce hydrated crystals of $Na_2SO_4.10H_2O$ by cooling the solution from 300K to 290 K with the help of cooling water which enters at 280 K and leaves at 290 K. Assuming evaporation to be negligible determine the number of sections of crystallizer, each 3 m long, required to process 0.25 kg/s of product. **(10)**

Data:

Solubility of Na_2SO_4 at 300 K and 290 K is 40 kg and 14 kg per 100 kg water respectively.

Mean heat capacity liquor = 3.8 kJ/kg K

Heat of Crystallization = 230 kJ/kg

Available area for heat transfer in crystallizer is 3 m^2 per 1 m length of crystallizer

Overall heat transfer coefficient = 0.15 kW / m^2 K

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