B.TECH. SEM -V (CHEMICAL 2014 COURSE (CBCS) : SUMMER - 2018

SUBJECT : MASS TRANSFER OPERATION

Day : **Monday**
Date : **21/05/2018**

S-2018-2319

Time : **10.00 AM TO 01.00 PM**
Max. Marks : 60

N.B.

1) All questions are **COMPULSORY.**
2) Figures to the right indicate **FULL** marks.
3) Steam tables are **ALLOWED.**

Q.1 **a)** Derive the equation for steady state molecular diffusion in fluids at rest and in laminar flow. **(06)**

b) Explain in detail diffusivity of liquids. **(04)**

OR

Q.1 **a)** Derive the equation for steady state equimolal counter diffusion. **(06)**

b) Write a short note on diffusivity of gases. **(04)**

Q.2 Derive the material balance equations for: **(10)**

a) Continuous cross current multistage cascades

b) Continuous counter current multistage cascades

OR

Q.2 **a)** Explain in detail mass, heat and momentum transfer analogies. **(05)**

b) Explain in detail surface stretch theory. **(05)**

Q.3 A mixture of acetone vapour and air containing 5% by volume of acetone is to be freed to its acetone content by scrubbing it with water in packed bed absorber. The flow rate of the gas mixture is 700 m^3/hr of acetone-free air measured at NTP and that of water is 1500 kg/hr. The absorber operates at an average temperature of 20^0 C and a pressure of a 101 kPa. The scrubber absorbs 98% acetone. The equilibrium relation for the acetone vapour water system is given by $Y^* = 1.68 X$

Y^* = k mole acetone /k mole dry air

X = k mole acetone/ kmole water.

Calculate :

a) Mean driving force for absorption

b) Mass transfer area if the overall mass transfer coefficient is K_G = 0.4 k mole of acetone/m^2 (k mole acetone per k mole dry air)

OR

Q.3 500 kg/hr of a SO_2 – air mixture containing 5% by volume of SO_2 is to be scrubbed with 2,00,000 kg/hr of water in a packed tower. The exit concentration of SO_2 is reduced to 0.15%. The tower operates at 1 atm. The equilibrium relation is given by **(10)**

$Y^*=30X$

$$Y=\frac{\text{Mole } SO_2}{\text{Mole air}}$$

$$X=\frac{\text{Mole } SO_2}{\text{Mole water}}$$

If the packed height of tower is 0.42 m. Calculate the height of transfer unit.

P.T.O.

Q.4 Define and explain following terms related to humidification: **(10)**

a) Absolute humidity
b) Relative humidity
c) Humid volume
d) Humid heat
e) Adiabatic saturation temperature

OR

Q.4 Explain in detail: **(10)**

a) Humidity chart
b) Lewis relation

Q.5 A batch solid for which the following table of data applied to be dried from 25% to 6% moisture under conditions identical to those for which the data were tabulated. The initial weight of the wet solid is 300 kg and the drying surface is 1 m^2/ 8 kg dry weight. Determine the time for drying. **(10)**

X	0.35	0.25	0.2	0.18	0.16	0.14	0.12	0.1	0.09	0.08	0.064
N	0.3	0.3	0.3	0.266	0.239	0.208	0.180	0.150	0.097	0.07	0.025

Where $X = \frac{\text{kg moisture}}{\text{kg dry solid}}$

$N = \frac{\text{kg moisture evaporated}}{\text{hr.m}^2}$

OR

Q.5 1000 kg (dry mass) of non-porous solid is dried under constant drying conditions with an air velocity of 0.75 m/s. The area of drying surface is 55 m^2. If the initial rate of drying is 0.3 g/m^2s, how long it will take to dry a material from 0.15 to 0.025 kg water/kg dry solid? The critical moisture content is 0.125 kg water/kg dry solid. Assume that the falling rate is linear. The equilibrium moisture content may be assumed to be zero. **(10)**

If the air velocity is increased to 4 m/s, what will be anticipated saving in drying time?

Assume that the rate of evaporation in constant rate period is proportional to the air velocity raised to the power of 0.80.

Q.6 Calculate the yield of $MgSO_4.7H_2O$ crystals when 1000 kg saturated solution of $MgSO_4$ at 353 K is cooled to 303 k assuming 10% of the water is lost by evaporation during cooling. **(10)**

Solubility of $MgSO_4$ at 353 k = 64.2/100 kg of water. Solubility of $MgSO_4$ at 303 k = 40.8/100 kg water. At Wt. Mg = 24, S = 32, H = 1 and O = 16.

OR

Q.6 Derive equation for calculating : **(10)**

a) % yield of crystallization
b) Enthalpy balances for crystallization

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