Solution for mid sem. Exam - 2018

Subject - Chemical Engg - II, code - 071505

Branch - Leather Technology (VIth sem)



Q.1 (a) Explain the methods for super saturation.

Ans - (1) Supersaturation by cooling a solution through indirect heat exchange.

(2) Supersaturation by evaporation of a part of the solvent.

(3) Supersaturation by adding a new substance

(4) Supersaturation by chemical reaction with a third substance.

Q.1 (b) Write down the mechanism of crystallization.

Ans. The first step is nucleation and the second is called crystal growth - the growth of crystals to macroscopic size.

The generation of a new solid phase either on an inert material in the solution or in the solution itself is called nucleation while the increase in size of this nucleus with layer by layer addition of solute is called crystal growth.

Q.2 (a) What are the difference between physical and chemical adsorption.

Ans -

| Physical adsorption | Chemisorption |
|---|---|
| (1) Forces involved are weak. | 1. Forces involved are stronger. |
| (2) It is readily reversible phenomenon. | (2) It is irreversible process. |
| (3) Heat of adsorption is small | (3) Heat of adsorption is large. |
| (4) Non-specific in nature, entire surface is available for adsorption. | (4) Highly specific in nature and restricted to active sites on the surface. |
| (5) Activation energy is low, nearly negligible | (5) Activation energy is high, corresponding to chemical reaction. |

Q.2 (b) Explain the properties of good adsorbent.

Ans. (1) Adsorbent solids are usually used in granular form with size ranging from 12mm in diameter to 55 mm.

(2) They must possess a large surface area per unit mass.

(3) They should have preferential ability to take up the adsorbate

(4) These are usually highly porous materials.

(5) They should be free flowing for ease in handling.

(6) They should have adequate strength and hardness.

(Q-3(a)) Decline the formula for steady state diffusion of A thorough non diffusing B in gas phase.

Ans. diffusion - $N_A = N x_A + J_A$

$$N_A = (N_A + N_B)\frac{C_A}{C} - D_{AB}\frac{\partial C_A}{\partial z}$$

$$\int_{C_{A1}}^{C_{A2}} \frac{-dC_A}{N_A C - C_A(N_A + N_B)} = \frac{1}{C D_{AB}} \int_{z_1}^{z_2} dz$$

$$\frac{1}{N_A + N_B} \ln \frac{N_A C - C_{A2}(N_A + N_B)}{N_A C - C_{A1}(N_A + N_B)} = \frac{z}{C D_{AB}}$$

$$N_A = \frac{N_A}{N_A + N_B} \frac{D_{AB}}{z} \ln \frac{(N_A/(N_A + N_B)) - C_{A2}/C}{(N_A/(N_A + N_B)) - C_{A1}/C}$$

for ideal gas,

$$\frac{C_A}{C} = \frac{P_A}{P_t} = y_A$$

$P_A$ = Partial pressure of com A

$P_t$ = total pressure

$y_A$ = mole fraction

$$C = \frac{n}{V} = \frac{P_t}{RT}$$

$$N_A = \frac{N_A}{N_A + N_B} \frac{D_{AB} P_t}{RTz} \ln \frac{(N_A/(N_A + N_B))P_t - \bar{P}_{A2}}{(N_A/(N_A + N_B))P_t - \bar{P}_{A1}}$$

A is diffusing and B is non diffusing.

$N_A$ = const, $N_B = 0$

$$\frac{N_A}{N_A + N_B} = 1$$

So, (1)

$$N_A = \frac{D_{AB} P_t}{RTz} \ln \frac{P_t - P_{A_2}}{P_t - P_{A_1}}$$

Ques. 3. (b) Explain fick's law of diffusion.

Ans. The diffusivity, or diffusion coefficient, $D_{AB}$ of a constituent A in solution in B, which is a measure of its diffusive mobility, is then defined as the ratio of its flux $J_A$ to its concentration gradient

$$J_A = -D_{AB} \frac{\partial c_A}{\partial z} = -c D_{AB} \frac{\partial x_A}{\partial z}$$

Q-5 (a) Explain about Humid volume.

Ans. **Humid volume** - The humid volume $v_H$ of a vapour gas mixture is the volume of unit mass of dry gas and its associated vapours at the maximum temp and pressure.

For an ideal vapour-gas mixture of absolute humidity $y'$ at temp $t_G$ and pressure $P_t$. the humid volume is given by.

$$v_H = \left(\frac{1}{m_B} + \frac{y'}{m_A}\right) \times 22.41 \times \frac{t_G + 273}{273} \times \frac{1.013 \times 10^5}{P_t}$$

$$v_H = 8315 \left(\frac{1}{m_B} + \frac{y'}{m_A}\right) \left[\frac{t_G + 273}{P_t}\right]$$

$v_H$ = humid volume, $m^3/kg$ dry gas

$t_G$ = temperature of mixture, °C.

$P_t$ = Pressure - $P_a$

(Q. 56) What do you understant by Relative saturation.

Ans. The relative saturation, also called relative humidity is defined by -

$$\text{Relative saturation - fraction} = \frac{P_A}{P_{A\,sat}}$$

$$\text{Relative saturation - \%} = \frac{100\,P_A}{P_{A\,sat}}$$

Q-6 An an oxygen–nitrogen mixture at 1 atm and 20°C the concentration of oxygen at two places of 0.3 cm apart are 20 and 80 volume present respectively. Calculate the rate of diffusion of oxygen expressed as gm/cm² for the case of unicomponent diffusion (nitrogen is non – diffusing).

Data:- value of diffusivity between oxygen – nitrogen = 0.181 cm²/sec.

R = 82.06 atm.cm³/gm.mol.K

ns- $D_{AB} = 0.181\ cm^2/sec$

$P_t = 10\ atm$

$T = 25 + 273 = 298\ K$

$Z = 0.3\ cm$

$N_A = ?$

$$N_A = \frac{D_{AB}\, P_t\, (\bar{P}_{A_1} - \bar{P}_{A_2})}{RT\, P_{Bm}}$$

volume% = mole%.

$\bar{P}_{A_1} = 0.3 \times 10 = 3\ atm$

$\bar{P}_{A_2} = 0.20 \times 10 = 2\ atm$

$\bar{P}_{B_1} = 10 - 3 = 7\ atm$

$\bar{P}_{B_2} = 10 - 2 = 8\ atm$

$$\bar{P}_{Bm} = \frac{\bar{P}_{B_2} - \bar{P}_{B_1}}{\ln\left(\frac{\bar{P}_{B_2}}{\bar{P}_{B_1}}\right)} = \frac{8-7}{\ln\frac{8}{7}} = \frac{1}{0.117} = 8.54$$

$$N_A = \frac{0.181 \times 10 \times (3-2)}{82.06 \times 298 \times 0.3 \times 8.54}$$

$$N_A = 2.88 \times 10^{-5} \text{ gm.mol/sec.cm}^2$$

$$= 2.88 \times 10^{-5} \times 32 \times 3600$$

$$= 3.317 \text{ gm/cm}^2\text{.hr}$$

$$N_A = 3.317 \text{ gm/cm}^2\text{.hr}$$ Ans.