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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

August 2024 Supplementary Examinations

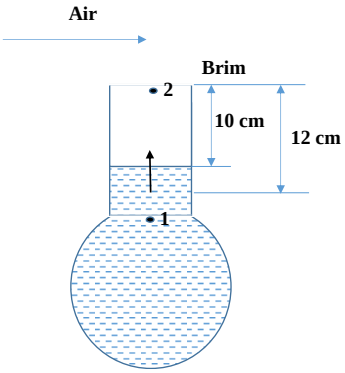
Programme: B.E. **Semester: IV**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 19CH4DCMT1 **Max Marks: 100**
Course: Mass Transfer-I

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.
3. Use of Phychrometric chart, steam table, and data sheets is allowed.

UNIT - I

1 a) Derive an expression to find the diffusivity of a binary gas mixture for the following cases. **12**
   i. Steady-state diffusion of one component through non-diffusing component
   ii. Steady-state equimolar counter diffusion

b) The apparatus shown in the following figure is kept at 40°C and 1 atm pressure. The air is circulated so that the concentration of water vapor in the air is zero. If 29 hours are needed for the level to fall down from 10 cm to 12 cm below the brim of the tube, what is the diffusivity of water in air? Vapor pressure of water at 40°C is 120 mmHg and density of water at 40°C is 992.2 kg/m^3. **08**



OR

2 a) Derive an expression to find the overall mass transfer coefficient for diffusion between phases based on both gas (K_G) and liquid (K_X). **08**

b) The diffusivity of the gas pair O_2 – CCl_4 is determined by observing the steady state evaporation of CCl_4 into a tube containing oxygen. The distance between the CCl_4 liquid level and the top of the tube is 17.1 cm. The pressure and temperature were 755 mmHg and 0°C. It is found that 0.0208 cc of CCl_4 evaporated in a 10 h period after steady state is reached. Data: cross sectional area of the tube = 0.82 cm^2, vapour pressure of CCl_4 at 0°C = 33 mmHg, density of CCl_4 liquid = 1590 kg/m^3. Estimate the diffusivity of O_2 – CCl_4. **08**

c) Discuss the mechanism of diffusion through polymers. **04**

UNIT - II

3 a) Explain the following terms. **10**

i. Humid volume
ii. Dew point
iii. Relative humidity
iv. Humid heat
v. Enthalpy

b) An air (B) – water vapor (A) sample has a dry-bulb temperature of 55°C and an absolute humidity of 0.030 kg water/kg dry air at 1 standard atmospheric pressure. Determine the following. **10**

i. Percentage humidity
ii. Molal absolute humidity
iii. Partial pressure of water vapor in the sample
iv. Vapor pressure of water
v. Dew point

OR

4 a) Develop an equation for adiabatic saturation temperature curve. **10**

b) With a neat sketch, explain the working principle of spray chambers. Draw a typical conditioning diagram for humidification process. **10**

UNIT - III

5 a) A batch of solids is to be dried from 25 to 6% moisture. The initial weight of the wet solid is 160 kg and the drying surface is 1 m^2/40 kg dry weight. The following data is available. Critical moisture content = 0.2 kg water/kg dry solid, critical rate of drying = 0.3×10^{-3} kg/m^2s. Determine the time for drying, for falling rate period use the following data. **10**

X	0.2	0.18	0.16	0.14	0.12	0.1	0.09	0.08
***N*×10³** (kg/m^2s)	0.3	0.266	0.239	0.208	0.180	0.15	0.097	0.07

b) Derive an expression for evaluating the total drying time for all the cases of drying. **10**

UNIT – IV

6 a) What are the characteristics of a good adsorbent? **04**

b) Explain the applications and limitations of Freundlich adsorption isotherm. **06**

c) From basics, show that for a two-stage cross-current adsorption process following equation is obtained. $\left(1-\frac{1}{n}\right)=\left(\frac{Y_1}{Y_2}\right)^{1/n}-\frac{1}{n}\left(\frac{Y_0}{Y_1}\right)$. State all the assumptions made. **10**

UNIT - V

7 a) Explain the Miers supersaturation theory in crystallization with a figure. **06**

b) Classify the crystallizers based on the method of supersaturation. **06**

c) An aqueous solution of sodium sulfate containing 28% Na_2SO_4 is cooled to 20°C and left undisturbed so that $Na_2SO_4 \cdot 10H_2O$ crystals are formed. Calculate how much crystals will be deposited from a 500 kg original solution. What will be the yield of crystallization? Data: the solubility of $Na_2SO_4 \cdot 10H_2O$ at 20°C is 19.4 kg/100 kg H_2O. **08**

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