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

Autonomous Institute Affiliated to VTU

September / October 2023 Supplementary Examinations

Programme: B.E. **Semester: IV**
Branch: Biotechnology **Duration: 3 hrs.**
Course Code: 19BT4DCUO2 **Max Marks: 100**
Course: Unit operations- 2 **Date: 19.09.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

UNIT - I

1 a) Explain the construction and working principle of double pipe heat exchanger with a neat diagram. **10**

b) 88 mm O.D pipe is insulated with a 50 mm thickness of an insulation having a mean thermal conductivity of 0.087 W/m K and 30 mm thickness of an insulation, having mean thermal conductivity of 0.064 W/m K. If the temperature of the outer surface of the pipe is 623 K and the temperature of the outer surface of insulation is 313 K, calculate the heat loss per meter of pipe. **10**

OR

2 a) Derive the equation for log mean temperature difference for countercurrent flow in a heat exchanger. **10**

b) Calculate the inside heat transfer coefficient for fluid flowing at a rate of 300 cm^3/s through a 20 mm inside diameter tube of heat exchanger. **10**

Data: Viscosity of flowing fluid = 0.8 Ns/m^2

Density of flowing fluid = 1.1 g/cm^3

Specific heat of fluid = 1.26 kJ/ Kg K

Thermal conductivity of fluid = 0.384 W/m K

Viscosity at wall temperature = 1 N s/ m^2

Length of heat exchanger = 5 m

UNIT - II

3 a) Explain the working principle of forward feed and backward feed arrangement of multiple effect evaporator. **10**

b) Describe the construction and working principle of horizontal tube evaporator. State its advantages and disadvantages. **10**

UNIT - III

4 a) Hydrochloric acid (A) at 283 K diffuses through a thin film of water (B) 4 mm thick. The Concentration of A at location 1 on one boundary of the film is 12 **10**

weight % (density ρ_1 = 1060.7 kg/m^3) and on other boundary, at location 2, is 4 weight % (density ρ_2 = 1020.15 kg/m^3). The diffusivity of HCl in water is 2.5×10^{-9} m^2/s. Calculate the flux of diffusion of A assuming water to be non-diffusing.

b) Explicate the two-film theory for mass transfer with suitable diagram. Derive equation for overall mass transfer coefficient and explain controlling film concept. **10**

UNIT - IV

5 a) Illustrate the working principle of simple distillation with a neat diagram. Derive Rayleigh's equation. **10**

b) The vapour-pressure of n-hexane (A) and n-octane (B) are given in the following table at 101.3 kPa pressure. Assume that Raoult's and Dalton's laws apply. Compute the vapour-liquid equilibrium compositions and construct a T-x-y plot for the system. **10**

Data:

T, K	341.7	352.4	366.3	380.2	394.1	398.6
p^o_A, kPa	101.3	136.6	196.3	283.9	399.9	455.9
p^o_B, kPa	16.1	23.1	37.1	57.8	87.2	101.3

OR

6 a) Derive the operating lines for rectifying and stripping sections for fractional distillation with suitable diagrams. **10**

b) A mixture of benzene and toluene containing 40 mole% of benzene is to be separated in a fractionating column to give a distillate containing 90 mole% of benzene and a bottom product containing 10 mole% of benzene. Feed is liquid at its bubble point. Using average relative volatility of 2.4, find out the number of theoretical stages required at reflux ratio of 2.5. **10**

UNIT - V

7 a) Discuss the process of nucleation and crystal growth in crystallization. What are the methods by which super-saturation can be obtained? **10**

b) Differentiate between physical adsorption from chemical adsorption. Describe in detail adsorption isotherms. **10**

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