Reg. No. : | | | | | | | | | | | | |

Question Paper Code: 2145491

B.E. / B.Tech. DEGREE EXAMINATIONS, NOV / DEC 2024
Fifth Semester
Biotechnology
U20BT504 – HEAT AND MASS TRANSFER OPERATIONS
(Regulation 2020)

Time: Three Hours | Maximum: 100 Marks

Answer ALL questions

PART – A (10 x 2 = 20 Marks)

1. State Fourier law of conduction.

2. Define fin efficiency and fin effectiveness.

3. Distinguish between natural and forced convection heat transfer.

4. Define Grasahof number and its significance in free convection heat transfer.

5. What is black body radiation?

6. What is microheat exchanger?

7. What is interphase mass transfer?

8. List two differences between countercurrent and co-current operations in mass transfer.

9. What are the characteristics of staged extraction?

10. What are the key parameters involved in solid-liquid equilibrium in extraction?

PART – B (5 x 16 = 80 Marks)

11. (a) A furnace wall is made up of three layer of thickness 25 cm, 10 cm and 15 cm with thermal conductivities of 1.65 W/mK and 9.2 W/mK respectively. The inside is exposed to gases at 1250°C with a convection coefficient of 25 W/m^2 K and the inside surface is at 1100°C , the outside surface is exposed to air at 25°C with convection coefficient of 12 W/m^2K .Determine (i) The unknown thermal conductivity (ii) The overall heat transfer coefficient (iii) All the surface Temperatures. (16)

(OR)

(b) A circumferential rectangular fin of 140mm wide and 5mm thick are fitted on a 200mm diameter tube. The fin base temperature is 170° C and the ambient temperature is 25°C. . Estimate fin Efficiency and heat loss per fin. Take Thermal conductivity K = 220W/mk Heat transfer co-efficient h = $140W/m^2k$. (16)

12. (a) Derive an equation for free convection by use of dimensional analysis. (16)

(OR)

(b) In a long annulus (3.125 cm ID and 5 cm OD) the air is heated by maintaining the temperature of the outer surface of inner tube at 50°C. The air enters at 16°C and leaves at 32°C. Its flow rate is 30 m/s. Estimate the heat transfer coefficient between air and the inner tube. (16)

13. (a) Emissivities of two large parallel plates maintained at 800^o C and 300^0 C are 0.3 and 0.5 respectively. Find the net radiant heat exchange per square meter of the plates. If a polished aluminium shield (Є = 0.05) is placed between them. Find the percentage of reduction in heat transfer. (16)

(OR)

(b) A parallel flow heat exchanger is used to cool 4.2 kg/min of hot liquid of specific heat 3.5 kJ/kg K at 130^o C. A cooling water of specific heat 4. 18 kJ/kg K is used for cooling purpose of a temperature of 15^o C. The mass flow rate of cooling water is 17 kg/min. calculate the following. (16)

1. Outlet temperature of liquid
2. Outlet temperature of water
3. Effectiveness of heat exchangers

14. (a) An Open pan 20 cm in diameter and 8 cm deep contains water at 25°C and is exposed to dry atmospheric air. If the rate of diffusion of water vapor is 8.54×10-4 kg/h, estimate the diffusion co-efficient of water in air. (16)

(OR)

(b) CO_2 and air experience equi-molar counter diffusion in a circular tube whose length and diameter are 1 m and 50 mm respectively. The system of total pressure of 1 atom and a temperature of 250°C. The ends of the tube are connected to large chambers in which the species concentrations are maintained at fixed values. The partial pressure of CO2 at one end is 190 mm of Hg while at the other end is 95 mm Hg. Estimate the mass transfer rate of CO2 and air through the tube. (16)

15. (a) Explain the principles of leaching and the different types of leaching equipment. Discuss their use in extracting pharmaceutical components from raw materials. (16)

(OR)

(b) Explain the operation of pulsed extractors and centrifugal extractors. Discuss how these types of extractors improve mass transfer and separation efficiency compared to traditional extraction methods. Include their applications in industries like pharmaceuticals and chemical processing. (16)

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