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Total No. of Questions : 09

B.Tech. (Food Technology) (Sem.–4)

HEAT AND MASS TRANSFER

Subject Code : BTFT227-19

M.Code : 79981

Date of Examination : 12-07-22

Time : 3 Hrs. Max. Marks : 60

INSTRUCTIONS TO CANDIDATES :

1. **SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.**
2. **SECTION-B contains FIVE questions carrying FIVE marks each and students have to attempt any FOUR questions.**
3. **SECTION-C contains THREE questions carrying TEN marks each and students have to attempt any TWO questions.**

SECTION-A

1. Write briefly :

a) Describe Fourier's law of thermal conduction.

b) Write the equation for natural convection and forced convection in terms of Nusselt No.

c) Describe, how the temperature changes in the steady state and unsteady state heat transfer.

d) Define transmissivity, emissivity in thermal radiation.

e) What is lumped system analysis? When is it applicable?

f) Define Fick's law of Mass transfer.

g) Describe extractive and azeotropic methods of Distillation.

h) What is NTU in Heat exchanger? And describe effective of heat exchanger.

i) Describe the concept of black body and gray body.

j) Consider a 4-m-high, 6-m-wide, and 0.3-m-thick brick wall whose thermal conductivity is k 0.8 W/m°C. On a certain day, the temperatures of the inner and the outer surfaces of the wall are measured to be 14°C and 6°C, respectively. Determine the rate of heat loss through the wall on that day.

SECTION-B

2. A 2m-long, 0.3-cm-diameter electrical wire extends across a room at 15°C. Heat is generated in the wire as a result of resistance heating, and the surface temperature of the wire is measured to be 152°C in steady operation. Also, the voltage drop and electric current through the wire are measured to be 60 V and 1.5 A, respectively. Disregarding any heat transfer by radiation, determine the convection heat transfer coefficient for heat transfer between the outer surface of the wire and the air in the room.

3. Explain the adoption and distillation process in detail and where are they applicable in food industry. Give any two example of each.

4. Consider a cylindrical container of inner radius r1 8 cm, outer radius r2 10 cm, and thermal conductivity k 45 W/m°C. The inner and outer surfaces of the container are maintained at constant temperatures of T1 200°C and T2 80°C, respectively, as a result of some chemical reactions occurring inside. Obtain a general relation for the temperature distribution inside the shell under steady conditions, and determine the rate of heat loss from the container. Length of cylinder is 1 m.

5. Calculate the temperature of mango juice (density= 970 kg/m^3) in a steam jacketed hemispherical kettle after 8 min. of heating. The radius of the kettle is 0.75 m. The convective heat-transfer coefficient in the steam jacket is 5500 W/ (m^2 °C). The inside surface temperature of the kettle is 95°C. The initial temperature of mango juice is 25°C. Assume specific heat of mango juice is 3.90 kJ/ (kg °C).

   (Use Lumped System)

6. A mixture of He and N_2 gas is contained in a pipe at 298 K and 1 atm total pressure which is constant throughout. At one end of pipe at point 1 the partial pressure PA_1 of He is 0.60 atm and at the other end 0.2 m PA_2 = 0.20 atm. Calculate the flux of He at steady state if DAB of the He-N_2 mixture is 0.687×10^{-4} m^2/s.

SECTION-C

7. Water is boiling in a 12-cm-deep pan with an outer diameter of 25 cm that is placed on top of a stove. The ambient air and the surrounding surfaces are at a temperature of 25°C, and the emissivity of the outer surface of the pan is 0.95. Assuming the entire pan to be at an average temperature of 98°C, determine the rate of heat loss from the cylindrical side surface of the pan to the surroundings by (a) natural convection and (b) radiation (c) If water is boiling at a rate of 2 kg/h at 100°C, determine the ratio of the heat lost from the side surfaces of the pan to that by the evaporation of water. The heat of vaporization of water at 100°C is 2257 kJ/kg.

8. A counter-flow double-pipe heat exchanger is to heat water from 20°C to 80°C at a rate of 1.2kg/s. The "heating is to be accomplished by geothermal water available at 160°C at a mass flow rate of 2 kg/s. The inner tube is thin-walled and has a diameter of 1.5 cm. If the overall heat transfer coefficient of the heat exchanger is 640 $W/m^2°C$, determine the length of the heat exchanger required to achieve the desired heating.

9. Define Extraction and Leaching. And explain the working principle of any two differential contact extraction equipments with clean diagram.

NOTE : Disclosure of Identity by writing Mobile No. or Making of passing request on any page of Answer Sheet will lead to UMC against the Student.