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Question Paper Code : 80057

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Fourth Semester

Biotechnology

BT 8401 — FLUID MECHANICS AND HEAT TRANSFER OPERATIONS

(Regulation 2017)

Time : Three hours Maximum : 100 marks

(Heat and Mass Transfer data book is allowed)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write the relationship between gauge pressure and absolute pressure.
2. List out the minor losses in flow through pipes.
3. Write the difference between laminar and turbulent flow.
4. Compare Reciprocating and centrifugal pump.
5. Write Fourier's law of heat conduction equation and derive the unit for thermal conductivity.
6. When lumped heat capacity model is preferred?
7. What is the importance of Leiden frost point in pool boiling?
8. Compare film and drop wise condensation.
9. Write Wein's law of radiation.
10. Compare LMTD and NTU method of heat exchanger analysis.

PART B — (5 × 13 = 65 marks)

11. (a) Two large plane surfaces are 2.4 cm apart. The space between the surfaces is filled with glycerine. What force is required to drag a very thin plate of surface area 0.5 square meter between the two large plane surfaces at a speed of 0.6 m/s, if the thin plate is in the middle of the two plane surfaces. Take the dynamic viscosity of glycerine is 0.81 Ns/m^2.

Or

(b) (i) Explain the equation of continuity. (6)

(ii) Explain rate of flow measurement using Venturimeter. (7)

12. (a) List out the applications of fluid flow through packing and also explain the characteristics of packed bed.

Or

(b) (i) Explain the fluidization phenomena and minimum fluidization velocity. (6)

(ii) Explain the working principle of Centrifugal pump with a neat sketch. (7)

13. (a) The door of a cold storage plant is made from two 6 mm thick glass sheets separated by a uniform air gap of 2 mm. The temperature of the air inside the room is –20°C and the ambient air temperature is 30°C. Assuming the heat transfer coefficient between glass and air is to be 23.26 W/mk, determine the rate of the heat leaking into the room per unit area of the door. Neglect convection effects in the air gap. Thermal conductivity of glass and air are 0.75 W/mK and 0.02 W/mK respectively.

Or

(b) Derive the governing equation for a uniform cross section rectangular plate fin and find the heat transfer rate equation for a very long fin.

14. (a) A 30cm long plate is hung vertically in the air at 27°C while its temperature is maintained at 77°C. Calculate the boundary layer thickness at the trailing edge of the plate. If a similar plate is placed in a wind tunnel and air is blown over it at a velocity of 4 m/s, estimate boundary layer thickness at the trailing edge of the plate.

Or

(b) Air stream at 27°C is moving at 0.3 m/s across a 100 W electric bulb at 127°C. If the bulb is approximated by a 60 mm diameter sphere, estimate the heat transfer rate and the percentage of power lost due to convection.

15. (a) Water enters a cross flow heat exchanger (both fluids unmixed) at 5°C and flows at a rate of 4600 kg/h to cool 4000 kg/h of air that is initially at 40°C. Assume over all heat transfer coefficient is 150 W/m² K. For an exchanger surface area of 25 m², calculate the exit temperature of air and water.

Or

(b) A pipe carrying steam having an outside diameter of 20 cm runs in a large room and is exposed to air at a temperature of 30°C. The pipe surface temperature is 400°C. Calculate the loss of heat to the surroundings per metre length of pipe due to thermal radiation. The emissivity of the pipe surface is 0.8. What would be the loss of heat due to radiation if the pipe is enclosed in a 40 cm diameter brick conduit of emissivity 0.91?

PART C — (1 × 15 = 15 marks)

16. (a) A pipe line of 0.6 m diameter is 1.5 km long. To increase the discharge, another line of the same diameter is introduced parallel to the first in the second half of the length. Neglecting minor losses, find the increase in discharge if friction factor (4f) = 0.04. The heat at inlet is 300 mm.

Or

(b) An aluminium sphere weighing 5.5 kg and initially at a temperature of 290°C is suddenly immersed in a fluid at 15°C. The convective heat transfer coefficient is 58 W/m²K. Estimate the time required to cool the aluminium to 95°C, using the lumped capacity method of analysis.

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Question Paper Code : X 10203

B.E./B.Tech. Degree Examinations, November/December 2020 AND

APRIL/MAY 2021

Fourth Semester

Biotechnology

BT8401 – fluid mechanics and Heat Transfer Operations (Regulations 2017)

Time : Three Hours Maximum : 100 Marks

Answer all questions

Part – a **(10×2=20 Marks)**

1. State Newton's laws of viscosity.
2. What is meant by laminar and turbulent flow ?
3. Define fluidization.
4. A packed column of 0.5 m diameter 3.5 long is packed with spherical solid particles of 5.5 mm diameter is used for adsorption. The flow rate of gas is 0.055 kg/s and the flow rate of liquid is 0.5 kg/s. The weight of packing is 800 kg and density of packing material is 2600 kg/m^3 and density of gas is 1.5 kg/m^3. Calculate the fractional voidage of packed column.
5. What is meant by conduction ?
6. Differentiate thermodynamics and heat transfer.
7. Give the importance of Nusslet number.
8. Identify any two significance of heat transfer coefficient.
9. How will you determine the spectral density emitted by electromagnetic radiation emitted by a black body ?
10. Illustrate the various flow arrangement in heat exchangers.

 Part – B **(5×13=65 Marks)**

11. a) i) A long 15 cm cylindrical metal rod slides inside the tube filled with oil. The inner diameter of the tube is 5 cm and the clearance is 0.05 mm. The mass of the bar is 0.5 kg when immersed in the oil. What is the viscosity of the oil if steady state velocity of the rod is 0.1 m/s ? **(6)**

ii) Describe the principle, construction and working principle of an orifice meter. **(7)**

(OR)

b) Derive Bernoulli's equation for steady flow of an incompressible fluid. What are the corrections factors to be incorporated for practical applications ?

12. a) i) A fluid with viscosity 18.3 cp and density 1.32 g/cm^3 is flowing in a horizontal tube of radius 0.21 inches. For what pressure gradient will the flow becomes turbulent ? **(6)**

ii) Determine the loss of pressure in overcoming the friction in a coil which water flows with a velocity of 1.2 m/s. The coil is made of used steel pipe with inner diameter 30 mm (e = 0.2 mm). The diameter of a turn of the coil is 1 m. The number of turns is 10. The average temperature of water is 30°C. **(7)** (OR)

b) Estimate the minimum fluidization velocity for a bed of particles fluidized by water. Also calculate the bed voidage, e and the ratio of the height of the fluidized bed to that of fixed bed for $\frac{u}{u_{mf}} = 10$

Data : d_p = 120∝m, ϕ_s= 1, ρ_p = 2500 kg/m^3, e_{mf} = 0.45, ρ = 1000 kg/m^3, ∝ = 0.9 m Pas. **(13)**

13. a) A pipe with 150 mm OD is lagged with double layer of insulation each of equal thickness that is 50 mm. The thermal conductivity of one of the insulating material is five times the other. What will be the ratio of heat loss when better insulating material forms an outer layer to that of the better insulating material placed next to the pipe. Assume the inner and outer surface temperature of the composite insulation are fixed. **(13)** (OR)

b) Draw and analyse the process of steady state heat conduction through a composite plane wall. **(13)**

14. a) The inner surface of a high temperature reactor will operate at 1623 K. The wall of the reactor will have an overall thickness of 350 mm and is to be made up of an inner layer of firebrick material (K_r = 0.86 W/mK), covered with a layer of insulation (K_i = 0.86 W/mK). This insulating material has a maximum operating temperature of 1473 K. The ambient temperature will be 293 K and it is estimated that the heat transfer coefficient at the exposed surface of the insulation will be 10 W/m^{2}K. Calculate the thickness of the refractory and insulation, which gives minimum heat loss and the magnitude of this loss

in W/m^2. **(13)** (OR)

b) Determine the heat transfer coefficient for water flowing in a tube of 16 mm diameter at a velocity of 3 m/s. The temperature of the tube is 24°C and the water enters at 80°C and leaves at 36°C. Use Dittus-Boelter equation when a = 0.4 for heating and a = 0.3 when the fluid is cooled and use Sieder-Tate equation to estimate "h".

Data : $\rho = 84.1\ kg/m^3$, $C_p = 4178 j/kgK$, $\propto = 485 \cdot 10^{-6}$ Pas, k = 0.657 W/mk. **(13)**

15. a) i) What do you mean by view factor ? How will you measure view factor between the surface and itself ? **(7)**

ii) Find the equilibrium temperature of a perfect black body disc exposed normally to the sun's rays on the surface of the earth. The black of the disc is insulated. Take T_s = 6200 K, R = 6.92×10^5 km and L = $14.97 \cdot 10^7$ km. **(6)** (OR)

b) In a shell and tube counter flow heat exchanger water flows through a copper tube of 20 mm internal diameter and 23 mm outer diameter, while oil flows through the shell. Water enters at 20°C an comes out at 30°C, while the oil enters at 75°C and comes out at 60°C. The water and the oil film coefficients are 4500 and 1250 W/m^2°C respectively. The thermal conductivity of the tube wall is 355 W/m°C. The fouling factors on the water an oil side may be taken to be 0.0004 and 0.001, respectively. If the length of the tube is 2.4 m. Calculate

the overall heat transfer coefficient and heat transfer rate. **(13)**

Part – C **(1×15=15 Marks)**

16. a) Water is to be pumped from ground level tank, which is open to atmosphere to a cooling tower. The difference between the level of water in the tank and the discharge point is 15 metres. The velocity of water through 40 mm internal diameter discharge pipe is 3 m/s. In the pipe line there is a valve which is equivalent to 200 pipe diameter an fitting equivalent to 150 pipe diameter. The length of entire piping is 30 meters. Determine the power requirement of

pump if efficiency of pump is 60%. **(15)** (OR)

b) In a gas turbine power plant heat is being transferred in a heat exchanger from the hot gases leaving the turbine at 450°C to the air leaving the compressor at 170°C. The air flow rate is 5000 kg/h and the fuel air ratio is 0.015 kg/kg. The overall heat transfer coefficient for the heat exchanger is 52.33 W/m^2°C. The surface area is 50 m^2 and the arrangement is cross flow (both mixed an unmixed). Estimate the exit temperature of the air and gas sides and also the rate of heat transfer in the exchanger. Take C_p as 1.05kJ/kg°C, ε = 0.52, F = 0.76. **(15)** ——————