Paper / Subject Code: 31722 / Heat Transfer Operations

1T00535 - T.E.(Chemical Engineering)(SEM-V)(Choice Base Credit Grading System) (R-20-21) (C Scheme) / 31722 - Heat Transfer Operations

QP CODE: 10012594 **[03 Hours]** DATE: 24/11/2022 **[Total Marks:80]**

N. B.: (1) Question No. **1** is **Compulsory.**

(2) Attempt any **Three** questions out of the remaining **Five** questions.

(3) Figures to the **right** indicate **full** marks.

(4) Make **suitable** assumptions wherever **necessary.**

Q1	Answer the following sub-questions	20
(a)	Derive the formula to calculate the critical radius of insulation for a cylinder	4
(b)	Explain the thermal and Hydrodynamic boundary layer in convection	4
(c)	Two large parallel plates of emissivity's 0.1 & 0.05 at an absolute temperature of 350 K & 300 K are situated 2.5 mm apart in air. Calculate the total heat transfer per unit area. Data: $\sigma = 5.67 \times 10^{-8}\ W/m^2K^4$	4
(d)	Write about heat transfer in agitated vessels	4
(e)	Differentiate between Forward and backward feed of evaporators	4
Q2		
(a)	A Cylindrical tube of length "L" with inside radius r_1 and outside radius r_2 is lagged by insulating material with r_3 as the outer radius of insulation. Derive an equation for the rate of heat flow through a cylindrical tube.	10
(b)	A furnace is constructed with 250 mm of firebrick, 120 mm of insulating brick, and 225 mm of building brick. The inside temperature is 1225 K and the outside temperature 337 K. If the thermal conductivities are 1.3, 0.25, and0.7 W/m K, find the heat loss per unit area and the temperature at the junction of the firebrick and insulating brick.	10
Q3		
(a)	Show by dimensional analysis, the Nusselt number is a function of the Reynolds number and Prandtl number for the cases of **Forced convection**	10
(b)	Air at 308 K flows across a 50 mm diameter cylinder at a velocity of 50 m/s. The cylinder surface is maintained at a temperature of 423 K. Estimate the heat loss per unit length of the cylinder. Data: Physical properties of air at the film temperature of 665 K are: $\mu = 2.14 \times 10^{-5}$ Kg/ms $\rho = 0.996\ kg/m^3$ $k = 0.0312\ W/m^oC$ Npr =0.695 The average heat transfer coefficient may be calculated using the following correlation $N_{Nu} = 0.0266\ (N_{Re})^{0.805}\ (N_{Pr})^{1/3}$	10
Q4		
(a)	Explain the different types of pool boiling regimes.	10

(b) Two long planes A and B are maintained at 600K and 300K and their surface emissivity are 0.8 and 0.5 respectively. Two thin radiation shields C and D having emissivity's 0.5 and 0.4 are introduced between the given planes. The given planes are in order A, C, D and B. Assuming all the planes to be infinitely long, find the rate of heat exchange per unit area and steady-state temperatures attained by planes C and D. 10

Q5

(a) For Parallel flow heat exchanger Show that 10

$$\varepsilon = \frac{e^{-NTU(1+C)}}{1+C}$$

(b) A heat exchanger has heat transfer coefficient 1200 W/m^{2}K on a side whose surface area is 100 m^2 Calculate the effectiveness and outer temperature of hot and cold fluids for co-current flow if hot fluid inlet temperature is 550K, cold fluid inlet temperature is 310 K, mass flow rate of hot fluid is 5.5 kg/s, the mass flow rate of cold fluid is 6.2 kg/s, the specific heat of hot fluid is 3125 J/kg, the specific heat of cold fluid is 4.184 KJ/kg 10

Q6.

(a) An aluminum rod of 12 mm in diameter and 100 mm long protrudes from a wall maintained at 550 K into the environment maintained at 288 K. Estimate heat loss by rod using that rod end is insulated. Also find the fin, efficiency and temperature at end of fin. Data: k aluminum = 200 W/mK, Heat Transfer Coefficient is 20 W/m^{2}K 10

(b) Explain the various types of feed arrangements in detail for the evaporator with a diagram 10

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