B.Tech. SEM -IV (Chemical) 2014 Course (CBCS) : WINTER - 2018

SUBJECT : PROCESS HEAT TRANSFER

Day : Thursday
Date : 15/11/2018

W-2018-2328

Time : 02.30 PM TO 05.30 PM
Max. Marks : 60

N. B. :

1) All questions are **COMPULSORY**.
2) Figures to the right indicate **FULL** marks.
3) Draw neat and labeled diagram **WHEREVER** necessary.
4) Assume suitable **DATA**, if necessary.

Q. 1 **a)** Write S. I. units for the following quantities used in heat transfer. **(04)**

i) Thermal conductivity
ii) Overall heat transfer coefficient
iii) Heat transfer coefficient for convective heat transfer
iv) Unit thermal resistance

b) Derive an expression to get $r_c = (k_b / h_a)$ **(06)**

Where r_c = *Critical radius of insulation*

k_b = *Thermal conductivity of insulation*

h_a = *Surface coefficient of heat transfer*

OR

A 4 in schedule 40 wrought iron pipe $k = 55\ W/m^0C$, is covered with 2.5 cm of magnesia insulation ($k = 0.071\ W/m^0C$). If the inside pipe wall and outer insulation surface temperature are 150°C and 30°C, respectively, find the heat loss per meter of pipe length? **(10)**
ID and OD of iron pipe = 3.0 cm and 3.6 cm respectively

Q. 2 Find out the correlation between heat transfer coefficient and other quantities for forced convection by using any dimensional analysis method. **(10)**

OR

Calculate the heat transfer coefficient for fluid flowing through tube having inside diameter 40 mm. The fluid is flowing at the rate of 6000 kg/hr. The fluid is being heated. The other properties are as given below: **(10)**

Viscosity of flowing fluid $= 0.004\ Ns/m^2$

Density of flowing fluid $= 1.07\ gm/cm^3 = 1.07 \times 10^3\ kg/m^3$

Specific heat of fluid $= 2.73\ kJ/kg\,K$

Thermal conductivity $= 0.256\ W/m\,K$

Q. 3 Derive an expression to get heat transfer coefficient when the condensation is occurring on vertical surface. **(10)**

OR

It is desired to boil water at atmospheric pressure on a copper surface which is electrically heated. Estimate the heat flux from the surface to the water, if the surface is maintained at 110°C. **(10)**

For water at 100^0C

$\lambda = 2257\ kJ/kg$	$\Pr = 1.75$
$\rho_L = 958.4\ kg/m^3$	$\sigma = 58.9 \times 10^{-3}\ N/m$
$Cp_L = 4.211\ kJ/kg\,K$	$k_{sf} = 0.013$
$\mu_L = 277.5 \times 10^{-6}\ Ns/m^2$	$T_w = 110^0C$
	$T_s = 100^0C$

Q.4 **a)** An opaque gray surface has an emissivity 0.37 at a temperature of 330°C source. What will be its reflectivity for black body radiation coming from this temperature source? **(04)**

b) Explain: **(06)**

i) Reflectivity

ii) Absorptivity

iii) Transmissivity

OR

A horizontal steam pipe 20 m long 50 mm internal diameter, 60 mm outside diameter losses 13.5 kW heat to the surroundings at 310K. The pipe carries steam at 500 K. Given that the convective heat transfer coefficient $h_c = 1.65(\Delta T)^{0.25}\ W/m^2K$, and Stefan Boltzman Constant $= 5.87 \times 10^{-8}\ W/m^2K^4$. Find the emissivity of bare surface of the pipe. **(10)**

Q. 5 **a)** Explain with neat diagram multiple effect evaporator unit. **(07)**

b) Explain forward feed arrangement and backward feed arrangement in evaporator. **(03)**

OR

A jacketed stainless steel vessel 3 mm thick is used for the evaporation of water, steam condenses in the jacket at 115.5°C. The kettle handles 40 liters of water and has a heat transfer surface area 0.28 m^2. **(10)**
Liquid side film coefficient of heat transfer is 5000 W/m^2K.
Heat transfer coefficient for condensing steam is 9000 W/m^2K.
Latent heat of vaporization of water is 2400 kJ/kg
Thermal conductivity of jacketed vessel = 43.5 W/m K.

Calculate:

i) The total heat transferred.

ii) Overall heat transfer coefficient

iii) Quantity of water evaporated per hour

Q. 6 A liquid is to be heated in a cylindrical vessel using LPG gas with mass flow rate $\dot{m}$. The cylindrical portion of the vessel is insulated. Derive an expression to determine time to heat a liquid from T_1 to T_2 sensibly. **(10)**

Given:

Diameter of vessel = D (m) Thermal conductivity $k_{vessel} = k \left(\frac{W}{m\,^0C}\right)$,

Calorific value and LPG = $C_V \left(\frac{J}{kg}\right)$, Mass of liquid = m (kg)

Specific heat of liquid = $C_p \left(\frac{J}{kg^0C}\right)$

OR

Consider agitator vessel, comprising internal coils for heating the contents of agitated vessel. The liquid mass M kg with specific heat C_P and initial temperature t_1 is to be heated by isothermal heating medium at temperature T_1. Derive an expression to estimate time to raise temperature of liquid from t_1 to t_2. **(10)**

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