B.TECH. SEM -IV (CHEMICAL) 2014 COURSE (CBCS) :
SUMMER - 2018
SUBJECT: PROCESS HEAT TRANSFER

Day: **Thursday** Time: **10.00 AM TO 01.00 PM**
Date: **07/06/2018** Max. Marks: 60

S-2018-2272

N.B.:

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

Q.1 A furnace operates of 900^0C. The heat transfer coefficient at the inner furnace wall is 100 W/m^2 ^{0}C. The furnace wall is backed up by two layers of insulation. First layer of insulation is of insulation bricks 120 mm thickness and second layer of fire bricks is of 100 mm thickness. The third layer is metal plate backing of 10 mm thickness. The contact resistance between the layers of insulation is $2.6\times10^{-4} m^2\ ^0C/w.$ and contact resistance between fire brick and metal plate is $1.5\times10^{-4} m^2\ ^0C/w.$ The ambient air temperature is 30 ^{0}C and convective heat transfer coefficient on the outer metal plate surface is 15 w/m^{20}C. **(10)**

$k_{\text{insulation brick}}$ = 0.6 w/ m ^{0}C
$k_{\text{fire brick}}$ = 0.8 w/ m ^{0}C
$k_{\text{metal plate}}$ = 46 w/ m ^{0}C
Calculate:
i) Heat flow through the furnace wall
ii) Overall heat transfer coefficient.

OR

Q.1 Derive an expression for rate of heat flow for steady state conduction through composite spherical shells. **(10)**

Q.2 What are the dimensional analysis applications in convective heat transfer? Derive an expression for natural convection using Buckingham's π theorem. **(10)**

OR

Q.2 What are the factors affecting film coefficient? Discuss the correlations available for the calculation of film coefficient of heat transfer for turbulent flow inside tubes. **(10)**

Q.3 Derive an expression for average film coefficient of heat transfer for the film condensation on vertical plates. State the assumptions made. **(10)**

OR

Q.3 Ammonia vapors are condensed at 34^0C on a square array of 25 × 25 horizontal tubes. Outside diameter of the tube is 30 mm and length of each tube is 1.6 m surface temperature of the tubes is maintained at 22^0C. Calculate the rate of condensation of ammonia vapors. Properties of ammonia at average temperature are **(10)**

$\rho_{NH_3 vap.} = 0.6894\ kg/m^3$, $\rho_{NH_3\ \text{liquid.}} = 600\ kg/m^3$,

$\mu = 0.21\times10^{-3} N\,s/m^2$, $k = 0.51 w/mK$, $\lambda = 1125 kJ/kg.$

P. T. O.

Q.4 **a)** Calculate the emissive power of sun if the solar constant is 1550 w/m^2. **(05)**
Mean distance between earth and sun =1.5 $\times 10^{11}$m
Diameter of the sun = 1. 39$\times 10^9$m
Diameter of the earth = 1.29 $\times 10^7$m
$\sigma = 5.67 \times 10^{-8} w/m^2K^4$
Also estimate the sun temperature.

b) Differentiate between black body, grey body and opaque body. **(05)**

OR

Q.4 **a)** Derive an expression for radiation heat transfer between two nonblack surfaces. **(07)**

b) What is Stefan Boltzmann's law? **(03)**

Q.5 0.6 kg/ sec of a solution at 25^{0}C and containing 14.1 % by weight of NaOH is to be concentrated to 24.1% by weight solution in a single stage evaporator. The temperature of the heating steam is 130^{0}C. Boiling point of the solution in the evaporator is 112^{0}C. The heat losses of the evaporator are 40,000 watts. Overall heat transfer coefficient = 800w/m^{2}K. **(10)**
Latent heat of steam = 2183kJ/kg
Latent heat of Vaporization = 2225 kJ/ Kg.
Calculate:

i) The quantity of water evaporated
ii) Quantity of steam consumed
iii) Heat transfer area required for the evaporation.

OR

Q.5 **a)** Derive an expression to obtain the heat transfer areas in triple effect evaporators. **(05)**

b) Describe the working principle of falling film evaporator and state its advantages. **(05)**

Q.6 Consider one dimensional unsteady state conduction in a plate of thickness 2x. The plate is at a uniform temperature T at t=0. At t=0 the ambient surrounding temperature is suddenly changed to temperature T_1 and maintained constant. Develop an expression to determine temperature T at any position x and time t. Assume convection resistance to be negligible. **(10)**

OR

Q.6 Express the nomenclature for transient heat flow in a semi-infinite solid. Also obtain an expression for temperature distribution and surface heat flux. **(10)**

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