T.E. chem (COA)-I HTO-I 24/11/14

QP Code : 14873

½

(3 Hours) [Total Marks : 80

N.B : (1) Question No. 1 is **compulsory**.
(2) Solve any **three** from remaining.
(3) Assume suitable data, correlation if required.
(4) **Figure** to **right** indicates **full** marks.
(5) **All** questions carry **equal** marks.

1. Solve all sub questions :—

(a) Calculate the critical radius of insulation for asbestoss, [k = 0.17 W/mk] surrounding a pipe and exposed to a room temperature at 293k with h = 3 w/m²k. Calculate the heat loss from a 473k, 50mm dia. pipe when covered with critical radius of insulation and without insulation. **5**

(b) Explain the significance of dimensionless groups. **5**
(i) Biot Number
(ii) Grasshoff's Number
(iii) Reynolds Number
(iv) prandtl Number
(v) Nusselt Number

(c) Determine the net radiant interchange between two parallel oxidized iron plates at distance of 25mm having sides 3m x 3m. The surface temperature of two plates are 373k and 313k respectively. Data : Emissivity of plates are equal = 0.74. **5**

(d) Explain thermal boundary layer in convection. **5**

2. (a) Derive the expression for heat transfer through furnace wall made of three different materials in series. Assume k_1, k_2, k_3 be the thermal conductivities of materials X1, X2, X3 be the respective thickness. hi and ho be convective heat transfer coefficients for inside and outside ambient air respectively. Assume hot gas and ambient cold air temperatures Ti and To respectively. **10**

(b) A furnace wall made up of steel plate 10mm thick is lined on inside with silica brick 150mm thick and on outside with magnesite brick 150mm thick. The temperature on inside of wall is 700°C and on outside is 15°C. Calculate quantity of heat passed walls per m². **10**
It is required to reduce heat flow to 1163 W/m² by means of air-gap between steel plate and magnesite brick. Estimate width of this gap. Thermal conductivities in W/m.k are 16.86, 1.75, 5.23 and 0.033 respectively for steel, silica brick, magnesite brick and air gap.

3. (a) Air at 1 atmosphere and 35°C flows across a 100mm diameter cylinder at a velocity 60 m/sec. The cylinder surface is maintained at a temperature of 200°C. Estimate heat loss per unit length of cylinder. 10

Date : The physical properties of air at film temperature
$\mu = 3.16 \times 10^{-5}$ kg/m.sec, $\rho = 0.967$ kg.m^3
$k = 0.0326$ W/m.k, $C_p = 3.43$ KJ/kg.k
Use : $N_{Nu} = 0.0266 (NRe)^{0.8} (Npr)^{0.33}$

(b) Derive design equation for heat exchanger "$Q = UA.\Delta Tlm$". 10

4. A heat exchanger is to be designed to heat 1720 kg/h of water from 293k to 318k with saturated steam condensing on the outside surface of brass tubes of 25mm O.D. and 22.5mm I.D. Tube length is 4m. Assuming water velocity is being constant at 1.2m/s. determine the no. of tubes required in a heat exchanger. 20

Data : Thermal conductivity of brass = 460 KJ/h.m.K.
Latent heat of vaporisation of steam = 2230 KJ/kg
Steam side coefficient = 19200 KJ/h.m^2.K
Physical properties of water at mean fluid temp.,
Density = 995.7 kg/m^3, Specific heat = 4.28 KJ/kg.k
Thermal conductivity = 2.54 KJ/h.m.K
Kinematic viscosity = 0.659×10^{-6} m^2/s.

5. (a) 100 tubes of O.D. 24.5mm are arranged horizontally in a square array and exposed to dry saturated steam at 1 atm. Estimate the mass rate to steam condensation per unit length of tunes for tube wall temperature of 96°C. The saturation temperature is 100°C. 10

Date : Properties of condensate at film temperature is -
$\rho = 960$ kg/m^3, $k = 0.68$ W/m.k, $\mu = 282 \times 10^{-6}$ kg/m.s, $\lambda = 2256.9$ KJ/kg.

(b) For heat transfer by forced convection show that Nussult number is function of Reynolds number and prandtle number by dimensional analysis. 10

6. Write short note on (any **four**) 20

(a) For radiation shield, radiation heat transfer rate 'Q' with 'n' shields $= \frac{1}{n+1} Q$ without shield.
(b) Wilson plot
(c) Plate heat exchanger
(d) Boiling regimes in pool boiling
(e) Effectiveness - NTU method of heat exchnager analysis
(f) Steam generation by waste heat.
