B.Tech. SEM -IV (Chemical) 2014 Course (CBCS) : WINTER - 2017

SUBJECT: PROCESS HEAT TRANSFER

Day: **Wednesday** Time: **02.30 PM TO 05.30 PM**

Date: **22/11/2017** Max. Marks: 60

W-2017-2064

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 flat furnace wall is constructed of 114 mm layer of sil-o-cel brick, with a thermal conductivity of 0.138 w/m ^{0}C, backed by a 229 mm layer of common brick of conductivity, 1.38 w/m ^{0}C. The temp of inner face of the wall is 760 ^{0}C and that of outer face is 76.6 ^{0}C. **(10)**

i) What is the heat loss through the wall?

ii) What is the temperature of the interface between the refractory and common brick?

iii) If the contact resistance of 0.088 ^{0}C m^2/w is present between tow brick layers, what would be the heat loss?

OR

Q.1 a) Derive an expression to calculate rate of flow of heat through a thick walled hollow cylinder. **(05)**

b) What is the role of extended surfaces in heat transfer applications? Explain the efficiency and effectiveness of a fin. **(05)**

Q.2 a) What are different dimensionless numbers used in convective heat transfer? Explain significance of Nusselt number and Stanton number. **(05)**

b) Describe the correlations to obtain heat transfer coefficient in laminar flow. **(05)**

OR

Q.2 Water is flowing through a tube of 16 mm diameter at a velocity of 3 m/s. The inlet and outlet temperature are 28^{0}C and 68^{0}C respectively. The tube wall is maintained at 82^{0}C. Calculate: **(10)**

i) the heat transfer coefficient

ii) length of the tube

Properties of water at mean bulk temperature are

$\rho = 988 kg/m^3$

$C_p = 4175 J/kg\ K$

$k = 0.647 w/m\ K$

$\mu = 0.55 \times 10^{-3} N\,s/m^2$

Q.3 a) What is pool boiling? Sketch and explain the pool boiling curves. **(05)**

b) How dropwise condensation can be achieved? Explain the mechanism of dropwise condensation. **(05)**

OR

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Q.3 Steam at 110^0 condenses on the outside of a tube having 80 mm outside diameter. The tube wall temperature is 96^0C. Calculate the value of heat transfer coefficient for condensing steam when the tube is in horizontal position and when the tube is in vertical position. **(10)**

properties of condensate are

$\rho_L = 960 kg / m^3$

$\mu_L = 0.29 \times 10^{-3} N s / m^2$

$k_L = 0.68 w / m\ ^0C$

$\lambda = 2255 kJ / kg$

$\rho_V = 0.6 kg / m^3$

Q.4 Derive an expression for radiation heat transfer between black surfaces. Explain the term radiation shape factor. **(10)**

OR

Q.4 a) What is Kirchoff's law? **(04)**

b) A hot pipe having surface temperature 245^0C is placed in a large enclosure. The enclosure walls are at 98^0C. The pipe surface can be assumed black. The total heat transfer coefficient including convection radiation effect is 37 w/m^{2}K, Stefan Boltzmann constant $\sigma = 5.67 \times 10^{-8} w / m^2 k^4$ Calculate the rate of radiant heat transfer and convective heat transfer coefficient at the pipe surface. **(06)**

Q.5 1000kg/ h of a dilute solution of sodium hydroxide containing 10 % NaOH is to be concentrated to 40 % NaOH by weight in a single effect evaporator. The feed is available at 25^0C. Boiling point of the solution may be considered as 100^0C. Specific heat of dilute solution = 4180 J/ kg K. Latent heat of vaporization of water = 2239 kJ/kg. Saturated steam corresponding to 1.8 bar pressure and 117 ^{0}C is available for heating purpose. **(10)**

Latent heat of condensation of steam = 2212 kJ/kg. If overall heat transfer coefficient for the system is 850 W/m^{2}K. Calculate

i) the quantity of water evaporated ii) Steam consumption.

iii) Surface area of the evaporator.

OR

Q.5 Describe with neat diagram the forward feed and backward feed arrangement in multiple effect evaporators. Also state the disadvantages of forward feed arrangement and advantages of backward feed arrangement. **(10)**

Q.6 A copper constant thermocouple is formed by soldering the tips of two wires. The tip can be considered as sphere, 1.5 mm diameter. It is to measure the temperature of air flowing through a pipe at temperature of 275^0C. Initial temperature of thermocouple is 25^0C . Calculate: **(10)**

i) temperature indicated by the thermocouple at that instance

ii) time required to attain a temperature of 270^0C.

Properties of thermocouple junction are

$\rho = 8960 kg / m^3$

$C_p = 400 J / kg\ K$

$k = 30 w / m K$

$h = 150 w / m^2\ K$

OR

Q.6 What is unsteady state heat conduction? Describe in detail the periodic transient state heat conduction process. **(10)**

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