Registration No. : | | | | | | | | | | |

*Total number of printed pages – 2*

**B. Tech**

**PCCH 4301**

# Fifth Semester Back Examination – 2014

## HEAT TRANSFER

## BRANCH : CHEM

**QUESTION CODE : L 214**

**Full Marks – 70**

**Time : 3 Hours**



*Answer Question No. **1** which is compulsory and any **five** from the rest.*
*The figures in the right-hand margin indicate marks.*
*Assume suitable notations and any missing data wherever necessary.*
*Answer all parts of a question at a place.*

1. Answer the following questions : 2×10

   (a) Define thermal conductivity. Arrange the followings in the increasing order of their thermal conductivities: Water, Ice, and Gases.

   (b) The variation of thermal conductivity of a metal with temperature is often correlated using an expression of the form : $k = k_0 + aT$, where k is thermal conductivity and T is temperature in Kelvin. What is the unit of 'a' in SI system ?

   (c) Differentiate between natural and forced convection.

   (d) What are the assumptions taken in the derivation of Reynolds analogy equation ?

   (e) Arrange the following in the increasing order of Prandtl number : Glycerol, Mercury, Water, and Oxygen.

   (f) What do you mean by 25 percent baffle cut ?

   (g) Write the advantages of square pitch over triangular pitch.

   (h) Differentiate between sub-cooled boiling and pool boiling of saturated liquid.

   (i) Define a grey body.

   (j) How heat transfer coefficient is related to number of passes in a shell and tube heat exchanger ?

2. (a) Derive the steady-state heat conduction equation for a hollow spherical shell of inner radius $R_i$ (maintained at $T_i$) and outer radius $R_o$ (maintained at $T_o$). Assume K as the mean thermal conductivity of the material. 5

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(b) A hollow sphere has an inside surface temperature of 200°C and the outside surface temperature of 20°C. Calculate the heat loss by conduction for an inside and outside diameter of 4 cm and 10 cm respectively. The thermal conductivity of the material is 15 kcal/hr.m.°C. 5

3. (a) State the Buckingham's $\pi$-theorem of dimensional analysis. 3

(b) The resistance force F experienced by a partially submerged body depends upon the velocity-V, length-L, viscosity-$\mu$, density of the fluid-$\rho$, and gravitational acceleration-g. Obtain the dimensionless expression for Fby using Buckingham's $\pi$-theorem method of dimensional analysis. 7

4. (a) Differentiate between film type and drop wise condensation. 2

(b) Derive the Nusselt equation for a vertical tube of length L and film thickness $\delta$ in film type condensation. 8

5. (a) With a neat diagram describe the different parts of a shell and tube heat exchanger. 6

(b) What are the advantages of multi pass over single pass heat exchanger? Draw the temperature profile for a 2-4 shell and tube heat exchanger. 4

6. (a) How evaporation is different from drying ? 2

(b) Calculate the amount of steam required for concentrating the solution of caustic soda from 28 % wt. of solids to 40% wt. of solids in a single effect evaporator. The feed rate is 25000 kg/hr and its temperature is 60°. The absolute pressure in the evaporator is 0.2 kg/cm$^2$ (boiling point 60°). Saturated steam at 1.4 kg/cm$^2$ (108.7°C) is to be used as heating medium. The elevation in boiling point is 25°C. If the overall heat transfer coefficient is 670 kcal/hr.m$^2$.°C, calculate the heating surface required. The enthalpy data for various streams are as follows : 8

Vapour at 0.2 kg/cm$^2$= 623kcal/kg,

28% NaOH at 60°C = 50 kcal/kg,

40% NaOH at 85°C= 90 kcal/kg, and

Latent heat of steam at 1.4 kg/cm$^2$ = 534 kcal/kg.

7. Briefly explain the mechanism involved in the pool boiling of saturated liquid with a suitable graph. 10

8. Write short notes on any **two** of the following : 5×2

(a) Extended surface

(b) Plate type heat exchanger

(c) Forced circulation evaporator

(d) Critical radius of insulation.