(Set-PS)

B.Tech-5th (Chem.)

Heat Transfer

Full Marks : 70

Time : 3 hours

Answer **six** questions including **Q.No.1** which is compulsory.

The figures in the right-hand margin indicate marks.

Symbols carry usual meaning.

1. Answer *all* questions : 2×10

   (*a*) Define thermal Conductivity.

   (*b*) Define efficiency of the fin.

   (*c*) Sketch formation of boundary layer and show laminar, transition and turbulent flow.

   (*d*) Differentiate between Natural & Forced convection.

   (*e*) What is overall heat transfer coefficient in a heat exchanger ?

(*f*) What is the critical thickness of insulation for cylinder and sphere ?

(*g*) Explain the critical thickness of insulation for cylinder and sphere.

(*h*) What is boiling ? Explain the nucleate boiling with neat sketch.

(*i*) What is dirt factor ? Give its units.

(*j*) Differentiate between black body and gray body with an example.

2. (*a*) What is Intensity of radiation ? Define Emissive power of a black surface. 4

(*b*) A pipe consists of 100 mm internal diameter and 8 mm thickness carries steam at 170 °C. The convective heat transfer coeffcient on the inner surface of pipe is 75 W/m^{2}C. The pipe is insulated by two layers of insulation. The first layer of insulation is 46 mm in thickness having thermal conductivity of 0.14 W/m °C. The second layer of insulation is also 46 mm

in thickness having thermal conductivity of 0.46 W/m °C. Ambient air temperature = 33 °C. The convective heat transfer coefficient from the outer surface of pipe = 12 W/m² Ç. Thermal conductivity of steam pipe = 46 W/m °C. Calculate the heat loss per unit length of pipe and determine the interface temperatures. 6

3. (*a*) With a neat and labelled sketch explain the various regimes in boiling heat transfer. 5

(*b*) Compare LMTD and NTU method of heat exchanger analysis. 5

4. (*a*) What is view factor ? Give the general expression for the view factor. 4

(*b*) Calculate the net radiant heat exchange per m² area for two large parallel plates at temperatures of 427 °C and 27 °C respectively (hot plate) = 0.9 and *e* (cold plate) = 0.6, if a polished aluminum sheet is placed between them, find the percentage reduction in the heat transfer, *e* (shield) = 0.4. 6

5. (*a*) Discuss the multiple effect evaporator. 4

(*b*) A single effect evaporator is to be fed with 5000 kg/h solution containing 10% solute by weight. The feed at 313 K is to be concentrated 40% by weight of solute under an absolute pressure of 101.325 kPa. Steam is available at an absolute pressure of 303.975 kPa (saturation temperature of 407 K). The overall heat transfer coefficient is 1750 W/m^2.K). Calculate : Heat transfer area and economy of the evaporator. C_p = 4.187 kJ/kg.K Treat solution as pure water for the purpose of calculation of enthalpies. 6

Temperature, K	Enthalpy, kJ/kg	
	Vapor	Liquid
313		170
373	2676	419
407	2725	563

6. (*a*) What is heat exchanger ? Give classification of heat exchanger and with a neat diagram discuss 2-4 shell and tube heat exchanger. 5

(*b*) A parallel flow heat exchanger has a hot and cold water streams flowing through it. The flow

rates are 600 kg/h and 1500 kg/h and inlet temperature are 43 K and 298 K on the hot and cold side respectively. The exit temperature on hot side required to be 323 K. Calculate the area of heat exchanger if the individual heat transfer coeffcieint on both side are 1600 $W/m^2.K$. Also find the outlet temperature of cold water. $C_p = 4187$ J/kg.K. 5

7. (*a*) Why LMTD is used in designing of double pipe heat exchanger ? Develop an expression for evaluation of LMTD in true cocurrent heat exchanger. 5

(*b*) A shell & Tube heat exchanger is being used to cool a hot fluid. The fluid enters at 80 °C and leaves 50 °C. The cold water is available at 20 °C which leaves at 35 °C. Determine the LMTD if the stream contact in a (*i*) Counter current manner, (*ii*) Cocurrent manner 5

8. (*a*) Give the physical interpretation of

(i) Gractz No

(*ii*) Paclet No

(*iii*) Reynolds No

(*iv*) Nusselt No

(*v*) Prandtl No

(*vi*) Grashoff No 6

(*b*) Explain the critical thickness of insulation. Show that in case of cylinder, the critical radius of insulation is given by $r_{cr} = k/h$ where k is the thermal conductivity and h is the air film heat transfer coefficient 4
