



SE-6729

B. E. - III (Sem. V) (Chemical) Examination
May/June - 2011
Heat Transfer

Time : 3 Hours]

[Total Marks : 100

Instruction :

(1)

नीचे दृष्टावेक निशानीवाणी विगतो उत्तरवही पर अवश्य कभवी. Fillup strictly the details of signs on your answer book.	Seat No. :
Name of the Examination :	<input type="text"/>
<input type="text" value="B. E. - 3 (SEM. 5) (CHEMICAL)"/>	<input type="text"/>
Name of the Subject :	<input type="text"/>
<input type="text" value="HEAT TRANSFER"/>	<input type="text"/>
Subject Code No. : <input type="text" value="6"/> <input type="text" value="7"/> <input type="text" value="2"/> <input type="text" value="9"/>	<input type="text" value="Student's Signature"/>
Section No. (1, 2,.....) : <input type="text" value="NIL"/>	

- (2) Figures to the right indicate full marks.
- (3) Assume suitable data when necessary.
- (4) Graph, data sheet etc. will be provided wherever necessary.
- (5) Draw neat sketches wherever necessary.

1 (a) Answer the following : 10×1=10

- (1) In Fourier's law, the proportionality constant is called is as _____.
- (2) Give the critical radius of insulation for a spherical shell.
- (3) What is heat flux ? Give unit of heat flux ?
- (4) What is the absorptivity of a black body ?
- (5) The main purpose of providing fins on heat transfer surface is to increase the _____.
- (6) What is the unit of thermal resistance ?
- (7) Stefan - Boltzmann law applies to _____ body.
- (8) What is logarithmic mean radius for cylinder (r_c^-) ?
- (9) Maximum heat transfer is obtained in _____ flow.
(a) Laminar (b) Turbulent (c) Transition
- (10) The value eof Plank's constant in SI unit is _____.

- (b) Derive expressions under one dimensional steady state heat conduction for temperature distribution for sphere. 5
- (c) What are extended surfaces ? Draw the different types of extended surfaces and give the different applications of extended surfaces in different areas. 5

2 Attempt the following : (any two) 8×2=16

- (a) A furnace wall is made up of three layers, one of red fire brick, one of insulating brick and one of 870° and 40°C respectively. The respective co-efficients of thermal conductivities of the layers are 1.0, 0.12 and 0.75 KCal/(hr.m.°c) and the thickness are 22 cm, 7.5 cm in and 11 cm.
Assuming close boiling of the layer at their interfaces find the rate of heat loss per square meter per hour and the interface temperature.
- (b) An oil pipe line $d_i/d_o = 44/51$ mm in the diameter is covered with a layer of concrete 80 mm thick. The thermal conductivity of pipe line material is 43 KCal/m.°C.hr and that of concrete is 1.1 KCal/m.°C.hr. The mean temperature of the oil is 120°C and the ambient air temperature 25°C. The local heat transfer coefficient from oil to wall is 86 KCal/hr.m².C and that of from the concrete surface to the air is 8.6 KCal/hr.m².C . Calculate the loss of heat from length of 1 metre of a bare pipeline and from the same length of pipeline covered with concrete.
- (c) Calculate the critical radius of insulation for asbestos $[K = 0.17 W/(m^2 \cdot K)]$ surrounding a pipe and exposed to a room air at 293 K with $h = 3.0 W/(m^2 \cdot K)$. Calculate the heat loss from a 473 K, 50 mm diameter pipe when covered with the critical radius of insulation and without insulation. (Neglect thermal resistance of pipe)

3 Attempt the following : (any two) 7×2=14

- (a) Consider two large parallel planes, one at 1000 K with emissivity 0.8 and other at 300 K having emissivity 0.6. A radiation shield is placed between them. The shield has emissivity as 0.1 on the side facing hot plate and 0.3 on the side facing cold plate. Calculate percentage reduction in radiation heat transfer as a result of radiation shield.
- (b) Derive that the net radiant heat between two elementary black surfaces is given by

$$q_{12} = rAF(T_1^4 - T_2^4)$$

where A is the surface area and F is the view factor between two surfaces and T_1 and T_2 are the corresponding surface temperatures.

- (c) Explain the following :
- (1) Monochromatic radiating power
 - (2) Emissivity
 - (3) State stefan - Boltzmann law for radiation
 - (4) State Plank's law for radiation
 - (5) State Wein's displacement law for radiation
 - (6) State Kirchoff's law for radiation
 - (7) Solid angle.

4 (a) Answer the following :

- (1) What is LMTD correction factor ? 1
- (2) Define capacity of evaporator. 1
- (3) Orange Juice can be concentrated in 1
 - (i) One through falling film evaporator
 - (ii) Long tube evaporator with upward flow
 - (iii) Forced circulation evaporator.
- (4) Baffles are used in shell and tube heat exchanger to induce _____ out side the tubes. 1
- (5) Give significance of Biot Number. 2
- (6) What is subcooled Boiling ? 2
- (7) Explain the difference between forward feed and backward feed arrangement in multi effect evaporator. 2

(b) Answer the following :

- (1) What is condensation number ? 2
- (2) Explain the phenomena of boiling of water over heated surface. 6

5 Answer any two : 8×2=16

- (a) What is effectiveness of heat exchanger ? Derive the equation of effectiveness for parallel flow heat exchanger.
- (b) What do you mean by LMTD ? Derive the equation of LMTD for counter flow heat exchanger.
- (c) A horizontal cylinder 2.5 cm diameter and 0.6 m long is suspended in water at 20°C. Calculate the rate of heat transfer, if the cylinder surface is at 55°C. What would be the rate of heat transfer if the cylinder is suspended in light oil at 55°C. The following properties at 37.5 °C may be used.

Properties	Water	Oil
Density Kg/m^3	992	905
Viscosity $Kg/m\ hr$	2.47	82.0
Thermal conductivity W/mk	0.622	0.133
B K^{-1}	3.96×10^{-4}	7.2×10^{-4}
Pr.	4.64	3.24

6 Answer any two : 8×2=16

- (a)
 - (i) Raynold's analogy
 - (ii) Thermal Boundary layer
- (b) Explain shell and tube heat exchanger
- (c) A single effect evaporator is to be designed to concentrate 10000 Kg/hr of chemical solution from 10% to 20% solids by weight. Feed enters at 30°C. Saturated steam at 110°C (latent heat 540 KCal/kg) is available. Condensate leaves at saturation temperature. The solution boils at 45°C (latent heat 570 KCal/kg), Specific heat may be taken as 1 KCal/kg °C. The overall heat transfer co-efficient may be taken as 1800 KCal/hr m^2 °C. Calculate :
 - (i) Steam consumption kg/hr
 - (ii) Economy
 - (iii) Heat transfer area.