



**SF-8169**

**B. E. - II (Sem - IV) (Chemical) Examination**

**May / June - 2011**

**Process Heat Transfer  
(New Syllabus)**

Time : Hours]

[Total Marks : 100

**Instructions :**

(1)

नीचे दशांशवैव निशानीवाणी विगतो उत्तरवही पर अवश्य लक्षणी. 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. - II (Sem - IV) (Chemical)"/>	<input type="text"/>
Name of the Subject :	<input type="text"/>
<input type="text" value="Process Heat Transfer (New Syllabus)"/>	<input type="text"/>
Subject Code No. : <input type="text" value="8"/> <input type="text" value="1"/> <input type="text" value="6"/> <input type="text" value="9"/>	<input type="text"/>
Section No. (1, 2,...): <input type="text" value="Nil"/>	
Student's Signature	

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

1 (a) Answer the following : **10x1=10**

- (i) What is the effect of temperature on thermal conductivity of liquids ?
- (ii) What is unsteady-state heat transfer ?
- (iii) Maximum heat transfer is obtained in \_\_\_\_\_ flow.
- (iv) Define : Black body.
- (v) Critical radius of insulation is the ratio of \_\_\_\_\_ to \_\_\_\_\_.
- (vi) State Wein's displacement law.
- (vii) What is Radiation Shield ?
- (viii) The ratio of momentum diffusivity to thermal diffusivity is known as \_\_\_\_\_ number.

- (ix) What is Heat Flux ? Give unit of Heat Flux.
- (x) Give the analogy between flow of heat and electricity.
- (b) Derive Fourier's general equation for one dimensional unsteady state heat conduction. **5**
- (c) Explain modes of heat transfer in details. **5**
- 2** Attempt the following (any two) **8x2=16**
- (a) A flat furnace wall is constructed of a 115 mm layer of silica brick with a thermal conductivity of 0.4 KCal/hr.inc.c backed by a 230 mm layer of common brick of thermal conductivity 4 KCal/hr.m.c. The temperature of the inner face of the wall is 760° C and that of the outer face is 77°C. Find out following :
- (i) What is the heat loss through the wall in KCal/m<sup>2</sup>.hr. ?
- (ii) What is the temperature of interface between the silica brick and common brick ?
- (b) A steel pipe with an outside diameter of 115 mm and a wall thickness of 5 mm is covered with 50 mm thickness of 85% magnesia. The surface temperature on the inside of the pipe is 423 K (150° C) and that on the outside of insulation is 305 K (32° C). Calculate :
- (i) The heat flow per meter of length.
- (ii) The temperature at the outer surface of the steel pipe and
- (iii) The conductance of the pipe and insulation based on its inside surface area.  
 Thermal conductivity (K) for steel = 43.03 w/m.k.  
 Thermal conductivity (K) for insulation = 0.07 w/m.k.
- (c) A pin fin 2.5 mm diameter is made of copper  $CK = 396 \frac{w}{(m \cdot k)}$ . It protrudes from a wall maintained at 95°C and placed in 25°C air. The convective heat transfer co-efficient over the fin is  $10 \frac{w}{(m^2 \cdot k)}$ . Calculate the heat loss from the fin length 25 mm.

- 3** Attempt the following : (any two) **7x2=14**
- (a) Write Plank's law, derive the Stefan Boltzmann law from the planks law equation.
  - (b) Calculate the rate of heat loss from a thermo flask if the polished silvered surfaces have emssivities of 0.05, the liquid in the flask is at 368 K (95° C) and the casing is at 293 K (20°C). Calculate the loss if both surfaces were black.
  - (c) A chamber of heat curing large aluminium sheets, lacquered black on both sides, operates by passing the sheets vertically between two steel plates 150 mm apart. One of the plates is at 300° C and the other, exposed to the atmosphere, is at 25° C.
    - (i) What is the temperature of the lacquered sheet ?
    - (ii) What is the heat transferred between the walls when equilibrium has been reached ? Neglect convection effects. Emissivity of steel is 0.56, emssivity of lacquered sheets is 1.0.
- 4** Attempt the following questions : **9x2=18**
- (a) Give the physical significance of Nusselt number and Reynolds number.
  - (b) Application of baffles in Heat Exchanger.
  - (c) Fouling factor in Heat Exchangers.
  - (d) Classification of Heat Exchangers.
  - (e) What Characteristics of the Fluid are to be considered while deciding its route in heat exchanger.
  - (f) Write Dittus-Boelter equation.
  - (g) State Dunhring's Rule.
  - (h) Define capacity and economy of evaporator.
  - (i) Application of multiple effect evaporator.

5 Solve any **two** of the following : **8×2=16**

- (a) (i) Define Filmwise and Dropwise condensation.  
(ii) Natural and Forced Convection.
- (b) Give the importance of LMTD and derive equation for calculation of LMTD.
- (c) Water at 303K (30°C) enters a 25mm I.D. tube at a rate of 1200 L/h. Steam condenses on the outside surface of tube 28mm O.D. at a temperature of 393 K (120°C) and its film transfer coefficient may be taken as  $7000 \text{ w}/(\text{m}^2 \cdot \text{k})$ . Estimate the length of the tube required to heat water to 343 k (70°C).

Data - Thermal conductivity of tube wall

material = 348.9 w/m.k properties of water at means

temperature of 323 k (50°C) are  $k = 0.628 \text{ W}/(\text{m.k})$ ,

$\rho = 980 \text{ kg}/\text{m}^3$ , and  $\mu = 6 \times 10^{-4} \text{ kg}/(\text{m.s})$

$C_p = 4.187 \text{ kJ}/(\text{Kg.K})$

6 Solve any **two** of the following : **8x2=16**

- (a) Vapour recompression in evaporators.
- (b) Give the construction and working with diagram of Double Pipe Heat Exchanger.
- (c) A solution containing 10% solids is to be concentrated to a level of 50% solids. Steam is available at a pressure of 0.20 MPa. [Saturation temperature of 393 k (120°C)]. Feed rate to the evaporator is 30000 kg/h. The evaporator is operating at a reduced pressure such that the boiling point is 232K (50°C). The overall heat transfer coefficient is 2.9 KW/(m<sup>2</sup>.k).

Estimate (i) Steam economy (ii) Heat transfer surface area for feed introduced at 293 k (20°C).

Data : Specific heat of feed = 3.98 kJ/(kg.k)

Latent heat of condensation of steam at 0.20 Mpa = 2202 kJ/kg. Latent heat of vaporisation of water at 323 K (i.e. at the pressure in the vapour space = 2383 kJ/kg.)