Roll No. | | | | | | | | | | | | | **Total No. of Pages : 03**

Total No. of Questions : 09

B.Tech.(Petroleum Refinary Engineering) (2013 Onwards) (Sem.–3)

HEAT TRANSFER

Subject Code : BTPC-303

M.Code : 72192

Time : 3 Hrs. **Max. Marks : 60**

INSTRUCTION TO CANDIDATES :

1. **SECTION-A is COMPULSORY consisting of TEN questions carrying TWO marks each.**
2. **SECTION-B contains FIVE questions carrying FIVE marks each and students has to attempt any FOUR questions.**
3. **SECTION-C contains THREE questions carrying TEN marks each and students has to attempt any TWO questions.**

SECTION-A

1. Answer briefly :

a. What do you understand by optimum thickness of insulation?

b. Bring out the point of difference between natural and forced convection with the help of examples.

c. Write down physical significance of Nusselt's number.

d. What do you understand by hydrodynamic boundary layer and thermal boundary layer? Which one is important in heat transfer and why?

e. What do you understand by "Grey Surface" with reference to Radiation Heat Transfer?

f. What is the mechanism of transfer of heat by radiation?

g. What is the difference between 'capacity' and 'economy' terms used in case of evaporators?

h. Differentiate between pool boiling and subcool boiling.

i. Differentiate between film wise condensation and drop wise condensation. In which case is the heat transfer higher and why?

j. A condenser of a hydrocarbon vapour is designed for horizontal installation. Is its capacity likely to be affected if it is installed vertically? Why and how?

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SECTION-B

2. A pipe carrying steam at 230 °C has an internal diameter of 12cm and the pipe thickness is 7.5mm. The conductivity of the pipe material is 49 W/mK and the convection heat transfer coefficient on the inside is 85 W/m^2K. The pipe is insulated by two layers of insulation of thickness 5cm each having thermal conductivities = 0.15 W/mK and 0.48 W/mK, respectively. The outside is exposed to air at 35°C with a convection heat transfer coefficient of 18 W/m^2K. Determine the heat loss for 5 m length of pipe. Also determine interface temperatures and the overall heat transfer coefficient based on inside and outside areas.

3. A thermocouple is formed by soldering end-to-end wires of 0.5 mm dia. The thermal diffusivity of the material is 5.3×10^{-6} m^2/s. The conductivity of the material is 19.1 W/mK. The probe initially at 30°C is placed in a fluid at 600°C to measure the temperature of the fluid. If the convection heat transfer coefficient between the wire and the fluid is 85 W/m^2 K, determine the time constant for the probe and also the time taken for it to read 598°C.

4. Determine the rate of heat loss from a 100 mm diameter steam pipe placed horizontally in ambient air at 30°C. The length of the pipe is 4 m and wall temperature, Tw = 170°C.

   Use the following empirical expression :

   $Nu = 0.53\ (Gr \times Pr)^{1/4}$

   Properties of air at 100°C are as following :

   $\beta = 1/373\ K^{-1}$, ν (kinematic viscosity) $= 23.13 \times 10^{-6} m^2/sec$

   k = 0.0325 W/m.K, Pr = 0.7

5. Define over all heat transfer coefficient. Comment on the relative magnitudes of the thermal resistances. What is the difference between U_I and U_O?

6. Define Monochromatic and total emissive power. Describe how the monochromatic emissive power varies with the wavelength for emissions form a black body? At what wavelength is the black body monochromatic emissive power the maximum?

SECTION-C

7. a. State the assumptions of Nusselt theory of condensation and obtain an expression for local value of condensing heat transfer coefficient over a vertical flat plate of length L. (6)

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b. Draw the boiling curve and identify the different boiling regimes. Discuss critical heat flux and Leidenfrost point. (4)

8. a. Crude oil flows at the rate of 10000 kg/hr through the inside pipe of a double pipe heat exchanger and is heated from 32°C to 90°C. The heat is supplied by a petroleum fraction initially at 230 °C, flowing through the annular space. If the temperature of the heating fluid falls down to 100 °C at the exit of the heat exchanger, compare the performances of parallel and counter current heat exchangers with respect to heat transfer area and fluid flow rates. Overall heat transfer coefficient is 400 kcal/hr.m^2°C. Specific heat of crude oil and petroleum fraction are 0.56 and 0.60 kcal/kg. °C, respectively. (6)

b. Show the temperature variation along the length of a double pipe heat exchanger when hot and cold fluid flow in parallel and counter flow fashion. Give expressions to calculate LMTD for these arrangements. (4)

9. a. Classify various types of evaporators being used in process industry. Discuss the construction and working details of caladeria type evaporator. (5)

b. What do you understand by 'boiling point elevation' (BPE)? Elaborate with the help of 'Duhring rule'. (5)

NOTE : Disclosure of Identity by writing Mobile No. or Making of passing request on any page of Answer Sheet will lead to UMC against the Student.

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