Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B. E. - SEMESTER – IV • EXAMINATION – WINTER 2012

Subject code: 140503 **Date: 29/12/2012**

Subject Name: Process Heat Transfer

Time: 02.30 pm - 05.00 pm **Total Marks: 70**

Instructions:

1. **Attempt any five questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Explain different modes of heat transfer along with their basic laws. **07**

(b) With the help of a neat sketch explain the working of 1-2 shell & tube heat exchanger and its important parts. **07**

Q.2 **(a)** Derive the expression for critical radius of insulation for a cylinder. **07**

(b) Liquid ammonia at -20^{0}C is stored in a spherical vessel of inner and outer radii 1m and 1.05m, respectively. The inner shell of 3 cm thickness is made of Nickel steel (k = 19 W/mK) and the outer shell of thickness 2cm is made of carbon steel (k = 54 W/mK). The vessel is exposed to atmospheric air at 30^{0}C. The inside and outside film coefficients are 100 W/m^{2}K and 10 W/m^{2}K, respectively. Calculate the rate of heat loss from liquid ammonia. **07**

OR

(b) A vertical cylinder of 20mm diameter and 2m height is maintained at constant temperature of 40^{0}C. The ambient air temperature is 20^{0}C. Calculate the amount of heat generated by the cylindrical body. Use the equation: $Nu = 0.12\ (Gr \times Pr)^{1/3}$. **07**

The properties of air at film temperature can be used as follows:

Density = 1.165 kg/m^3, sp. Heat = 1005 J/kgK, thermal conductivity = 0.0267 W/mK, viscosity = 1.866×10^{-5} Ns/m^2.

Q.3 **(a)** Discuss natural convection in vertical and horizontal cylinders. **06**

(b) Define: i) emissivity, ii) Black body, iii) View factor, iv) Radiation shield **08**

OR

Q.3 **(a)** Write short notes on: i) Planck's law ii) Kirchoff's law. **08**

(b) A black body having surface area 0.035m^2 is enclosed in an enclosure having 50mm thick wall and surface area 0.6m^2. The inner surface of the enclosure is maintained at 235^{0}C, while the outer surface is at ambient temperature of 33^{0}C. It can be assumed that the inner and outer surface areas of the enclosure are equal and at steady conditions. The thermal **06**

conductivity of the enclosure wall is 0.9 W/mK. Calculate the temperature of the black body.
Stefan Boltzman constant = 5.67×10^{-8} W/m^{2}K^4.

Q.4 **(a)** Discuss the reasons for boiling point elevation in an evaporator and its effect. **06**

(b) A single effect evaporator is to be designed to concentrate 9000 kg/hr of a solution from 12% to 20% solids. Feed enters at 25^{0}C. Saturated steam at 110^{0}C (latent heat = 540 kcal/kg) is available. The condensate leaves at the condensing temperature. Saturation temperature of vapor to the condenser is 40^{0}C (λ = 580 kcal/kg). Specific heat of all solutions may be taken as 1 kcal/kg^{0}C. Boiling point rise is 5^{0}C. The evaporator has an overall heat transfer coefficient of 1900 kcal/hr.m^2.^{0}C. **08**

Calculate: i) evaporator capacity, ii) evaporator economy,
iii) the area of heating surface required.
Use 1 kcal = 4186 J.

OR

Q.4 **(a)** Explain the construction and working of a falling film evaporator with a neat sketch. **06**

(b) Define evaporator capacity and evaporator economy. **04**

(c) Draw the pool boiling curve and write the highlight of each segment in brief. **04**

Q.5 **(a)** Write a short note on significance of various dimensionless numbers in heat transfer. **05**

(b) Kerosene is heated in a 1-2 shell & tube heat exchanger by a fluid. Kerosene flows in the tube at 25 kg/s and is heated from 20^{0}C to 55^{0}C. The hot fluid enters the shell at 115^{0}C and leaves at 50^{0}C. The maximum design velocity of fluid through the tubes is 2.5 m/s. The properties of kerosene at bulk temperature are as follows: sp. Gravity = 0.805, viscosity = 0.52 cp, specific heat = 1.8 kJ/kgK, thermal conductivity = 0.15 W/mK. The tubes are of low carbon steel having ID=1.575cm and OD=1.905cm. Assume dirt factor 0.0022 m^{2}K/W. The film coefficient of hot fluid is 2800 W/.m^{2}K. **09**

Calculate: i) number of tubes, ii) length of tube.

OR

Q.5 **(a)** Discuss different types of condensation. **07**

(b) In a countercurrent double pipe heat exchanger oil flows through a 1.5m long copper tube of 18mm ID and 24mm OD and cooled from 60^{0}C to 30^{0}C using water from cooling tower at 25^{0}C. Water flows through the annulus and exit at 35^{0}C. The convective heat transfer coefficient between the oil and the tube is 500 W/m^{2}K and the convective heat transfer coefficient between the tube and water is 800 W/m^{2}K. Calculate the rate of heat transfer. Thermal conductivity of copper = 386 W/mK. **07**

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