Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

B.E. Sem-IV Remedial Examination Nov/ Dec. 2010

Subject code: 140503 **Subject Name: Process Heat Transfer**

Date: 06 / 12 / 2010 **Time: 03.00 pm – 05.30 pm**

Total Marks: 70

Instructions:

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

Q.1 **(a)** **Define the term:** **07**

(i) Conduction, Convection and Radiation
(ii) Fourier's law
(iii) L.M.T.D.
(iv) Nueselt No.
(v) Nucleate boiling
(vi) Stefan Boltzman law
(vii) Capacity & Economy of evaporators

(b) Derive an expression for steady state heat conduction through a composite cylinder of three layers. **07**

Q.2 **(a)** Derive the equation for L.M.T.D. and explain its importance. **07**

(b) How overall heat transfer coefficient can be derived from individual heat transfer coefficients. **07**

OR

(b) Methanol flowing in the inner pipe of a double pipe exchanger is cooled from 60 ^{o}C to 30 ^{o}C with water flowing in the outer pipe. The inside and outside diameter of the inner pipe are 26 mm and 35 mm, respectively. The thermal conductivity of steel is 50 W/ (m K). The individual coefficients and fouling factors are: **07**

Methanol coefficient = 250 W/(m^2 K) ; Water coefficient = 500 W/(m^2 K) ;
Inside fouling factor = 0.86 x 10 $^{-3}$ (m^2 K)/W ;
Outside fouling factor = 1.7 x 10 $^{-3}$ (m^2 K)/W

Calculate the overall coefficients based on the outside area of the inner pipe including dirt factors and excluding dirt factors.

Q.3 **(a)** Differentiate: Drop-wise & Film-wise condensation **07**

(b) Calculate the heat transfer area of 1-2 pass heat exchanger for the following data: Inlet and outlet temperature of hot fluid is 150 ^{o}C and 80 ^{o}C, respectively. Inlet and outlet temperature of cold fluid is 30 ^{o}C and 45 ^{o}C, respectively. **07**

Overall heat transfer co-efficient = 4100 W/(m^2 K) ;
Rate of heat transfer = 407 KW ; LMTD correction factor = 0.84

OR

Q.3 **(a)** Name different types of heat exchanger and explain plate type heat exchanger in details. **07**

(b) 27 t/h of pure isobutene is to be condensed at 332 K in a horizontal tubular heat exchanger using water as a cooling media. Water enters at 300 K and leaves the exchanger at 315 K. Calculate the LMTD, heat load and mass flow rate of cooling water. **07**

Data:

Latent heat of vaporization of isobutene is 286 kJ/kg and specific heat of water is 4.187 kJ/(kg K)

Q.4 **(a)** Compare forward feed arrangement with backward feed arrangement in case of multiple effect evaporation system. **07**

(b) Calculate the amount of steam required for concentrating the solution of caustic soda from 28% w/w of solids to 40% w/w of solids in a single effect evaporator. The feed rate in 25000 kg/hr and its temperature is 60 ^{o}C. The absolute pressure in the evaporator is 0.2 kg/cm^2. (Boiling point 60 ^{o}C). Saturated steam at 1.4 kg/cm^2 (108.7 ^{o}C) is to be used as heating medium. The elevation in boiling point is 25 ^{o}C. If the overall heat transfer coefficient is 670 Kcal/ (hr m^2 ^{o}C), calculate the heating surface required. The enthalpy data for various streams are as follows: **07**

Vapor at 0.2 kg/cm^2 = 623 kcal/kg
28 % NaOH at 60°C = 50 kcal/kg
40 % NaOH at 85°C = 90 kcal/kg
Latent heat of steam at 1.4 kg/cm^2 = 534 kcal/kg.

OR

Q.4 **(a)** Write a short note: Extended surface heat exchangers **07**

(b) Differentiate single pass and multi-pass shell and tube heat exchanger along with sketch. **07**

Q.5 **(a)** Write if brief on concept of black body. **07**

(b) Estimate the total heat loss by convection and radiation from an unlagged steam pipe, 50 mm O.D. at 415 K to air at 290 K. **07**

Data : Emissivity, e = 0.90

Film coefficient (h_c) for calculation of heat loss by natural convection is given by $h_c = 1.18\ (\Delta T/Do)^{0.25}$ W/(m^2 K)

OR

Q.5 **(a)** Explain importance of Insulation, critical radius and steam trap. **07**

(b)

(i) State the method of increasing the economy of an evaporator. **02**

(ii) What are the advantages of square pitch arrangement over the triangular pitch in case of heat exchanger tubes ? **03**

(iii) When is LMTD correction factor is used in heat exchanger calculation ? **02**

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