Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER– II (Old course)• REMEDIAL EXAMINATION – SUMMER 2015

Subject Code: 1722101 Date:12/05/2015

Subject Name: Design of Heat Exchange Equipments

Time: 02:30 pm to 5:00 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)** For a balanced heat exchanger $\left[\frac{C_{min}}{C_{max}} = 1\right]$, show that for counter flow heat exchanger, $\varepsilon = \frac{NTU}{1+NTU}$ **07**

(b) What is Extended surface heat exchanger? Discuss Plate-fin and tube-fin heat exchangers with their applications. **07**

Q.2 **(a)** Explain the basic advantages and limitations of compact heat exchangers. **07**

(b) List and explain the factors to be considered while selecting heat exchangers. **07**

OR

(b) 1. In a gas to liquid heat exchanger, why are fins provided on the gas side? **07**

2. In the heat transfer relation $Q = UAF\Delta T_{lm}$ a heat exchanger, what is the quantity F called? What does it represent? Can F be greater than one?

Q.3 **(a)** Explain Forward feed system for multiple effect evaporators with neat sketch and discuss its design considerations. **07**

(b) Explain constructional features of Gasketed-plate type heat exchanger. **07**

OR

Q.3 **(a)** State design and operational consideration while selecting as well as design practices of condensers. **07**

(b) Explain rotary and fixed matrix regenerators with their applications. **07**

Q.4 **(a)** What is a baffle? Discuss different type and geometry of baffles used in shell and tube heat exchanger. **07**

(b) Distilled water with a flow rate of 50 kg/s enters a baffled shell and tube heat exchanger at 30 °C and leaves at 23 °C. Heat will be transferred to 150 kg/s of raw water coming from a supply at 18 °C. You are informed to design the heat exchanger for this purpose. A single shell and single tube pass is preferable. The tube O.D. and I.D. is 19 mm and 16 mm. Tubes are laid out on 2.54 cm square pitch. Maximum length of the heat exchanger is 8 m is required because of space limitations. Assume K_{tube} = 42.3 W/m K and maximum flow velocity through the tube is to be 2 m/s to prevent erosion. Also perform thermal analysis of the heat exchanger using Bell-Delaware method using correction factor of 60%. The following correlations and properties may be used; **07**

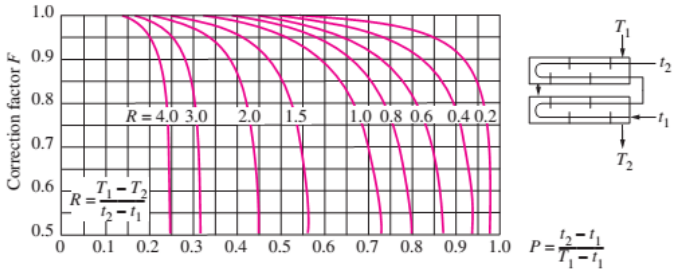
	Tube side fluid	Shell side fluid
ɟ (kg/m^3)	998.2	995.9
μ (Ns/m^2)	10.02×10^{-4}	8.15×10^{-4}
k (W/m.K)	0.598	0.612
c_p (J/kg.K)	4182	4179
Pr	7.01	5.75

	Tube side fluid	Shell side fluid
Corelations used	$Nu_b = \dfrac{(f/2)\,\mathrm{Re}_b\,\mathrm{Pr}_b}{1.07+12.7(f/2)^{1/2}\left(\mathrm{Pr}_b^{1/2}-1\right)}$ $f = (158\ln \mathrm{Re}_b - 3.28)^{-2}$	$h_{id} = j_i c_p \left(\dfrac{\dot{m}_s}{A_s}\right)\left(\dfrac{k_s}{c_p\mu_s}\right)^{2/3}$ $j_i = 0.185\,\mathrm{Re}_s^{-0.324}$

OR

Q.4 **(a)** Explain the general design consideration of shell and tube heat exchanger design. **07**

(b) A shell and tube heat exchanger with 2-shell passes and 8 tube passes is used to heat ethyl alcohol (C_p = 2670 J/kg °C) in the tubes from 25 °C to 70 °C at a rate of 2.1 kg/s. The heating is to be done by water (C_p = 4190 J/kg °C) that enters the shell at 95 °C and leaves at 60 °C. If the overall heat transfer coefficient is 800 W/m^2 °C, Determine the heat transfer surface area of the heat exchanger using (a) the LMTD method and (b) the Ůï NTU method (NTU = 1.7). **07**



Q.5 **(a)** Explain horizontal and vertical shell side condenser with neat sketch. **07**

(b) 1. Consider a double pipe counter flow heat exchanger. In order to enhance heat transfer, the length of the heat exchanger is now doubled. Do you think, its effectiveness will also be double? **07**

2. How is the NTU of a heat exchanger defined? What does it represent? Is a heat exchanger with a very large NTU (say, 10) necessarily a good to buy?

OR

Q.5 **(a)** Explain briefly design considerations for a pulverized coal furnace. **07**

(b) Water at a flow rate of 5000 kg/h will be heated from 22 to 37 °C by hot water at 142 °C. A 15 °C hot water temperature drop is allowed. A number of 3.5 m long hairpins of I.D. = 0.0779 m by I.D. = 0.0525 m and O.D. = 0.0603 m double pipe heat exchangers with annuli and pipes each connected in series will be used. Hot water flows through the inner tube. Inside and outside fouling factors are 0.000176 m^{2}K/W and 0.000352 m^2 K/W. Assume that the pipe is made of carbon steel (k = 54 W/m K). The heat exchanger is insulated against heat losses. Calculate the number of hairpins. Take properties of hot and cold water in a following manner: **07**

	Hot water	Cold water
ɟ (kg/m^3)	932.53	996.4
µ (Pa.s)	0.207×10^{-3}	0.841×10^{-3}
k (W/m.K)	0.687	0.609
c_p (kJ/kg.K)	4.268	4.179
Pr	1.28	5.77
	$f = (1.58\ln \mathrm{Re} - 3.28)^{-2}$	$f = (3.64\log_{10} \mathrm{Re} - 3.28)^{-2}$
Use : $Nu_b = \dfrac{(f/2)\,\mathrm{Re}_b\,\mathrm{Pr}_b}{1+8.7(f/2)^{1/2}\left(\mathrm{Pr}_b-1\right)}$ for both fluids		

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