Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E. SEMESTER III–EXAMINATION – WINTER 2015

Subject code: 2731105 **Date: 04/12/2015**

Subject Name: Design of Heat Exchanger

Time: 2:30 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)**	Explain the advantages of plate fin heat exchangers over shell and tube heat exchanger.	**07**
	(b)	Explain the following design consideration for a heat exchanger, • Predication of heat transfer coefficient • Pumping power • Size and weight of Heat Exchanger	**07**
Q.2	**(a)**	Define: (1) Prandtl number (2) Reynold Number and (3) Nusselt number. State the generally accepted critical Reynolds numbers for (a) flow over a flat plate (b) flow in tube.	**07**
	(b)	According to constructional features classify heat exchange equipments.	**07**
		OR	
	(b)	What is the heat capacity rate? Justify: minimum heat capacity fluid is used in the denominator for calculation of heat exchanger effectiveness.	**07**
Q.3	**(a)**	Explain constructional features of Gasketed plate heat exchanger.	**07**
	(b)	Explain giving precious reason why fouling fluids are not used in compact heat Exchangers?	**07**
		OR	
Q.3	**(a)**	With usual nomenclature derive ε – NTU method for counter flow heat exchanger.	**07**
	(b)	Explain passes and flow arrangements in Gasketed plate heat exchangers. State it's application also.	**07**
Q.4	**(a)**	State design consideration of coal fired furnace.	**07**
	(b)	Give classification of evaporators. How they are different than other heat exchangers? Name the three recent correlations for in tube flow boiling refrigerants?	**07**
		OR	
	(a)	Explain in detail construction and design of industrial condensers.	**07**
	(b)	Explain the design of double pipe heat exchangers by approximate method.	**07**
Q.5	**(a)**	What is a baffle? Discuss different type and geometry of baffles used in shell and tube heat exchangers.	**07**

(b) Distilled water with a flow rate of 50 kg/s enters a baffled shell and tube heat exchanger at 32 °C and leaves at 25 °C. Heat will be transferred to 150 kg/s of raw water coming from a supply at 20 °C. You are informed to design the heat exchanger for this purpose. A single shell and tube 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
ρ (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
Correlations used	$Nu_b = \dfrac{(f/2)\mathrm{Re}_b\,\mathrm{Pr}_b}{1.07+12.7(f/2)^{1/2}\left(\mathrm{Pr}_b^{1/2}-1\right)}$ $f=(1.58\ln\mathrm{Re}_b-3.28)^{-2}$	$h_{id}=j_i c_p\left(\dfrac{\dot{m}_s}{A_s}\right)\left(\dfrac{k_s}{c_p\mu_s}\right)^{2/3}$ $j_i=0.185\,\mathrm{Re}_s^{-0.324}$

OR

Q.5 (a) Name and explain the various leakages and bypass streams taken in to account in determination of shell side heat transfer coefficient and pressure drop in Bell Delaware method. **07**

(b) Water at a flow rate of 5000 kg/h will be heated from 20 to 35 °C by hot water at 140 °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 counter flow 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
ρ (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 : $Nu_b=\dfrac{(f/2)\mathrm{Re}_b\,\mathrm{Pr}_b}{1+8.7(f/2)^{1/2}(\mathrm{Pr}_b-1)}$ for both fluids		

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