Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER II (OLD) – • EXAMINATION – SUMMER 2016

Subject Code: 1722101 Date: 17/05/2016

Subject Name: Design of Heat Exchange Equipments

Time:10:30 am to 01:00 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 rating and sizing of heat exchangers. Evaluate which method of design (LMTD or ε-NTU) is preferred for Rating problem. **07**

(b) Discuss the basic criteria for a heat exchanger selection from various types available. **07**

Q.2 **(a)** What is hydraulic diameter? How is it defined? What is it equal to for a concentric tube heat exchanger of having Inner tube diameters = di and do and outer tube diameters = Di and Do respectively? **07**

(b) Discuss classification of heat exchangers and also suggest the specific exchanger construction type that may be used in the following applications: **07**
(a) Air Preheater (b) automotive Radiator (c) Condenser of an air conditioner

OR

(b) Can the outlet temperature of the cold fluid in a heat exchanger be higher than the outlet temperature of the hot fluid in a parallel-flow heat exchanger? How about in a counter-flow heat exchanger? Explain. **07**

Q.3 **(a)** Water at a flowrate of 5000 kg/h will be heated from 20 to 35℃ by hot water at 140 ℃. A 15 ℃ hot water temperature drop is allowed. A number of 3.5 m hairpin of 3 in (I.D. = 0.0779m) by 2 in (I.D. = 0.0525 m, 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. Fouling factors are R_i = 0.000176 m^2-K/W and R_o = 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 number of hairpins required.** **07**

The properties of both the fluids at bulk mean temperature are given in the table.

The properties of both the fluids at bulk mean temperature are given in the table. Fluid	Hot Water (Inner tube)	Cold Water (Annulus fluid)
Density, ρ, kg/m^3	932.53	996.4
Sp. Heat, Cp, kJ/kg-K	4.268	4.179
Viscosity, μ, Pa-s	0.207×10^{-3}	0.841×10^{-3}
Thermal Conductivity, k, W/m-K	0.687	0.609
Prandtl Number, Pr	1.28	5.77
Following correlation can be used		
$$Nu_b = \frac{\left(\frac{f}{2}\right)(Re_b)Pr_b}{1 + 8.7\left(\frac{f^{\frac{1}{2}}}{2}\right)(Pr_b - 1)}$$		
where, $f = (1.58 \ln Re - 3.28)^{-2}$		

(b) Discuss various tube layouts in a shell and tube heat exchanger. Also discuss **07**

the type of layout preferred when a shell side fluid is subjected to fouling and requires external cleaning.

OR

Q.3 **(a)** Explain the passes and flow arrangements for gasketed plate heat exchangers. **07**

(b) Explain furnace design with help of Lobo and Evans Method **07**

Q.4 **(a)** Discuss the different types of condensers used in refrigeration and air conditioning applications. **07**

(b) Explain classification of evaporators. Discuss air-cooling evaporator in brief **07**

OR

Q.4 **(a)** According to TEMA classify different shell types used in shell and tube heat exchangers **07**

(b) Distilled water with a mass flow rate of 50 kg/s enters to shell side of a shell and tube Heat exchanger at 32℃ and leaves at 25℃. The heat will be transferred to 150 kg/s of raw water coming from a supply at 20 ℃. **Calculate the heat transfer coefficient on a shell side of the heat exchanger using following specification and correlations.** **07**

Shell Side specification	Tube side specification
Shell Diameter, Ds= 0.58 m Baffle spacing, B = 0.50 m Clearance, C = 0.00635 m Pitch Size P_T = 0.0254 m Tube Layout –Square pitch	O.D. = 19 mm I.D. = 16 mm No of tubes = 374 No of pass = 1 K_{tube} = 60W/m^{2}K

Kern correlation for shell side $Nu = 0.36(Re)^{0.55}(Pr)^{1/3}$

Properties	Units	Shell side	Tube Side
ρ	kg/m^3	995.9	998.2
C_p	kJ/kg K	4.179	4.182
μ	Kg/ms	0.000815	0.0001002
k	W/m K	0.614	0.598
Pr		5.75	7.01

Q.5 **(a)** Air enters at 1 atm and 30℃ the core of finned tube heat exchanger, surface 8.0-3/8T type. The air flows at the rate of 1500kg/h perpendicular to the tubes and exits with a mean temperature of 100℃. The core is 0.5 m long with 0.25 m^2 frontal area. **Calculate the average heat transfer coefficient.** The exchanger geometrical parameters are as follows **07**

σ= (A_{min}/A_{fr})= 0.494 and β = (At/V)= 446 m^2/m^3

The properties at bulk temperature of 65℃

ρ = 1.038 kg/m^3, μ = 2.04 × 10^{-5} Kg/ms, C_p = 1.007 kJ/kg-K, Pr = 0.719

Re	j
600	0.019
700	0.018
800	0.017

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

OR

Q.5 **(a)** Discuss plate fin and tube fin heat exchangers with their applications **07**

(b) Explain a procedure for sizing a Compact Heat Exchanger **07**

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