Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – II • EXAMINATION – WINTER • 2014

Subject code: 1722101 Date: 02-12-2014

Subject Name: Design of Heat Exchange Equipments

Time: 02:30 pm - 05:00 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) Explain classification of heat exchangers based on geometry of construction. **07**

Q.2 **(a)** List four different types of flow regimes in a duct flow with heating or cooling. Explain in brief about fully developed (hydrodynamically and thermally) turbulent flow of single-phase fluid in smooth circular ducts. **07**

(b) Answer the following (any two) **07**

1. Why compact heat exchangers are more suitable for gaseous fluid?
2. What is the use of tie rods and spacers in shell-and-tube heat exchangers
3. Draw a parallel and series arrangements of hairpin heat exchanger

OR

(b) Explain giving the precise reasons weather the following statements are true or false: (any two) **07**

(1) NTU values for most heat exchangers are limited to 5

(2) The square lay out is more effective in heat transfer than the triangular layout of tubes.

(3) Plate heat exchangers are widely used in milk pasteurizing

Q.3 **(a)** The objective of this problem is to design a water to water heat exchanger. The decision was made to use a number of 3.5 m long hairpin heat exchanger of 3 in (ID=0.0779 m) by 2 in (ID = 0.0525 m, OD = 0.0603 m) with annuli and pipes each connected in series. Assume that the pipe is made of carbon steel (k =54 W/mK). **07**

Fluid	Annulus fluid Cold water	Tube side fluid Hot water
Flow rate, kg/h	5000	
Inlet temperature, ℃	20	140
Outlet temperature,℃	35	125
Density, kg/m^3	996.4	932.53
Sp. Heat, kJ/kg ℃	4.179	4.268
Viscosity, kg/m s	0.841×10^{-3}	0.207×10^{-3}
Prandtl Number (Pr)	5.77	1.28
Thermal conductivity, W/m-K	0.609	0.687
Fouling factors, m^2K/W	0.000352	0.000176

Using above data calculate the following

1. Velocity in the tubes and in the annulus
2. Calculate hydraulic and equivalent diameter of annulus
3. Overall heat transfer coefficient with fouling

(b) Explain ñUò and ñZò arrangements for gasketed ï plate heat exchanger. **07**

OR

Q.3 **(a)** Classify condensers on the basis of the cooling medium and explain evaporative condensers **07**

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

Q.4 **(a)** Air at 1 atm pressure and 400 K temperature with a velocity of 10 m/s flows across a compact heat exchanger matrix (tube-fin type) having the 8.0-3/8Tconfiguration. Calculate the heat transfer coefficient using following geometrical and fluid properties data. **07**

Density, kg/m^3	0.8825
Sp. Heat, kJ/kg ℃	1.013
Viscosity, kg/m s	2.29×10^{-5}
Prandtl Number (Pr)	0.719
σ = minimum free-flow are/ frontal area	0.534
D_h = Hydraulic Diameter	0.3633 m
Re (Reynolds number)	**Colburn j- factor**
2000	0.008
3000	0.007

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

OR

Q.4 **(a)** Classify regenerators. Explain rotary regenerators. **07**

(b) Explain water and air cooling Evaporators **07**

Q.5 **(a)** Find the heat transfer coefficient for the shell and tube heat exchanger with the following specification using Kern s method: **07**

Shell inside diameter (Ds) = 0.39 m; Tube diameter: ID = 16 mm and OD = 19 mm
Baffle spacing (B) = 0.25 m; Pitch Size (P_T) = 0.024 m (square)

Fluid Specification:

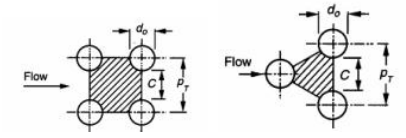
Mass flow rate = 50000 kg/h; density = 983.2 kg/m^3; Sp. Heat = 4184 J/kgK; Dynamic Viscosity = 4.67×10^{-4}Ns/m^2; Thermal Conductivity = 0.652 W/m K

(b) Compare plate heat exchanger with shell and tube heat exchangers. **07**

OR

Q.5 **(a)** Discuss Bell-Delaware method taking into account the effect of various leakage and bypass steams to evaluate shell side heat transfer co-efficient **07**

(b) Write down equivalent diameter (D_e) on shell side for a shell and tube heat exchanger having square and triangular pith-tube layout. **07**



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