Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Sem-II Examination July 2010

Subject code: 722101

Subject Name: Design of Heat Exchange Equipments

Date: 05 /07 /2010 **Time: 11.00am – 1.30pm**

Total Marks: 60

Instructions:

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

Q.1 **(a)** According to constructional features, classify heat exchange equipments. **06**

(b) Derive an equation for heat transfer effectiveness from first principle, for a simple parallel flow heat exchanger. **06**

Q.2 **(a)** Explain design consideration for shell and tube heat exchanger. **06**

(b) A shell and tube heat exchanger is to be designed for heating 9000 kg/hr of water from 15^0C to 85^0C by hot engine oil (Cp=2.35 kJ/kg K) flowing through the shell of the heat exchanger. The oil makes a single pass in the shell, entering at 150 ^{0}C and leaving at 95^0C with an average heat transfer coefficient of 400 W/m^{2}K. The water flows through 10 thin-walled tubes of 25 mm diameter with each tube making 8 passes through the shell. Calculate the length of tube required for the heat exchanger to accomplish the specified water heating. The heat transfer coefficient on the water side is 3000 W/m^{2}K. **06**

OR

(b) Air at 2 bar pressure and 200ºC temperatures gets heated as it flows through 2.5 cm diameter tube with a velocity of 10 m/s. A constant heat flux condition is maintained at the wall and wall temperature is 20 ºC above the air temperature all along the length of the tube. Make calculations for the heart transfer per unit length of the tube. Also determine the increase in bulk temperature over a 3 meter length of the tube. The appropriate correlation for the convection coefficient is **06**

$Nu = 0.023 (Re)^{0.8} (Pr)^{0.4}$.

Where the different thermo-physical properties of air are : $\mu = 2.57 \times 10^{-5}$ Ns/m^2, Cp = 1025 J/Kg- K,

k = 0.0385 W/m-K.

Q.3 **(a)** Explain various 'TEMA-Standard' Shell designs for the shell and tube heat exchangers. **06**

(b) Water (Sp. Heat = 4 kJ/kg-K) enters a cross flow exchanger (both fluids unmixed) at 15 ºC and flows at the rate of 7.5 kg/s. It cools air (Cp= 1 kJ/kg K) flowing at the rate of 10 kg/s form an inlet temperature of 120 ºC. For an overall heat transfer coefficient 780 kJ/m^2-hr-K and an exchanger surface area of 240 m^2. Determine the total heat transfer and the outlet temperature of air. **06**

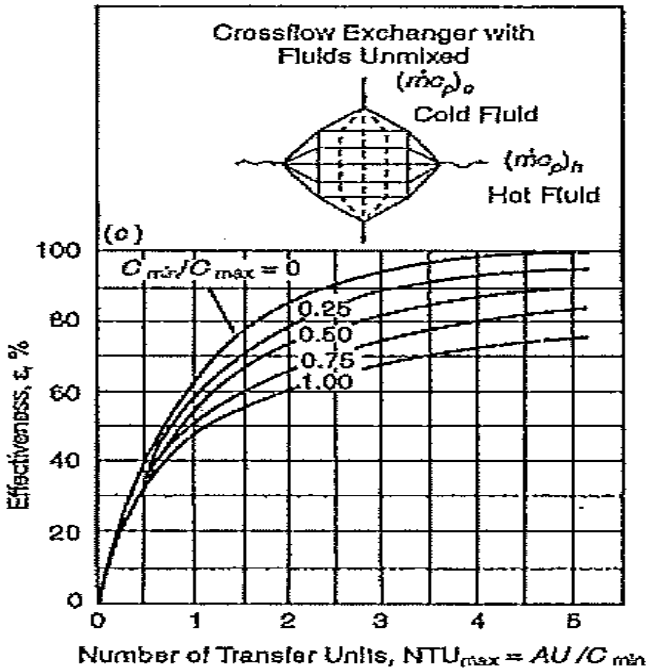

Figure 1. Effect of heat capacity ratio of cross flow heat exchanger performance.

OR

Q.3 **(a)** Explain strategy for Fouling consideration in various heat exchangers. **06**

(b) Discuss: (i) Rating and Sizing for a heat exchanger. **06**
(ii) Importance of LMTD method of heat exchanger design.

Q.4 **(a)** Explain typical designs of plate fin heat exchangers used in industries. **06**

(b) Air at 2 atm and 500 K with the velocity (u_∞) of 20 m/s flow across a compact heat exchanger matrix (where, ratio of minimum free-flow area to frontal area is 0.78). Calculate the heat transfer coefficient and the frictional pressure drop. Length of the matrix is 0.8 m. Refer table 1 if required for appropriate property selection. **06**

Table 1. Effect of Reynolds number on heat transfer and pressure drop characteristics

Re	$\frac{h}{GCp}.\mathrm{Pr}^{2/3}$	f	Density ratio at inlet and outlet
3000	0.004	0.012	0.8
4000	0.0045	0.018	0.9
4500	0.0056	0.023	1.0
5000	0.0065	0.030	1.0

OR

Q.4 **(a)** Discuss typical design of surfaces used as plates and heat exchange area. **06**

(b) Compare 'welded plate heat exchanger' and 'plate and frame heat exchanger'. **06**

Q.5 **(a)** Give classification of evaporators. How they are different than other heat exchangers? Explain any one of them in detail. **06**

(b) Explain in detail construction and design of industrial condensers. **06**

OR

Q.5 **(a)** Explain typical constructional aspects of regenerative heat exchangers. **06**

(b) State design considerations for a coal based furnace. **06**

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