

GUJARAT TECHNOLOGICAL UNIVERSITY**M. E. - SEMESTER – II • EXAMINATION – SUMMER • 2014****Subject code: 1723903****Date: 20-06-2014****Subject Name: Thermal Equipment Design (Mechanical)****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.
4. Use of Steam table and Refrigeration table are permitted.

- Q.1** (a) Give classification of heat exchanger. Draw the temperature distribution for following arrangement : (i) parallel flow (ii) Counter flow (iii) Cross flow (iv) Condenser (v) evaporator. **07**
- (b) In a parallel flow heat exchanger, the engine oil is cooled from 120°C to 60°C by water entering at 20°C and leaving at 50°C, Estimate : (i) Ratio of heat capacities of oil to cooling water (ii) effectiveness of heat exchanger and NTU (iii) Minimum temperature of oil upto which it can be cooled by increasing length of tube of heat exchanger. Assume Flow rates remain same. **07**

- Q.2** (a) Describe with neat sketch different types of baffles used in heat exchangers. State the importance of baffles. **04**

- (b) A double pipe heat exchanger is employed to heat raw water ($\dot{m}_c = 4.85 \text{ kg/s}$) from 20°C to 60°C using waste hot water ($\dot{m}_h = 2.81 \text{ Kg/s}$) cooled in the process from 95°C to 75°C. The hot water flows in the inner tube (ID = 35mm, OD = 44mm) in counter flow to the raw water which flows in annulus (ID = 72mm, OD = 88mm). Calculate the total length of heat exchanger. Consider $K_w = 60 \text{ W/m}^0\text{K}$. **10**

OR

- (b) A double pipe heat exchanger is employed to heat raw water ($\dot{m}_c = 4.85 \text{ kg/s}$) from 20°C to 60°C using waste hot water ($\dot{m}_h = 2.81 \text{ Kg/s}$) cooled in the process from 95°C to 75°C. The hot water flows in the inner tube (ID = 40 mm, OD = 48 mm) with 32 nos. of longitudinal carbon steel fins (Fin Width = 0.89mm, Fin Height = 12.7mm & Root Width = 4 mm) in counter flow to the raw water which flows in annulus (ID = 75mm, OD = 89mm). Calculate the efficiency of the fin. Consider $K_{fin} = 60 \text{ W/m}^0\text{K}$. **10**

- Q.3** (a) Explain with neat sketch shell and coil type condenser. **05**

- (b) Water at a flow rate of 60 kg/s enters a baffled shell and tube heat exchanger at 35°C and leaves at 25°C. The heat will be transferred to 150 kg/s of raw water coming from a supply at 15°C. Calculate overall heat transfer co-efficient using Kern Method. The tube diameter is 19mm OD and 16mm ID laid out on a 1 inch square pitch and max. length of heat exchanger is 8 m. The tube material is 0.5 Cr-alloy with total fouling resistance of 0.000176 m².K/W. The surface over design should not exceed 30%. Take $\mu_{wall} = 6.04 \times 10^{-4} \text{ N.s/m}^2$. Shell diameter is 0.39m & Baffle cut is 0.25m. Take tube side heat transfer co-efficient is 6245 W/m²K. **09**

OR

- Q.3** (a) Classify the evaporators. Explain plate type evaporator with neat sketch. **08**

- (b) The following are the values measured on a shell-and-tube ammonia condenser: 06

Velocity of water flowing through the tubes, V m/s	1.30	0.55
Overall heat transfer co-efficient, U_0 W/m ² K	2350	1610

Water flowed inside the tubes while refrigerant condensed outside the tubes (OD-48mm, ID-44mm, $K = 60$ W/m K.). Using the concept of Wilson's plot, determine the condensing heat transfer coefficient. What is the value of overall heat transfer coefficient when the velocity of water is 0.262 m/s?

- Q.4 (a) Explain the factors affecting surface selection in compact heat exchanger. 07
 (b) Hot air at 2 atm and 500 K at the rate of 8 kg/s flows across a circular finned tube matrix configuration as shown in figure 1. The frontal area of the heat exchanger is 0.8m*0.5 m and the core is 0.5 m long. Geometrical configuration are shown in figure 1. Calculate (i) Heat transfer coefficient (ii) Total frictional drop between air inlet and air outlet. 07

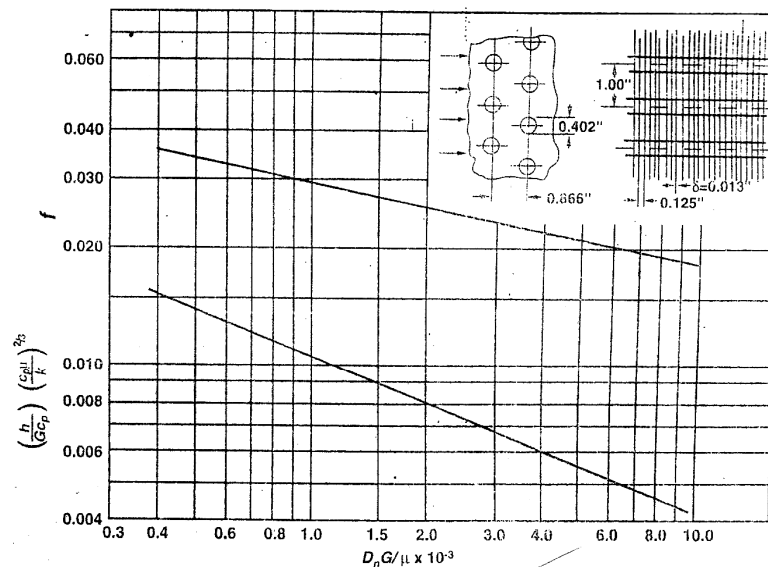
OR

- Q.4 (a) Explain different geometrical characteristics of tubular heat exchanger for staggered arrangement with neat sketch. 07
 (b) Explain the step by step calculation procedure for a sizing problem in a parallel flow compact heat exchanger 07

- Q.5 (a) Derive the equation to calculate the chimney height in a natural draft cooling tower. 07
 (b) Explain the importance of hyperbolic shape in natural draft cooling towers and importance of wet bulb temperature in the cooling tower calculations. 07

OR

- Q.5 (a) Explain step by step procedure of designing a cooling tower. What are the primary inputs required to design a cooling tower. 07
 (b) Enlist different elements of Artificial draft cooling towers. Explain their functions and the materials used in those elements. 07



Heat transfer and friction factor for a circular tube continuous fin heat exchanger: Surface 8.0-3/8 T; tube O.D. = 1.02 cm; fin pitch = 3.15/cm; fin thickness = 0.033 cm; fin area/total area = 0.839; air-passage hydraulic diameter = 0.3633 cm; free-flow area/frontal area, $\sigma = 0.534$; heat transfer area/total volume = 587 m²/m³.

FIGURE 1
