Seat No.: ________ Enrolment No.______________

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – II • EXAMINATION – SUMMER • 2013

Subject code: 1723903 **Date: 03-06-2013**

Subject Name: Thermal Equipment Design

Time: 10.30 am – 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.**
4. **Use of Steam table, Property table and Refrigeration table are permitted.**

Q.1 **(a)** Discuss the effect of fouling on the performance of heat exchangers. **07**

(b) A surface condenser used in power plant have 10m long, 3cm in diameter 12 nos. of tubes. The flow rate of cooling water is 1.1 kg/s. The inlet and outlet temperature of cooling water are 25^0C and 60^0C respectively. Determine (i) mass flow rate (ii) overall Heat Transfer Co-efficient (iii) NTU (iv) Effectiveness. Take h_{fg} = 2257 KJ/Kg **07**

Q.2 **(a)** State the basic design procedure for heat exchanger. **04**

(b) A double pipe heat exchanger consists of tube of 40.09mm inner diameter and 48.3 mm outer diameter surrounded by a shell of 96.66mm bore. Dowtherm flowing in a tube at a rate of 2 kg/s is heated from 25^0C to 55^0C by hot water in counter flow in the annulus cooling from 90^0C to 80^0C. Calculate the length of the heat exchanger to achieve these temperatures. Use $Nu=0.023Re^{0.8}Pr^{0.4}$ **10**

OR

(b) A double pipe heat exchanger is employed to heat raw water (m_c=5 kg/s) from 15^0 to 65^0C using waste hot water (m_h= 4.83Kg/s) cooled in the process from 95^0C to 75^0C.The hot water flows in the inner tube (ID = 40mm, OD = 48mm)with 25 nos. of longitudinal carbon steel fins (Fin Width = 0.89mm, Fin Height = 12mm & Root Width = 4mm) in counter flow to the raw water which flows in annulus (ID = 75mm,OD = 89mm). Calculate the length of the tubes. Consider K_{fin} material = 60 W/m ^{0}K. Use $Nu=0.023Re^{0.8}Pr^{0.4}$ **10**

Q.3 **(a)** Write a short note on shell and coil type evaporator. **07**

(b) The following are the values measured on a shell-and-tube ammonia condenser: **07**

Velocity of water flowing through the tubes, V m/s	1.25	0.63
Overall heat transfer co-efficient , U_0 W/m^{2}K	2250	1540

Water flowed inside the tubes while refrigerant condensed outside the tubes (OD-45mm, ID-40mm, K = 60 W/mK.). Using the concept of Wilsonȏs plot, determine the condensing heat transfer coefficient. What is the value of overall heat transfer coefficient when the velocity of water is 0.22 m/s?

OR

Q.3 **(a)** Give a note on tube in tube type condenser. **04**

(b) Distilled water with flow rate of 50 kg/s enters a baffled shell & tube heat exchanger at 32^0C and leaves at 25^0C. Heat will be transferred to 150 kg/s of raw water coming from a supply at 20^0C and leaving at 22.33^0C. Using Bell Delaware method, calculate the shell diameter of heat exchanger for the following data: tube O.D.: 19mm, tube ID.: 16mm, Square tube pitch: 25.4mm, baffle spacing: 0.5m (25% cut), max. Length = 8m, K_{tube} = 42.3 W/m .K, Total fouling resistance = 0.000176 m^2.K/W. Surface over design should not exceed 30%.The max. flow velocity through the tube is 2 m/s. Assume combined effect of correction factors = 60%.Nusselt no. for hot fluid is 132 and for cold fluid is 224.j_i = 0.0081. No. of tubes = 350. CL = 1, CTP = 0.93 PR = 1.33. **10**

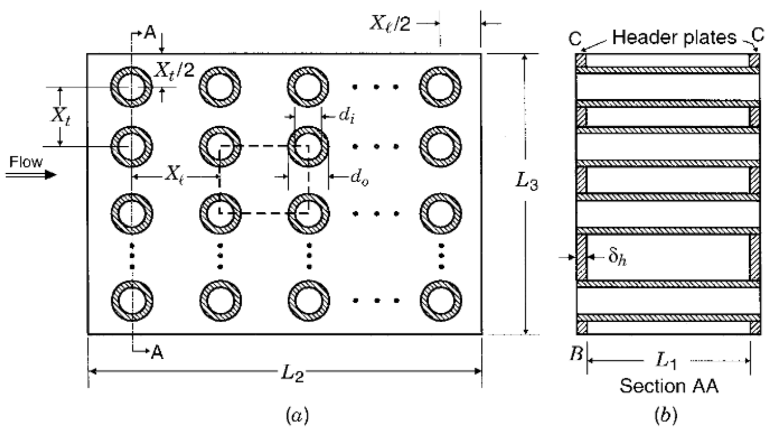
Q.4 **(a)** Explain the step by step calculation procedure for a rating problem in a compact heat exchanger. **07**

(b) Air at 2 atm and 500 K with a velocity of 20 m/s flows across a compact heat exchanger matrix having the configuration shown in Figure-1(surface 11.32-0737-S-R).Calculate the heat transfer coefficient and the frictional pressure drop. The length of the matrix is 0.8 m. **07**

OR

Q.4 **(a)** Explain factors influencing tube-fin heat exchanger performance in compact heat exchanger. **07**

(b) Find out different geometrical characteristics of tubular heat exchanger as shown in figure, where L_1=200mm, L_2=300mm, L_3=300 mm, d_i=10.67mm, d_o= 21.87 mm, ŭ$_h$=2.9134 mm **07**



Q.5 **(a)** Explain different components of induced draft cooling tower. **07**

(b) The findings of one typical trial pertaining to the Cooling Towers of a Thermal Power Plant 3 x 200 MW is given below: **07**

* Unit Load 1 & 3 of the Station = 398 MW
* Mains Frequency = 49.3
* Inlet Cooling Water Temperature °C = 44 (Rated 43°C)
* Outlet Cooling Water Temperature °C = 37.6 (Rated 33°C)
* Air Wet Bulb Temperature near Cell °C = 29.3 (Rated 27.5°C)
* Air Dry Bulb Temperature near Cell °C = 40.8°C
* Number of CT Cells on line with water flow = 45 (Total 48)
* Total Measured Cooling Water Flow m^3/hr = 70426.76
* Measured CT Fan Flow m^3/hr = 989544

Analyze the cooling tower and comment on the results obtained in the analysis

OR

Q.5 **(a)** Explain the factors affecting the cooling tower performance. **07**

(b) A chiller plant system (capacity 500kW) with COP at 4.5 is designed with a cooling tower, the design entering and leaving condenser water temperature of the cooling tower are 37°C and 32°C respectively, the design wet bulb temperature of the outdoor air is 28°C, what are: **07**

a) the cooling tower coefficient

b) the required condenser water and air mass rate (in kg/s) in the cooling tower

c) the required height of the fill

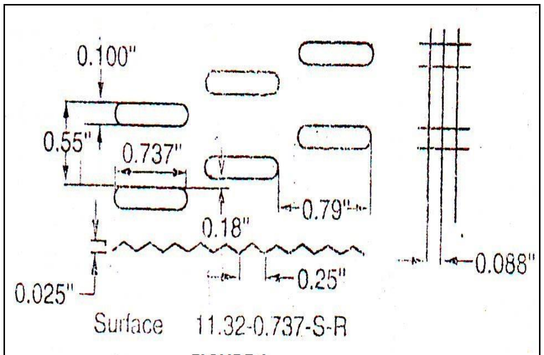


FIGURE 1

Properties of Air at 2 atm pressure

Temperature [Celsius]	200	250
Density : [kg / m^3]	1.49	1.36
Specific Enthalpy : [kJ / kg]	475.95	527.76
Specific Entropy : [kJ / kg K]	7.22	7.31
Specific isobar heat capacity(c_p) [kJ / kg K]	1.03	1.04
Heat conductance [10^{-3} W/m*K)]	37.98	41.05
Dynamic viscosity : [10^{-6} (Pa s)]	26.10	27.98
Kinematic viscosity : [10^{-6} m^2 / s]	28.20	33.64
Thermal diffusivity : [10^{-7} m^2 / s]	399.86	475.89
Prandtl-Number :	0.71	0.71

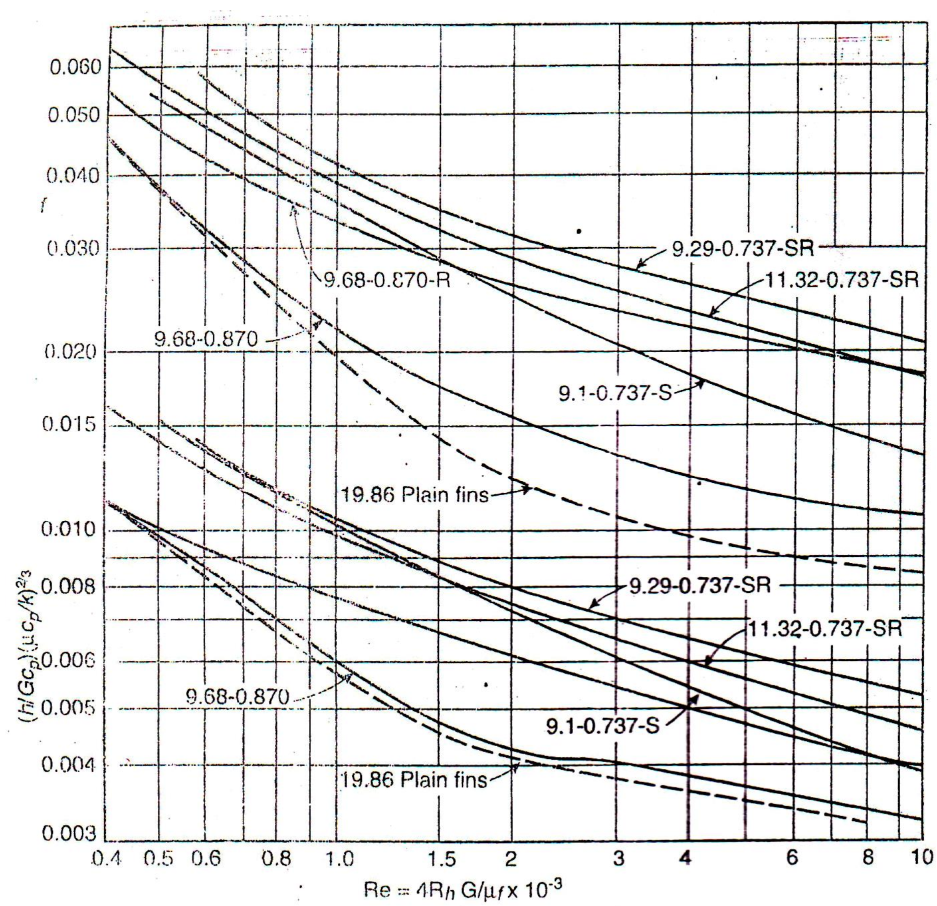


FIGURE 2

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