Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E –II[st] SEMESTER–EXAMINATION – JULY- 2012

Subject code: 1723903 Date: 10/07/2012

Subject Name: Thermal Equipment Design

Time: 10:30 am – 13:00 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)** Explain step by step the methodology for design of heat exchanger. **07**

(b) Steam condenses at atm. pressure on the external surface of tubes of the steam condenser. The tubes are 12 in nos. and each is 30 mm in diameter and 10mm long. The inlet and outlet temp. of cooling water flowing inside the tubes are 25^0C and 60^0C resp. If the flow rate is 1.1 Kg/s, calculate (i)the rate of condensation of steam (ii)the mean overall heat transfer co-efficient based on inner surface area (iii)the no. of transfer units (iv)the effectiveness of the condenser. **07**

Q.2 **(a)** What is baffle plate? Explain the importance and types of baffles with sketch. **07**

(b) A double pipe heat exchanger is employed to heat raw water ($\dot{m}_c$ =5 kg/s) from 15^0 to 65^0C using waste hot water ($\dot{m}_h$ = 4.83Kg/s) cooled in the process from 95 to 75^0C.The hot water flows in the inner tube (ID = 40mm, OD = 50mm)with 32 nos of longitudinal carbon steel fins (Fin Width = 0.89mm, Fin Height = 12.7mm & Root Width W_r = 4.02mm) in counter flow to the raw water which flows in annulus (ID = 75mm,OD = 90mm). Calculate the total length of heat exchanger. Consider K_W = 60 W/m ^{0}K. **07**

OR

(b) Using Kern method, Determine the overall heat transfer co-efficient for 2-P shell and tube type heat exchanger for the given data: Shell internal diameter = 0.39m, Nos. of tubes = 124, Tube parameters –OD=19mm, ID = 16mm, K_{tube} = 60 W/m^{2}K, baffle spacing =0.25m and cut = 25%, fouling resistance of 0.000176m^2.K/W on both side, Pitch size = 0.024m, μ_w=6.04 x 10^{-4} Ns/m^2. Mass flow rate = 13.88Kg/s **07**

Q.3 **(a)** Explain shell and tube type condenser. **07**

(b) Determine the required face area of an R-12 condenser for 5 TR refrigeration plant. The condensing temperature is 40^oC, the system COP is 4.9 and refrigeration effect is 110.8 KJ/kg. Air at an inlet temperature of 27 ^{0}C flows through the condenser with a face velocity of 2.5 m/s. The inside and outside diameters of the tubes are 11.26 and 12.68 mm, respectively. Fin efficiency is 0.73.Vertical spacing in a tube in raw = 43 mm; Tube spacing = 38 mm, centre to centre between fins = 3.175 mm, thickness of the fins= 0.254 mm. Nos. of raws = 4, Mean Reynolds No. = 431383, Condensation side h_i=8206.7 W/m^{2}K. Use $Nu_o = 0.117Re^{0.65}Pr^{0.33}$ **07**

OR

Q.3 **(a)** Explain direct expansion type fin and tube evaporator. **07**

(b) Write a short note on evaporative condenser. **07**

Q.4 **(a)** What is a compact heat exchanger? Give the classification of 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 fig 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)** Write short note on fixed matrix type regenerator. **07**

Q.4 **(b)** A rotary regenerator, with a rotational speed of 10 rpm, is used to recover energy from a gas stream at 250^0C flowing at 10 kg/s. This heat is transferred to the airstream at 10^0C, also flowing at 10 kg/s. The wheel depth is 0.22 m and diameter 1.6 m, so that its face area is approximately 1.8 m^2. The mass of the matrix is 150 kg with a surface-to-volume ratio of 3000 m^2/m^3, and the mean specific heat of the matrix material is 0.8 kJ/kg.K. The heat transfer coefficient for both fluid streams is 30 $W/m^2 \cdot K$. The mean isobaric specific heat of the gas is 1.15 kJ/kg. K and that of air is 1.005 kJ/kg .K. The flow split gas: air = 50%: 50%. For a counter-flow arrangement, calculate the following values: **07**

(a) The regenerator effectiveness

(b) The rate of heat recovery and the outlet temperatures of air and gas

(c) The rate of heat recovery and the outlet temperatures of air and gas if the rotational speed of the wheel is increased to 20 rpm

(d) The rate of heat recovery and the outlet temperatures of air and gas if the rotational speed of the wheel is reduced to 5 rpm

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

(b) Warm water from a condenser at a rate of 100 kg/s enters the wet cooling tower at 32^0C and is cooled by a moist humid air at 1 atm, 220C and 60 percent relative humidity and it leaves at 250C, saturated condition. The cooled water at the basin is 230C. determine **07**

i. Mass flow rate of air
ii. Volumetric flow rate of air
iii. Mass flow rate of make up water
iv. Volumetric flow rate of cooling tower water.

OR

Q.5 **(a)** Write a short note on forced draft cooling tower **07**

(b) Explain the components of cooling tower **07**

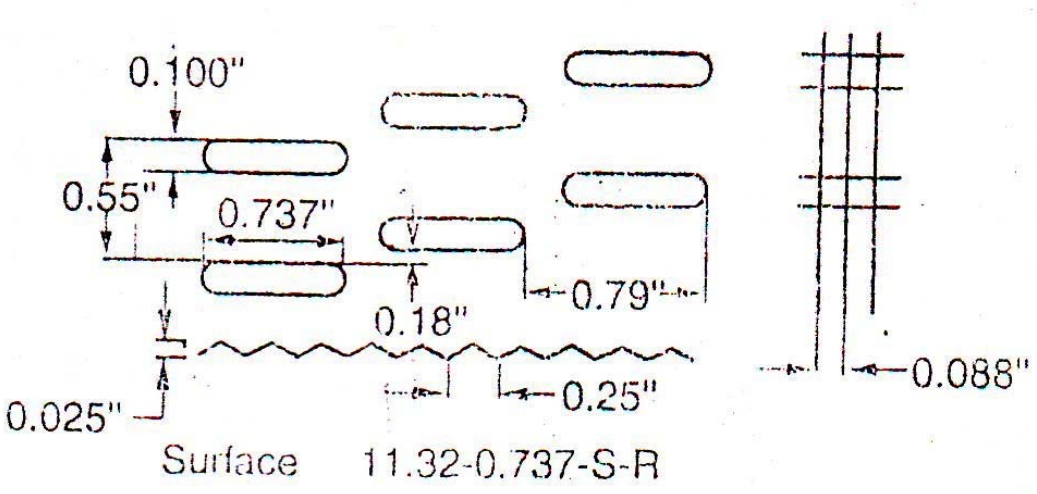
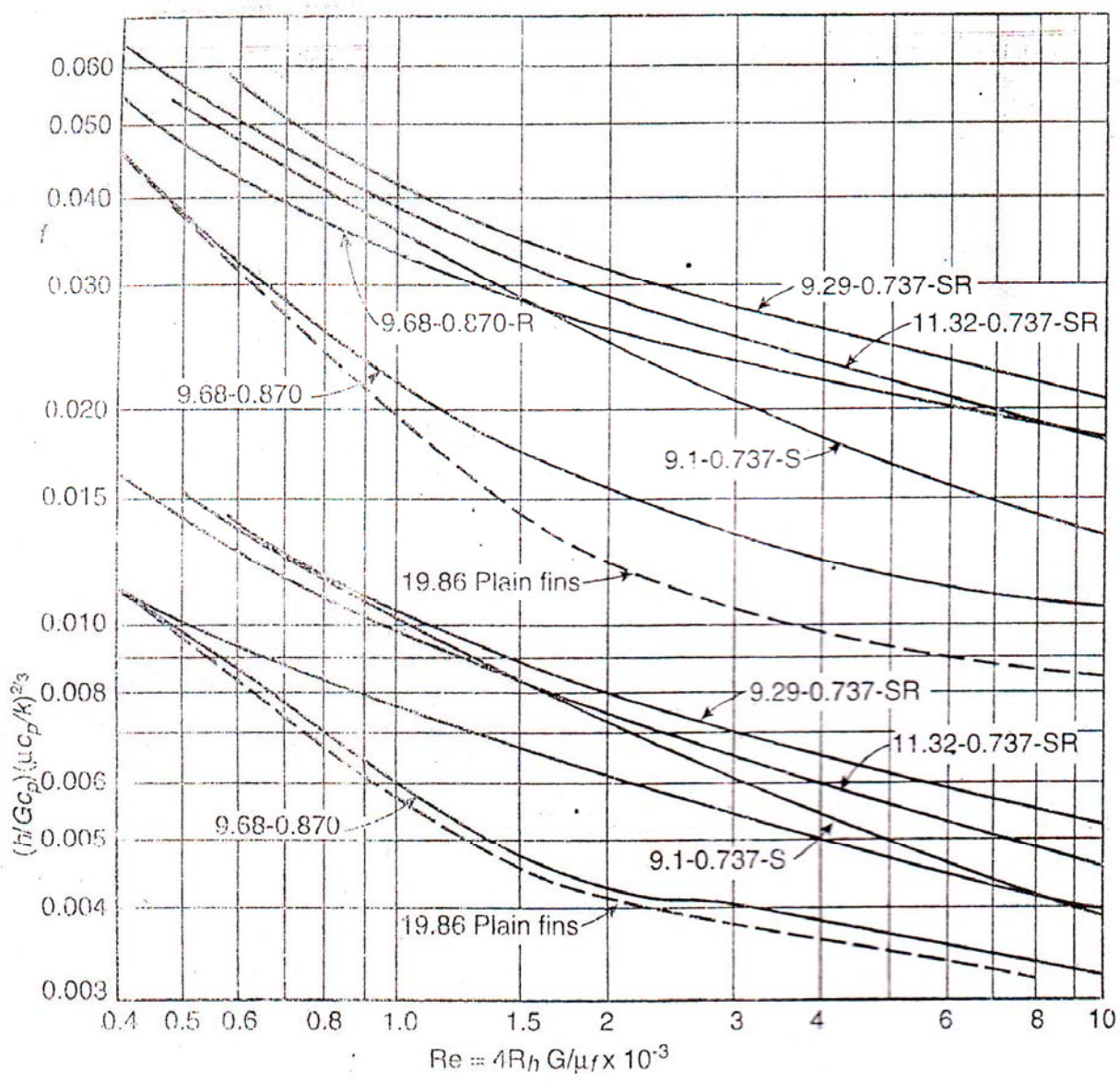


FIGURE 1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0.050
0.040
0.030
0.020
0.015
0.010
0.008
0.006
0.005
0.004
0.003
0.4
0.5
0.6
0.8
1.0
1.5
2
3
4
6
8
10
9.29-0.737-SR
11.32-0.737-SR
9.68-0.870-R
9.68-0.870
9.1-0.737-S
19.86 Plain fins
9.29-0.737-SR
11.32-0.737-SR
9.68-0.870
9.1-0.737-S
19.86 Plain fins
$(h/Gc_p)(\mu c_p/k)^{2/3}$
$Re = 4R_h G/\mu_f \times 10^{-3}$

FIGURE 2

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