

GUJARAT TECHNOLOGICAL UNIVERSITY**M. E. - SEMESTER – II • EXAMINATION – SUMMER • 2014****Subject code: 1722101****Date: 16-06-2014****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) Discuss recuperative and regenerative type of Heat Exchangers along with their specific applications **07**
- (b) Explain the advantage of using ϵ -NTU methodology to solve Rating problem of a heat exchanger. **07**

- Q.2** (a) Define Reynolds Number and state the generally accepted values of the critical Reynolds numbers for (a) flow over a flat plate (b) flow in tube **07**
- (b) When is a heat exchanger classified as being compact? Name the specific exchanger construction type that may be used in the following applications: **07**
- (a) Air Preheater (b) automotive Radiator (c) Condenser of an air conditioner

OR

- (b) Draw the temperature profile of a heat exchanger for the following condition. **07**
- (1) parallel flow (2) counter flow (3) $C_h \rightarrow \infty$ (4) $C_c \rightarrow \infty$
- Q.3** (a) Engine oil at a rate of 3 kg/s and 65 °C temperature flows through the annulus of a double pipe heat exchanger and comes out at 55 °C. Sea water is used to cool down the engine oil which flows through the inner tube at 20°C. The sea water outlet temperature is 30 °C. Calculate the following **07**
- (a) Hydraulic diameter and equivalent diameter for the annulus
- (b) Reynolds numbers for both the fluid

The properties of both the fluids at bulk mean temperature and also the geometrical dimension for the given heat exchangers are given in the table.

Fluid	Engine oil	Sea water
Density, ρ , kg/m ³	885.27	1013.4
Sp. Heat, C_p , kJ/kg-K	1.902	4.004
Viscosity, μ , kg/m-s	0.075	9.64×10^{-4}
Thermal Conductivity, k , W/m-K	0.1442	0.639
Prandtl Number, Pr	1050	6.29
Length of the hairpin = 4.5m		
Inner Tube ($d_o = 0.02667$ m, $d_i = 0.02093$ m) Outer Tube ($D_i = 0.0525$ m)		
Fin height, $H_f = 0.0127$ m; Fin Thickness, $\delta = 0.9$ mm, Number of fins = 30		
Material throughout = carbon steel ($k = 52$ W/mK)		

- (b) Discuss various shell types suggested by TEMA standard for shell and tube heat exchangers. **07**

OR

- Q.3** (a) Explain the constructional features of gasketed plate heat exchangers. **07**
- (b) Discuss stepwise procedure used for rating of gasketed plate heat exchangers **07**

- Q.4** (a) Classify condensers on the basis of the cooling medium used. Explain water cooled condenser in detail. **07**

- (b) Explain furnace design in detail. **07**

OR

- Q.4 (a)** Discuss square and triangle tube layout with their figures. Also discuss which layout will be preferable when shell side fluid is having fouling characteristics. **07**
- (b)** Distilled water with a mass flow rate of 80,000 kg/h enters to shell side of a shell and tube Heat exchanger at 35°C and leaves at 25°C. The heat will be transferred to 1,40,000 kg/h of raw water coming from a supply at 20 °C. Calculate the overall heat transfer coefficient of a shell and tube heat exchanger using following specification and correlations. **07**

Shell Side specification		Tube side specification	
Shell Diameter, $D_s = 0.39\text{m}$ Baffle spacing, $B = 0.30\text{ m}$ Clearance, $C = 0.00635\text{ m}$ Pitch Size $P_T = 0.03175\text{ m}$ Tube Layout ñSquare pitch		O.D. =0.0254 m I.D. = 0.0229 m No of tubes = 81 No of pass = 1 $K_{\text{tube}} = 60\text{W/m}^2\text{K}$	
$Nu = 0.36 \left(\frac{D_s G_s}{\mu} \right)^{0.28} \left(\frac{\mu C_p}{k} \right)^{1/3} \left(\frac{\mu_b}{\mu_s} \right)^{0.14}$		$Nu = \frac{\frac{f}{2} Re Pr}{1.07 + 12.7 \left(\frac{f}{2} \right)^{1/2} \left(Pr^{1/3} - 1 \right)}$ Where $f = (1.58 \ln Re - 3.28)^{-2}$	
Properties	Units	Shell side	Tube Side
ρ	kg/m ³	995.7	997
C_p	kJ/kg K	4.1785	4.179
μ	Kg/ms	0.000797	0.00095
k	W/m K	0.614	0.6065
Pr		5.43	6.55
$\mu_w = 0.00086\text{ Kg/ms}$			

- Q.5 (a)** Air at 1 atm and 400 K and with a velocity of $u_\infty = 10\text{ m/s}$ flows across a compact heat exchanger matrix having $\sigma = (A_{\text{min}}/A_{\text{fr}}) = 0.534$ and Hydraulic diameter(D_h)= 0.3633 cm. Calculate the heat transfer coefficient, h and frictional pressure drop for air side. The length of matrix is 0.6 m. Use following properties $\rho = 0.8825\text{ kg/m}^3$, $\mu = 2.29 \times 10^{-5}\text{ Kg/ms}$, $C_p = 1013\text{ J/kgK}$, $Pr = 0.719$ **07**

Air Side		
Re	j	f
2000	0.008	0.028
2500	0.007	0.025
3000	0.006	0.021

- (b)** Classify regenerators. Explain rotary regenerators with their applications **07**

OR

- Q.5 (a)** Discuss Bell-Delaware method to determine shell-side heat transfer coefficient **07**
- (b)** Discuss classification of evaporators used in Refrigeration and air-conditioning applications in detail. Name the three recent correlations for in tube flow boiling refrigerants. **07**
