Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject code: 1722101 Date: 24-12-2013

Subject Name: Design of Heat Exchange Equipments

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.**

Q.1 **(a)** Explain the factors to be considered while selecting heat exchangers? **07**

(b) For a balanced heat exchanger ($\frac{C_{min}}{C_{max}} = 1$), show that **07**

1. For Parallel flow, $\varepsilon = \frac{1 - e^{-2NTU}}{2}$
2. For counter flow, $\varepsilon = \frac{NTU}{1 + NTU}$

Q.2 **(a)** Give detailed classification of heat exchanger based on construction and flow arrangement of fluid? **07**

(b) Draw the temperature profile along the length of heat exchanger for following cases (1) $C_h \to \infty$ (2) $C_h = C_c$ and (3) $C_c \to \infty$ **07**

OR

(b) 1. When is a heat exchanger classified as being compact? Do you think a double pipe heat exchanger can be classified as a compact heat exchanger? **07**

2. In the heat transfer relation $\dot{Q} = UAF\Delta T_{lm}$ for a heat exchanger, What is the quantity F called? What does it represent? Can F be greater than one?

Q.3 **(a)** Explain the operation of a plate heat exchanger? What are its applications? **07**

(b) Explain the approximate design of plate heat exchanger to suit preliminary sizing of the plate units for a given heat duty? **07**

OR

Q.3 **(a)** Explain passes and flow arrangement in gasket plate heat exchanger. State its applications. **07**

(b) Give classification of evaporator in detail? How they are different than other heat exchanger? Name the three recent correlations for intube flow boiling refrigerants? **07**

Q.4 **(a)** Write two important functions of baffle and explain different type and geometry of baffles used in a shell and tube heat exchanger? **07**

(b) A heat exchanger is to be designed to heat raw water by the use of condensed water at 67 °C and 0.2 bar which will flow in the shell side with a mass flow rate of 50,000 kg/h. The heat will be transferred to 30,000 kg/h of city water coming from a supply at 17 °C. Water outlet temperature should not be less than 40 °C. A fouling resistance of 0.000176 m^2.K/W is suggested. Calculate the overall heat transfer coefficient for fouled as well as clean surfaces and length of tube for 2-P shell and tube heat exchanger using "Kern method". Use following specifications and Correlations; **07**

Tube side specification	Shell side specification
O.D. = 19 mm	Shell diameter = 0.39 m
I.D. = 16 mm	Pitch size = 0.024
No. of tubes = 124	Baffle spacing = 0.25 m
Tube layout- Square Pitch	$Nu = 0.36\left(\frac{D_e G_s}{\mu}\right)^{0.55}\left(\frac{\mu C_p}{k}\right)^{1/3}\left(\frac{\mu_b}{\mu_w}\right)^{0.14}$
K_{tube}= 60 W/m^{2}K	
$Nu_b = \frac{(f/2)(Re_b - 1000)Pr}{1+12.7(f/2)^{1/2}(Pr^{2/3}-1)}$ Where; $f = (1.58 \ln Re - 3.28)^{-2}$	

Properties	Units	Tube side	Shell side
ρ	Kg/m^3	996.8	983.2
C_p	J/kg K	4179	4184
μ	N.s/m^2	8.2×10^{-4}	4.67×10^{-4}
k	W/m K	0.610	0.652
Pr	-	5.65	3.00
$\mu_w = 6.04\times10^{-4}$ N.s/m^2			

OR

Q.4 **(a)** Draw and explain various shell designs suggested by the "TEMA standard" for the shell and tube heat exchanger? **07**

(b) The condenser of a large steam power plant is a shell and tube heat exchanger having a single shell and 30,000 tubes, with each tube making two passes. The tubes are thin walled with 25 mm diameter and steam condenses on the outside of the tubes with h_o = 11 kW/m^2 K. The cooling water flowing through the tubes is 30,000 kg/s and the heat transfer rate is 2 GW. Water enters at 20 °C while steam condenses at 50 °C. Find the length of the tubes in one pass. Properties of water at 27 °C are C_p = 4.18 kJ/kg K, μ = 855×10^{-6} N.s/m^2, k = 0.613 W/m K and Pr = 5.83. The flow of water is turbulent, use Dittus-Boelter equation towards water side: $Nu = 0.023\ Re^{0.8}Pr^{0.4}$ **07**

Q.5 **(a)** Explain the strategies to control fouling? **07**

(b) Explain the designed of coal fired furnace? **07**

OR

Q.5 **(a)** What is hairpin heat exchanger? Define hydraulic (D_h) and Equivalent (D_e) diameters for bare inner tube and annulus of a hairpin heat exchanger. **07**

(b) Explain rotary and fixed matrix regenerators with their applications. **07**

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