KUMARAGURU
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Register Number:……

M.E DEGREE EXAMINATIONS: JUNE 2017

(Regulation 2015)

Second Semester

ENERGY ENGINEERING

P15EETE07**:** Design Of Heat Exchangers

COURSE OUTCOMES

CO1: Discuss the components of heat exchangers

CO2: Analyze the heat exchanger for flow and strength

CO3: Appraise the design aspects of different heat exchangers

CO4: Design and develop a solution for compact and plate heat exchanger

CO5: Predict the performance characteristics of condensers and cooling towers

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Assertion (A): Plate fin heat exchangers are used in gas to gas applications CO1 [K_2]
   Reason (R): Fins are widely used when heat transfer coefficient is low for both sides.
   a) Both A and R are Individually true and R is the correct explanation of A
   b) Both A and R are Individually true but R is not the correct explanation of A
   c) A is true but R is false
   d) A is false but R is true

2. The heat capacity ratio does not have significant influence on effectiveness in NTU method when ….. CO2 [K_3]
   a) ε> 60%
   b) ε> 40%
   c) ε< 60%
   d) ε< 40%

3. The correction factor F introduced for the LMTD for computing heat transfer depends on…… CO2 [K_2]
   a) Overall heat transfer coefficient
   b) Area
   c) Temperature effectiveness
   d) effectiveness

4. Matching type item with multiple choice code CO5 [K_3]

List I	List II
A. Kandlikar correlation	i. Dittus Boelter
B. Winterton correlation	ii. flow through constant duct
C. Gnielinski correlation	iii. sum of convective and nucleate boiling
D. Shah correlation	iv. Martinelli parameter

	A	B	C	D
a)	ii	i	iii	iv
b)	iii	iv	ii	i
c)	ii	iv	iii	i
d)	iii	i	ii	iv

5. Assertion (A): While calculating effectiveness of the heat exchanger, the heat capacity of maximum value should be used. CO1 [K_2]

Reason (R): Effectiveness is the ratio between actual to the maximum possible heat transfer

a) Both A and R are Individually true and R is the correct explanation of A
b) Both A and R are Individually true but R is not the correct explanation of A
c) A is true but R is false
d) A is false but R is true

6. TEMA configuration for cross flow is…….. CO3 [K_2]

a) Class E
b) Class G
c) Class F
d) Class X

7. Consider the following steps to find shell side heat transfer coefficient by using Bell-Delaware method. CO3 [K_2]

1. Find the shell side properties of the fluid based on the type of fluid.
2. Find the cross flow area at the shell diameter.
3. Find the coulborn j-factor (j_i) for an ideal tube bank.
4. Substitute the properties and j_i to find heat transfer coefficient.

The correct sequence for calculating the length of the shell and tube heat exchanger is

a) 3-2-1-4
b) 2-1-4-3
c) 3-1-4-2
d) 1-2-3-4

8. Number of tubes in the shell and tube heat exchanger depends upon….. CO3 [K_2]

a) Tube diameter
b) Tube pitch
c) Tube passes
d) Tube length

9. Herring bone fin is also called as…..fin CO4 [K_2]

a) plate
b) wavy
c) longitudinal
d) elliptical

10. Which of the following statements are correct in selecting materials for manufacturing plate heat exchangers? CO4 [K_3]

1. Stainless steel is used for sea water.
2. Titanium is used for hypochlorite solutions.
3. Stainless steel is used for copper sulphate solutions.
4. Titanium is used for cooling hydrogen gases.

a) 1,2
b) 1,3
c) 2,3
d) 2,4

PART B (10 x 2 = 20 Marks)

11.	Differentiate between recuperator and regenerator.	CO1	[K_2]
12.	Mention the applications of compact heat exchangers	CO1	[K_2]
13.	State the drawback of Petuhov-Kirllov correlation in finding the Nusselt number for the flow.	CO2	[K_2]
14.	Classify the different stress acting on the pressure vessel.	CO2	[K_2]
15.	Mention the significance of hydraulic and hydraulic equivalent diameters in heat exchanger design calculations	CO3	[K_3]
16.	Describe about Colburn factor.	CO3	[K_2]
17.	Define enhancement ratio in compact heat exchangers	CO4	[K_2]
18.	Define Stanton number.	CO4	[K_2]
19.	State about Lockhart-Martinelli parameter.	CO5	[K_2]
20.	Differentiate between gravity controlled and shear controlled condensation process.	CO5	[K_2]

PART C (6 x 5 = 30 Marks)

21.	Energy engineer involved in designing the heat exchanger for oil cooler incorporated in 6 liter diesel engine truck. Select the appropriate heat exchanger for the above application with its description.	CO1	[K_4]
22.	A finned tube, single pass, cross flow heat exchanger with both fluids unmixed is used to heat air with hot water. The total heat transfer rate is 200 kW. The water enters the tube at 85 deg C and leaves at 30 deg C, while the air enters the finned tube at 15 deg C and leaves at 50 deg C. The overall heat transfer coefficient is 75 W/ m^2K. Calculate the surface area required.	CO2	[K_2]
23.	Enumerate purpose of hair-pins in double pipe heat exchanger and its contribution towards heat transfer.	CO3	[K_3]
24.	Paraphrase the requirements for allocation of streams while designing shell and tube heat exchanger.	CO3	[K_3]
25.	Summarize the contributions of increasing hA term while designing compact heat exchangers.	CO4	[K_3]
26.	With neat sketch, describe the different models representing condensate flow.	CO5	[K_2]

Answer any FOUR Questions

PART D (4 x 10 = 40 Marks)

27.	With neat sketch, explain the construction, working principle and the applications of finned tube double pipe heat exchanger.	CO1	[K_2]

28. A two tube pass, baffled single pass shell and tube heat exchanger is used as oil cooler. Cooling water enters the tubes at 25 deg C and the total flow rate of 8.157 kg/s and leaves at 32 deg C. The inlet and outlet temperatures of engine oil are 65 and 55 deg C, respectively. The heat exchanger has 12.25in ID shell, and the tubes have 0.652 in ID and 0.75in OD. A total of 160 tubes are laid out on 15/16 inch equilateral triangular pitch. R_{fo}=1.76*10-4 m2K/W, A_oR_W=1.084*10-5 m^2K/W, h_o =686 W/m^2 K, A_o /A_i =1.1476 and R_{fi}=0.00008 m^2K/W; find CO2 [K_2]

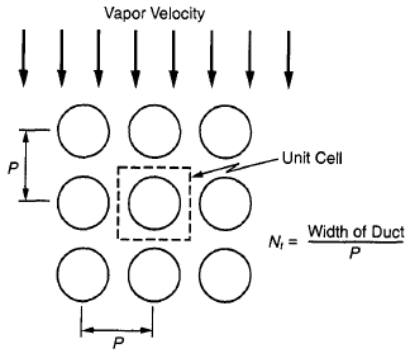
    1. The heat transfer coefficient inside the tube.
    2. The total surface area of the heat exchanger using LMTD method.

29. Distilled water with flow rate of 50kg/s enters a baffled shell and tube heat exchanger at 32 deg C and leaves at 25 deg C. Heat will be transferred to 150 kg/s of raw water coming from a supply at 20 deg C. Design a heat exchanger for this purpose. A single shell and single tube pass is preferable. The tube diameter is ¾ inch (19mm OD with 16 mm ID) and the tubes are laid out on a 1 inch square pitch. A maximum length of heat exchanger of 8m is required because of space limitations. The tube material is 0.5 cr-alloy (k=42.3 W/m K). The maximum flow velocity through the tube is also suggested to be 2 m/s to prevent erosion. Calculate and compare the shell side heat transfer coefficient using CO3 [K_3]

    1. Taborek method
    2. Bell- Delaware method.

30. Air at 1 atmosphere and 400 K with a free stream velocity of 10 m/s flows across a circular tube continuous fin compact heat exchanger with surface designation as 8 - 3/8 T. Calculate the heat transfer coefficient h, and frictional pressure drop for the air side. The length of the matrix is 0.6 m. CO4 [K_3]

31. Steam at a saturation temperature of 100 deg C is condensing in a bundle of 320 tubes with 0.56m wide duct. The tubes are arranged in a square, inline pitch (p= 35 mm) as shown in figure. The bundle is made of up to 20 rows of tubes with 3cm OD and with 16 tubes in each row. The tube wall temperature in each row is kept constant at 93deg C. The steam flows downward in a bundle, and at the sixth row of a tubes, local mass flow rate of vapor is m_g= 14 kg/s. Find the local heat transfer coefficient for the 6^{th} row of tubes using Butterworth's method. CO5 [K_3]



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