P P SAVANI UNIVERSITY

Seventh Semester of B. Tech. Examination December 2021

SEM E4511 Design of Heat exchangers **22.12.2021, Wednesday**

Time: 09:00 a.m. To 12:30 p.m. **Maximum Marks: 60**

Instructions:

1. The question paper comprises of two sections.
2. Section I and II must be attempted in separate answer sheets.
3. Make suitable assumptions and draw neat figures wherever required.
4. Use of scientific calculator is allowed.

SECTION – I

Q - 1 Define heat Exchanger. Application of heat exchanger **[05]**

Q - 2 (a) Explain Double pipe Heat exchanger with neat sketch. **[05]**

Q - 2 (b) Explain e-NTU method in brief **[05]**

OR

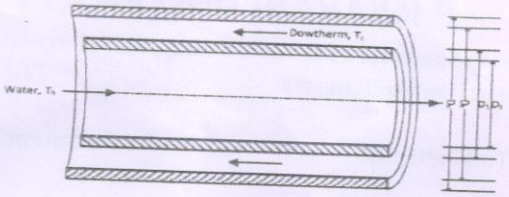
Q - 2 (a) Classification of Double pipe Heat Exchanger **[05]**

Q - 2 (b) Explain hydraulic Diameter and Equivalent Diameter **[05]**

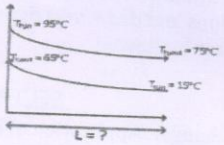
Q - 3 (a) Determine the heat transfer surface area required for a heat exchanger constructed from a 25.4 mm OD tube to heat helium from 78°C to 08°C using hot water at 858°C. The water and helium flow rates are 0.6 and 2.4 kg/s. Helium flows within the tubes. The overall heat transfer coefficient is 120W/m2 K. The specific heats for water and helium are 4.18 and 5.20 kJ/kg K, respectively. Consider a counterflow exchanger. Solve the problem by both the e-NTU and LMTD methods **[10]**

OR

Q - 3 (a) A double pipe heat exchanger of the dimensions shown in figure is employed to heat 5 kg/sec of Dowtherm A from 15°C to 65°C using waste hot water cooled in the process from 95°C to 75°C. The hot water flows in the inner tube in counter flow to the Dowtherm, which flows in the annulus. What is the total length of the heat exchanger required? Assume the tube material to be of steel with k = 60 W/m.K **[10]**



$D_o = 89$ mm
$D_s = 75$ mm
$D_1 = 48.3$ mm
$D_2 = 40.94$ mm



Fluid Properties:

Properties	Dowtherm A (at 40°C)	Water (at 85°C)
Density (kg/m^3)	1044	969
Specific Heat (J/kg.K)	1622	4197
Conductivity (W/m.K)	0.138	0.676
Viscosity (N.sec/m^2)	2.7×10^{-3}	3.11×10^{-4}

Q - 4 Explain any one in brief [05]

(i) Pin fin Heat Exchanger

(ii) Tube fin heat Exchanger

SECTION – II

Q - 1 Answer the Following: Choose best possible option [05]

(i) Which are the passive heat transfer augmentation techniques:

a) Extended surface, fluid pulsation, Inserts and swirl devices
b) Extended surface, Inserts and swirl devices, Additives for liquids and gases.
c) Fluid pulsation, Surface vibration, Inserts and swirl devices.
d) Application of electric field, Inserts and swirl devices, Additives for liquids and gases.

(ii) Fin effectiveness

a) Can be increased by using higher thermal conductivity material.
b) Can be increased by using Lower thermal conductivity material
c) Can be increased by using Higher thermal conductivity material
d) Depends on the geometry of the fin.

(iii) In pinch technology the design task is to find the best network of exchangers, heaters and coolers that can handle exchange of heat amongst hot and cold streams and utilities at minimum operating and annualized capital cost. This statement is True or False.

(iv) In an operation where we want to heat a stream of liquid by Steam, we have the option to use extended fins. Then which of the following is best suited?

a) Steam on the shell side with the fins on outer surface of the tube
b) Steam on the tube side with the fins on outer surface of the tube
c) Steam on the shell side with the fins on inner surface of the tube

d) Steam on the tube side with the fins on inner surface of the tube

(v) What are the three parts of Extended Surface heat exchangers when it is classified based on flow pattern?

a) Compound flow, Plate Fin and Cross Counter Flow

b) Compound flow, Tube Fin and Cross Counter Flow

c) Compound flow, Tube Fin and Plate Fin

d) Compound flow, Cross Parallel and Cross Counter Flow

Q - 2 (a) With neat sketch explain construction and working of shell and tube type heat exchanger. [05]

Q - 2 (b) Briefly explain performance evaluation of heat transfer enhancement techniques using perforated ribs and insert of Twisted tri-lobed in inner tube of heat exchanger. [05]

OR

Q - 2 (a) Explain importance of Pinch technology in analysis of Heat Exchanger. [05]

Q - 2 (b) Briefly explain performance evaluation of heat transfer enhancement techniques using twisted tape dimensions and right angled triangular rib as roughness on absorber surface of heat exchanger [05]

Q - 3 (a) Explain how the charts provided by Kays and London are useful in the design of heat exchangers. [05]

Q - 3 (b) Water enters a counter flow double pipe heat exchanger at 35 °C flowing at the rate of 0.8 Kg/s. It is heated by oil C_p=1.88 KJ/Kg K flowing at rate of 1.5 kg/s from an inlet temperature of 120 °C. For an area of 15 m^2, and an overall heat transfer coefficient of 350 W/m^2 K, determine the total heat transfer rate. Take specific heat of water as 4.18 KJ/ Kg K. [05]

OR

Q - 3 (a) Consider a heat exchanger in which both fluids have the same specific heats but different mass flow rates. Which fluid will experience a large temperature change – the one with the lower or the higher mass flow rate? Justify your answer. [05]

Q - 3 (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. Calculate the length of tubes in one pass. Properties of water at 27°C are C_p=4.18 KJ/ Kg K, m=855 X 10^{-6} NS/m^2, k=0.613 W/ m K and Pr=5.83 [05]

Q - 4 Attempt any one/two. [05]

(i) How TEMA charts are useful in design of multi pass heat exchanger.

(ii) Explain Bell Delaware method of shell and tube type heat exchanger.

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