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B. Tech. (Mech. Engg.) (Semester – 7th)
HEAT EXCHANGER DESIGN
Subject Code: BMECD1714
Paper ID: [18112340]

Time: 03 Hours **Maximum Marks: 60**

Instruction for candidates:

1. Section A is compulsory. It consists of 10 parts of two marks each.
2. Section B consist of 5 questions of 5 marks each. The student has to attempt any 4 questions out of it.
3. Section C consist of 3 questions of 10 marks each. The student has to attempt any 2 questions.

Section – A **(2 marks each)**

Q1. Attempt the following:

a) What is the purpose of using baffles in a heat exchanger?
b) Write down the names of various methods for enhancement of heat transfer.
c) Name the five examples of heat exchangers.
d) Explain Recuperators or surface exchangers.
e) Differentiate the parallel flow and counter flow heat exchanger with their graphs.
f) Explain evaporator and condenser.
g) Name the four factors on which overall heat transfer coefficient depends.
h) Differentiate between LMTD and NTU approach for design of heat exchanger.
i) What are the compact heat exchangers and their area of applications?
j) Explain TEMA codes.

Section – B **(5 marks each)**

Q2. In a shell and tube counter-flow heat exchanger water flows through a copper tube 20 mm I.D. (internal diameter) and 23 mm O.D. (outer diameter), while oil flows through the shell. Water enters at 20°C and comes out at 30°C, while oil enters at 75°C and comes out at 60°C. The water and oil side film coefficients are 4500 and 1250 W/m^2°C respectively. The thermal conductivity of the tube wall is 355 W/m°C. The fouling factor s on the water and oil sides may be taken to be 0.0004 and 0.001 respectively. If the length of the tube is 2.4 m. Calculate the following: (a) overall heat transfer coefficient; and (b) heat transfer rate.

Q3. Discuss types of fouling and their effect on the performance of heat exchangers. What are the cleaning methods used to remove fouling?

Q4. Derive an expression for the logarithmic mean temperature difference (LMTD) in case of parallel flow heat exchanger.

Q5. Draw rough sketch of temperature distribution curve for condenser and evaporator type heat exchangers. Also Discuss overall heat transfer coefficient for shell and tube type heat exchanger

Q6. In a parallel flow double-pipe heat exchanger water flows through the inner pipe and is heated from 20°C to 70°C. Oil flowing through the annulus is cooled from 200°C to 100°C. It is desired to cool the oil to a lower exit temperature by increasing the length of the heat exchanger. Determine the minimum temperature to which the oil may be cooled.

Section – C **(10 marks each)**

Q7. Steam at atmospheric pressure enters the shell of a surface condenser in which the water flows through a bundle of tubes of diameter 25 mm at the rate of 0.05 kg/s. The inlet and outlet temperatures of water are 15°C and 70°C, respectively. The condensation of steam takes place on the outside surface of the tube. If the overall heat transfer coefficient is 230 $W/m^2°C$, Calculate the following, using NTU method:

(i) The effectiveness of the heat exchanger,

(ii) The length of the tube, and

(iii) The rate of steam condensation.

Take the latent heat of vaporization at 100°C = 2257 kJ/kg.

Q8. In a certain double pipe heat exchanger hot water flows at a rate of 5000 kg/h and gets cooled from 95°C to 65°C. At the same time 50000 kg/h of cooling water at 30°C enters the heat exchanger. The flow conditions are such that overall heat transfer coefficient remains constant at 2270 W/m^2K. Determine the heat transfer area required and the effectiveness, assuming two streams are in parallel flow. Assume for the both the streams Cp = 4.2 kJ/kg K.

Q9. Write the short notes on the following:

I. Pinch analysis of heat exchangers

II. Hairpin heat exchanger