M.E. Second Semester (Mechanical Engineering (Thermal Engg.)) (New - CGS)

13518 : Elective - I : Heat Exchanger Design : 2 MTE 4

P. Pages : 2 | AU - 3370

Time : Three Hours | Max. Marks : 80

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Notes :
1. Answer **three** question from Section A and **three** question from Section B.
2. Due credit will be given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.
4. Illustrate your answer necessary with the help of neat sketches.
5. Use of slide rule logarithmic tables, Steam table, Mollier's Chart, Drawing instrument, Thermodynamic table for moist air, Psychrometric Charts and Refrigeration charts is permitted.
6. Use of pen Blue/Black ink/refill only for writing the answer book.

SECTION - A

1. a) A single pass shell and tube heat exchanger consisting of bundle of 100 tubes (inner diameter 25 mm and thickness 2 mm) is used for heating 8 kg/s of water from 25°C to 75°C with the help of steam condensing at atmospheric pressure on the shell side with condensing heat transfer coefficient 5000 W/m°C. Make the calculations for overall heat transfer coefficient based on inner area and length of tube bundle. Take the fouling factor on water side to be $0.0002\,m°C/W$ per tube and neglect the effect of fouling on the shell side and thermal resistance of tube wall. Thermophysical properties are, **8**

$\rho = 995\,kg/m^3$; $C_P = 4175\,J/kg°C$

$k = 0.15\,W/m°C$; $\mu = 55\times10^{-5}\,kg/m-s$

b) With the neat sketch explain following : **6**
i) Baffle Spacer detail.
ii) Segmental baffle.
iii) Disc and doughnut baffle.

2. a) Explain the lack of heat recovery in shell and tube type of heat exchanger, Also show with neat sketch the temperature relations in 1 - 2 and 2 - 4 heat exchangers. **6**

b) Hot oil at 100°C is used to heat the air in shell and tube heat exchanger. The oil makes six tube passes and the air makes one shell pass; 2 kg/s of air is to be heated from 20°C to 80°C. The specific heat of oil is 2100 J/kg°C and its flow rate is 3 kg/s. Calculate the area required for heat exchanger for $U = 200\,W/m^2°C$. **7**

3. A multitube and multi - shell pass heat exchanger with 2 shell passes and 4 - tube passes is used to cool the oil ($C_P = 3.56\,kJ/kg°K$) from 120°C to 45°C flowing at the rate of 3 kg/s through the tube. The cooling water ($C_P = 4.18\,kJ/kg°K$) enters the shell at 20°C with mass flow rate of 3.5 kg/s. The overall heat transfer coefficient is estimated to be $120\,W/m^2K$. **13**

Calculate :
i) the heat exchanger rate
ii) the correction factor for multipass arrangement.
iii) the heat transfer required for this exchange.

4. a) Explain different stresses in tubes of heat exchangers. 7

   b) Discuss the design considerations of heat exchangers. 6

5. a) Describe pressure vessels with respect to thermal stresses also explain different types of failures. 7

   b) Explain the effect of turbulence on flow distribution of heat exchanger. 6

SECTION - B

6. a) Discuss the design of liquid - gas - gas - liquid heat exchangers in detail. 6

   b) Explain the usefulness of baffles in heat exchangers also show its effect on flow configuration. 7

7. a) Discuss the factors affecting design of shell and tube type condensers in detail. 6

   b) Explain the working of evaporative condensers. 7

8. a) The design of a water cooled steam condenser has been made by presuming that, $U = 5000\ W/m^2K$ while deciding this value, the engineer presumed that the flowing water is very clean and accordingly he neglect the fouling resistance. Latter it is discovered that the cooling water is not clean at all and that it has a fouling resistance of the order of 0.0006 to $0.002\ m^2K/W$. Should the design calculations be remade? Comment. 7

   b) With the neat diagram explain the working of multiple-effect evaporation. 6

9. A heat exchanger is to be designed to condense 8 kg/s of an organic liquid ($t_{sat} = 80°C$; $h_{fg} = 600\ kJ/kg$) with cooling water available at 15°C and at a flow rate of 60 kg/s. The overall heat transfer coefficient is $480\ W/m^2{}^\circ C$. 13

   Calculate :

   i) The number of tubes required. The tubes are to be of 25 mm outer diameter, 2 mm thickness and 4.85 m length.

   ii) The number of tube passes. The velocity of the cooling water is not exceed 2 m/s.

10. a) Discuss the factors affecting the cooling tower performance also explain effectiveness of cooling tower. 7

    b) Discuss types of cooling towers also explain different testing and maintenance details. 7

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