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

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

AX - 3539

P. Pages : 2

Time : Three Hours

* 0 8 7 2 *

Max. Marks : 80

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. Diagrams and chemical equations should be given wherever necessary.
5. Illustrate your answer necessary with the help of neat sketches.
6. Use of slide rule logarithmic tables, Steam tables, Mollier's Chart, Drawing instrument, Thermodynamic table for moist air, Psychrometric Charts and Refrigeration charts is permitted.
7. Use of pen Blue/Black ink/refill only for writing the answer book.

SECTION – A

1. a) Classify heat exchanger according to construction and discuss the Recuperators. **5**

b) Write about any five factors to be considered in selection of heat exchanger. **4**

c) What is role played by baffle plates in shell and tube heat exchanger? Explain different types of baffle plate used in heat exchanger. **5**

2. a) A 2 shell passes and 4 – tube passes heat exchanger is used to glycerin from 20°C to 60°C by hot water, which enters the thin walled 2 cm diameter tubes at 80°C and leaves at 40°C. The total length of the tubes in the heat exchanger is 60 m. The convection heat transfer coefficient is $25\,w/m^{2}{}^{\circ}C$ on the glycerin (shell) side and $160\,w/m^{2}{}^{\circ}C$ on water (tube) side. Determine rate of heat transfer in heat exchanger, **8**

a) before any fouling.

b) after fouling, with fouling factor of $0.0006\,m^{2}{}^{\circ}C/w$ occurs on outer surface of tubes.

b) What are the limitation of LMTD method? How $\in$ –NTU method is superior to LMTD method. **5**

3. a) Discuss various shell types as per TEMA standards? **5**

b) Explain the working principle of regenerator, Also explain with neat sketch working of rotary storage type heat exchanger? **8**

4. Hot oil is to be cooled by water in a 1 – shell pass and 8 – tube pass heat exchanger. The tubes are thin walled and are made of each copper with an internal diameter of 1.4 cm. The length of each tube pass in the heat exchanger is 5 m, and the overall heat transfer is $310\,w/m^{2}{}^{\circ}C$. Water flows through the tube at a rate of 0.2 kg/s and the oil through shell at the rate of 0.3 kg/s. The water and oil enter at temperature of 20°C and 150°C, respectively. Determine the rate of heat transfer in the heat exchanger and the outlet temperature of the water and the oil. Use NTU method, take specific heat of water and oil to be 4.18 and $2.13\,kJ/kg^{\circ}C$. **13**

5. a) Briefly discuss the design methodology for heat exchanger. **7**

b) Discuss the different types of failures that occurs in shell & tube type heat exchanger. **6**

SECTION – B

6. A two – pass surface condenser is required to handle the exhaust from a turbine developing 15 mw with specific steam consumption of 5 kg/kwh. The condenser vacuum is 660 mm of Hg, when the barometer reads 760 mm of Hg. The mean velocity of water is 3 m/s, water inlet temperature is 24°C. The condensate is saturated water and outlet temperature of cooling water is 4°C less than the condensate temperature. The quality of exhaust steam is 0.9 dry. The overall heat transfer coefficient based on outer area of tubes is $4000\,w/m^2{}^\circ C$. The water tubes are 38.4 mm in outer diameter and 29.6 mm in inner diameter. Calculate the following : **13**

i) Mass of cooling water circulated in kg/min.
ii) Condenser Surface Area.
iii) Number of tubes required per pass, and
iv) Tube length.

7. a) The condenser of 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 tubes with $h_0 = 11 kw/m^2k$. 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 **8**

$C_P = 4.18 kJ/kg\,k$, $\mu = 855 \times 10^{-6}\ NS/m^2$,
$k = 0.613\,w/mk$ and $pr = 5.83$.

b) Write short note on different tube materials and tube layout used in shell and tube heat exchanger. **5**

8. a) Explain with neat sketch working of evaporative condenser. **7**

b) Explain the effect of the following parameters on the performance of the cooling tower. **6**

i) Wet bulb temperature.
ii) Range
iii) Approach

9. a) A steam turbine discharges 5000 kg/hr of steam at 40°C and 0.85 dry. The air leakage in the condenser is estimated to be 15 kg/hr. The temperature at suction of air pump is 32°C and the temperature of the condensate is 35°C. Find : **8**

i) Vaccume gauge reading
ii) Capacity of air pump,
iii) Loss of condensate in kg/hr, and
iv) quantity of cooling water if its temperature rise is limited to 10°C.

b) Give the brief procedure for design of surface condenser. **5**

10. a) What do you mean by dry Cooling Tower? Explain with neat sketch. **4**

b) Explain forced draught cooling tower with neat sketch. **4**

c) Explain parameters which govern the selection of pump and fan in the cooling tower. **6**

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