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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech II Semester Examinations, June/July - 2018
EQUIPMENT DESIGN FOR THERMAL SYSTEMS
(Thermal Engineering)

Time: 3hrs **Max.Marks:75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART - A

5 × 5 Marks = 25

1.a) Compare and contrast Casketed plate and Lamella heat exchangers. [5]
b) Explain the limitations and advantages of 2-6 heat exchangers. [5]
c) Bring out the influence of Impurities upon Condensation. [5]
d) Give the complete classification of Vaporizing Exchangers. [5]
e) Classify the Cooling Towers with line diagrams. [5]

PART – B

5 × 10 Marks = 50

2.a) Explain 3-8 heat exchanger and its usage.
b) A cross flow exchanger with cold fluid unmixed is used to cool air from 88^{0}C by using air at 22^0 C. The hot air flows at a rate of 3000 kg/hr while the cold air rate is 7000 kg/hr. The hot air leaves the exchanger at 56^0 C. Assuming the overall heat transfer coefficient to be 72 W/m^2 C, calculate the exit temperature of the cold fluid and the area of the heat exchanger. [5+5]

OR

3.a) Derive an equation for LMTD for cross flow heat exchanger.
b) In a shell and tube heat exchanger cold water at the rate of 5 kg/s is heated from 36 to 54 ^{0}C. The water is flow in tubes of 1 inch OD, 12 BWG. Hot water available at 96 ^{0}C and at a rate of 2.2 kg/s is used as the heating medium on the shell side of ID 21.25 inch. If the length of tubes must not be more than 2.2 m, calculate the number of tube passes, the number of tubes per pass, assuming the overall heat transfer coefficient as 1490 W/m^{2}K. [5+5]

4.a) What are the methods of augmentation of heat transfer? Explain any one method of augmentation in detail.
b) A 2-4 shell and tube heat exchanger is used to heat process fluid (water) from 30^{0}C to 80^{0}C. The mass flow rate of the process fluid is 8000 kg/hr and that of the service fluid is 6000 kg/hr, which is available at a temperature of 200^{0}C. The overall heat transfer coefficient is 1500 w/m^{2}k. Find out the outlet temperature of service fluid, and the area required to the heat transfer. After a long time of operation of the heat exchanger, it is found that the outlet temperature of the process fluid is only 70^{0}C. Find the fouling resistance developed during this period. Take Cp of service fluid = 2.8 KJ/kg K, Cp of process fluid = 4.2 KJ/kg K. [5+5]

OR

5.a) Explain Pressure drop in Pipes and Pipe Annuli with the help of suitable diagrams.

b) 20,000 kg/hr of API distilled is cooled from 100 to 50^{0}C using cooling water from 30 to 45^{0}C. Available for the service is a 50 mm ID, 1-2 exchanger having 246 tubes 60mm OD 16BWG, 5 m long on 9 cm^2 pitch. Baffles are spaced 10cm apart and the bundles are arranged for four passes. What arrangement gives the more nearly balanced pressure drops and what is the dirt factor? The viscosity to distillate is 3.1 centipoise at 40^{0}C and 1.3 at 100^{0}C. [5+5]

6.a) Derive an expression for average heat transfer co-efficient for condensation of vapor on a flat vertical plate, using Nusselt's theory.

b) Dry steam at 102^0 C condenses on the outside surface of a horizontal pipe of 30 cm outer diameter. The pipe surface is maintained at 82^0 C by circulating water through it. Determine the rate of formation of condensate per meter length of the pipe and heat transfer quantity. [5+5]

OR

7. The Refrigerant 134a vapor at a saturation temperature of 48 ^{0}C condenses on a horizontal smooth copper tube whose outside wall temperature is maintained constant at 40 ^{0}C. The outside tube diameter is 19 mm. Calculate the average condensation heat transfer co-efficient on the tube. The properties of R 134a at 48 ^{0}C are p_l = 1117.3 kg/m^3; p_v = 62.5 kg/m^3; k_l = 0.068W/mk; μ_l = 1.72 × 10^{-4} Ns/m^2; h_{fg} = 154.6 kj/kg. [10]

8.a) Explain about Forced and Natural circulation vaporizer with a neat line diagram.

b) 40,000 lb/hr of 30 API distillate is cooled from 220 to 120 ^{0}F by using cooling water from 80 to 110 ^{0}F. Available for the service is a 19 ¼ inch ID, 1-2 exchanger having 200 tubes ¼ inch OD, 16 BWG, 16 ft. long on 1.0 inch square pitch. Baffles are spaced 6 inch apart. and the bundles are arranged for four passes. What arrangement gives the more nearly balanced pressure drops and what is the dirt factor? What is optimum outlet water temperature? The viscosity of distillate is 3.1. Centipoise at 100 ^{0}F and 1.3 centipoise at 210 ^{0}F. [10]

OR

9.a) Write short note on Extended –surface Shell and tube Exchangers.

b) It is desired to cool 18,000 lb/hr of 28^0 API gas from 250 to 200^{0}F in double pipe exchanger containing of 3-in. IPS shells with 1½-in. IPS inner pipes on which are mounted 24 fins ½ in. high by 0.035 in.(20 BWG) wide. Water from 80 to 120^{0}F will serve as the cooling medium. Pressure drops of the 10.0 psi are allowed on both streams, and fouling factors of 0.002 for the gas oil and 0.003 for the water are required. How many 20-ft hairpins will be required? [5+5]

10.a) With the help of simple sketches explain the hyperbolic cooling towers bringing out the salient points.

b) Dry steam at 100^0 C condenses on the outside surface of a horizontal pipe of 2.5 cm outer diameter. The pipe surface is maintained at 84^0 C by circulating water through it. Determine the rate of formation of condensate per meter length of the pipe. [5+5]

OR

11. A steam turbine has a condenser flow (of steam) at a full load of 13000 kg/hr. The quality of steam at turbine exhaust is 0.88. The condenser pressure is 0.09 bar. Sea water used for circulation is at 2.4^0C. The terminal temperature difference between the steam and outgoing water is 56^0C. The circulating water velocity is maintained at 1.7 m/s. The condenser tubes are of 14 mm ID and 1.24 mm thickness. Determine:
a) The rate of flow of cooling water
b) The length of tubes
c) The number of tubes in condenser, Take $U_0 = 3350$ W/m^{2}k. [10]

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