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Sub: HTED(BTCHE606)

Unit 1st

10) Explain in brief on double pipe heat exchanger.

11) Explain in brief on plate heat exchanger.

12) State the advantage of a double pipe heat exchanger & its drawbacks.

13) Calculate the total length of a double pipe heat exchanger required to cool 5500kg/h of ethylene glycol from 358 k (85℃) to 341 k (68℃) using toluene as a cooling medium which flows in a counter current fashion. Toluene enters at 303 k (30℃) & leaves at335 k (62℃).

Data:

Outside diameter of double pipe = 70mm

Outside diameter of inside pipe = 43mm

Wall thickness of both pipes = 3mm

property	Ethylene glycol	Toluene
density	1080 kg/m^3	840 kg/ m^3
Specific heat	2.680 KJ/(Kg.K)	1.80 KJ/(Kg.K)
Thermal conductivity	0.248 W/(m.K)	0.146 W/(m.K)
Viscosity	3.4×10^{-3} Pa.s	4.4×10^{-4} Pa.s

Thermal conductivity of metal pipe is 46.52 W/ (m.K) & ethylene glycol is following through the inner pipe.

41) Hot oil at a rate of 1 2 kg/s [Cp =2083 J/(kg-K)] flows through double pipe heat exchanger. It enters at 633 K (360° C) and leaves at 573 K (300° C). The cold fluid enters at 303 K (30° C) and leaves at 400 K (127° C). If the overall heat transfer coefficient is 500 W/(m2.K), calculate the heat transfer area for (i) parallel flow and (ii) countercurrent flow.

42) In a double pipe counter current flow heat exchanger, 10000 kg/h of an oil having a specific heat of 2095 J/(kg K) is cooled from 353 K (80° C) to 323 K (50° C) by 8000 kg/h of water entering at 298 K (25° C). Calculate the heat exchanger area for an overall heat transfer coefficient of 300 W/(m^2.K). Take Cp for water as 4180 J/ (kg K).

Unit 2nd

1) Give the classification of shell and tube heat exchanger.
2) Draw neat sketch of U-tube heat-exchanger and explain briefly its construction.
3) Draw the neat sketch of 1-2 shell and tube heat exchanger and label its parts.
4) Give the classification of shell & tube heat exchanger.
5) Write in brief on plate heat exchanger.

6) It is required to design a shell and tube heat exchanger for heating 9000 kg/hr of water from 15°C to 88°C by hot engine oil (Cp=2.36 kJ/kg-K) flowing through the shell of the heat exchanger. The o-makes a single pass, entering at 150°C and leaving at 95°C with an average heat transfer coefficient of 400 W/m-K, the water flow through 10 thin-walled tubes of 25mm diameter with each tube making 8 passes through the shell. The heat transfer efficient on the water side is 3000 W/m²-K. Find the length of the tube required for the heat exchanger.

5)Design a shell and tube exchanger to heat 50,000 kg/h of liquid ethanol from 20 °C to 80 °C. Steam at 1.5 bar is available for heating. Assign the ethanol to the tube-side. The total pressure drop must not exceed 0.7 bar for the alcohol stream. Plant practice requires the use of carbon steel tubes, 25 mm inside diameter, 29 mm outside diameter, 4 mm long. Set out yours design on a data sheet & make a rough sketch of the heat exchanger.

Unit 3rd

43) Define the following terms:

(a) condenser (b) cooler (c) vaporizer (d) heater (e) reboiler (f) chiller

a condenser is required to condense n-propanol vapour leaving the top os a distillation column. The n-propanol is essentially pure, and is a saturated vapour at a pressure of 2.1 bara. The condensate needs to be subcooled to 45°C. Design a horizontal shell and tube condenser

44) A condenser is required to condense n-propyl vapour leaving the top of a ditillation column. The n-propyl is essentially pure, and is a saturated vapour at a pressure of 2.1 bar. The condensate needs to be sub-cooled to 45°C . Design a horizontal shell and tube condenser capable of handling a vapour rate of 30,000 kg/h. Cooling water is available at 30°C and the temperature rise is to be limited to 30°C. The pressure drop on the vapour stream is to be less than 50 kN/m^2, and on the water stream less than 70 KN/m^2 . The preferred tube size is 16 mm inside diameter, and 2.5 m long.

45) Estimate the heat transfer coefficient for steam condensing on the outside. And on the inside, of a 25mm outer diameter, 21mm inner diameter, vertical tube 3.66 m long, the steam condensate rate is 0.015 kg/s per tube & condensation takes place at 3 bars. The steam will flow down the tube.

46) Design a condenser for the following duty : 45,000 kg/h of mixed light hydrocarbon vapours to

be condensed. The condenser to operate at 10 bar. The vapour will enter the condenser saturated at 60°C & the condensation will be complete at 45 °C. The average molecular weight of the vapours is 52. The enthalpy of the vapours is 596.5 KJ/Kg & the condensate 247.0 kJ/kg. cooling water is available at 30°C & the temperature rise is to be limited to 10°C. Plant standards require tube of 20mm O.D, 16.8 mm i.d., 4.88 m(16ft) long of admiralty brass. The vapours are to be totally condensed and no sub-cooling is required.

Unit 4th

1) Explain in brief different types of agitators.
2) Explain different design of agitator with neat and labelled diagram.
3) Explain the selection criteria for agitator and power required for agitator
4) Explain in brief scale up procedures for turbulent flow with two test volumes.
5) An agitation unit consists of a 9-inch diameter, four bladed 45 inches pitched bladed turbine impeller in the tank that is 30 inches with a fluid of viscosity 10cp of & specific gravity 1.1. the agitators operate at a speed of 30rpm. Calculate the power per unit volume & the torque per unit volume if the ratio C/T is 0.3

Unit 5th

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1) Define the following terms:

(i) evaporation (ii) boiling point elevation (iii) capacity of evaporator and (iv) economy of an evaporator.

2) State why the economy of single effect evaporator is less than one?

3)State the method of increasing the economy of an evaporator.

4)What do you mean by multiple effect evaporation system?

6) What do you mean by double effect evaporator?
7) State the method of feeding multiple effect evaporation system.
8) Compare forward feed arrangement with backward feed arrangement in case of multiple effect evaporation system.
9) State the advantages of forced circulation evaporators and its application.
10) Write construction with neat sketch of standard vertical tube evaporator.

11) Draw the neat diagrams of forward feed arrangement and backward feed arrangement for feeding multiple effect evaporation system.

12) Mention the common examples of evaporation operation.

13) Draw neat sketch of long tube evaporator and explain briefly its construction and working.

14) Explain in brief forced circulation evaporator with external horizontal heating surface with reference to its construction and working.

15) A single effect evaporator is fed with 5000 kg/h of solution containing 1 % solute by weight. Feed temperature is 303 K (30° C) and is to be concentrated to a solution of 2 % solute by weight. The evaporation is at atmospheric pressure (101.325 kPa) and area of evaporator is 69 m^2. Saturated steam is supplied at 143.3 kPa as a heating medium. Calculate steam economy and overall heat transfer coefficient.

Data:
Enthalpy of feed at 303 K = 125.79 kJ/kg
Enthalpy of vapour at 101.325 kPa = 2676.1 kJ/kg
Enthalpy of saturated steam at 143.3 kPa = 2691.5 kJ/kg
Saturation temperature of steam= 383 K (110° C)
Boiling point of saturation= 373 K
Enthalpy of product = 419.04 kJ/kg
Enthalpy of saturated water at 383 K = 461.30 kJ/kg

16) A triple-effect evaporator is concentrating a solution that has no appreciable boiling point elevation. The temperature of steam to the first effect is 381.3 K (108.3° C) and boiling point of the solution in the last effect is 324.7 K (51.7° C). The overall heat transfer coefficients in the first, second and third-effect are 2800, 2200 and 1100 W/(m^2.K) respectively. At what temperatures will the solution boil in the first and second effects?

17) A single effect evaporator is to concentrate 20000 kg/h of a solution having a concentration of 5% salt to a concentration of 20 % salt by weight. Steam is fed to the evaporator at a pressure corresponding to the saturation temperature of 399 K (126° C). The evaporator is operating at atmospheric pressure and boiling point rise is 7 K. Calculate the heat load and steam economy.

Data: Feed temperature = 298 K (25°

C) Specific heat of feed = 4.0kJ/(kgK)

Latent heat of condensation of steam at

399 K = 218kJ/kg

Latent heat of vaporization of water at

373 K = 2257kJ/kg

Unit 6th

1) Explain in brief design of kettle reboiler
2) Explain the different types of reboiler.
3) Draw the neat sketch of kettle reboiler and explain in brief its construction.
4) Explain the typical design procedure for thermosyphon reboiler.
5) What is diiference between kettle reboiler and thermosyphone reboiler?
6) What is steam reboiler & thermosyphone reboiler?
7) A fluid whose properties are essentially those of o-dichlorobenzene is vaporized in the tubes of a forced convection reboiler. Estimate the local heat transfer coefficient at a point where 5 % of the liquid has been vaporized. The liquid velocity at the tube inlet is 2 m/s and the operating pressure is 0.3 bar. The tube inside diameter is 16mm and the local wall temperature is estimated to be 120° C.