A **Reg. No. :** | | | | | | | | | | |

Question Paper Code: 55903

B.E./B.Tech. DEGREE EXAMINATION, MAY 2018

Fifth Semester

Chemical Engineering

15UCH503 - HEAT TRANSFER

(Regulation 2015)

Duration: Three hours Maximum: 100 Marks

Answer All Questions

PART A - (10x 1 = 10 Marks)

1. Unit of rate of heat transfer is CO1- R

(a) Joule (b) Newton (c) Pascal (d) Watt

2. Thermal conductivity is maximum for which substance CO1- U

(a) Silver (b) Ice (c) Aluminum (d) Diamond

3. Forced convection in a liquid bath is caused by CO2- R

(a) Intense stirring by an external agency
(b) Molecular energy interactions
(c) Density difference brought about by temperature gradients
(d) Flow of electrons in a random fashion

4. Which dimensionless number has a significant role in forced convection? CO2- U

(a).Prandtl number (b).Peclet number (c).Mach number (d).Reynolds number

5. A perfectly black body CO3- R

(a) Absorbs all the incident radiation
(b) Allow all the incident radiation to pass through it
(c) Reflects all the incident radiation

(d) Has its surface coated with lamp black or graphite

6. A radiation shield should CO3- R

(a) Have high transmissivity

(b) Absorb all the radiations

(c) Have high reflexive power

(d) Partly absorb and partly transmit the incident radiation

7. Boiling refers to a change from the CO4- U

(a) Solid to a liquid phase (c) Liquid to a solid phase

(b) Vapor to a liquid phase (d) Liquid to a vapor phase

8. The number of kg of water vaporised per hour fed to the evaporator is defined as CO4- R

(a) economy (c) rate of evaporation

(b) capacity (d) rate of vaporisation

9. Which one is having highest value of fouling factor? CO5- A

(a). Clean water (b). Sea water (c). Liquid gasoline (d). Distilled water

10. Which of the following is not associated with heat exchanger? CO5- R

(a) Fouling (c) Capacity ratio

(b) NTU (d) Mc Adam's correction factor

PART – B (5 x 2= 10Marks)

11. State Fourier's law of heat conduction. CO1- U

12. Differentiate between natural convection and forced convection. CO2- U

13. State the Kirchoff's law on radiation heat transfer. CO3- U

14. Write the 'Capacity' and 'Economy' of a steam-heated tubular evaporator. CO4- U

15. Justify: LMTD correction factor is important in the design of heat exchangers. CO5- U

PART – C (5 x 16= 80Marks)

16. (a) A tube of 60 mm outer diameter (OD) is insulated with a 50 mm layer of silica foam, for which the conductivity is 0.055 W/m ^{0}C followed with a 40 mm layer of cork with conductivity of 0.05 W/m ^{0}C. If the temperature of the outer surface of the pipe is 150^{0}C and temperature of the outer surface of the cork is 30 ^{0}C. Calculate the heat loss in watts per meter of pipe. CO1-App (16)

Or

(b) (i)A 300 mm outer diameter pipe is covered with two layers of insulation (k_1=0.105 W/m.K and k_2=0.07 W/m.K) the better insulating material is on the outside and is 40 mm thickness. The other insulating material is of 50 mm thickness. The inner and outer surface temperatures of the insulation are 350°C and 50°C. Calculate (i) Heat loss per meter length (ii) Heat loss per square meter of outer insulation surface (iii) Temperature of the surface between the two layers of insulation. CO1 -Rem (8)

(ii) A hallow sphere 10 cm Inner Diameter and 30 cm Outer Diameter of a material having thermal conductivity 50 W/m K is used as a container for a liquid chemical mixture. Its inner and outer surface temperatures are 300^{0}C and 100^{0}C respectively. Determine the heat flow rate through the sphere. Also estimate the temperature at a point a quarter of the way between the inner and outer surfaces. CO1 -Ana (8)

17. (a) Derive the expression for the overall heat transfer coefficient for the transfer of heat between a hot and a cold fluid separated plane wall. CO2 -Rem (16)

Or

(b) Water flows at a velocity of 12 m/s in a straight tube of 60mm diameter. The tube surface temperature is maintained at 700ºC and the flowing water is heated from the inlet temperature of 150ºC to an outlet temperature of 450ºC. Taking the physical properties at mean bulk temperature of 300ºC as ρ=995.7 kg/m^3, CO2 -App (16)

C_p = 4.174 kJ/kgK, k=61.718 x 10^{-2} W/mK, $\boldsymbol{\nu}$=0.805 x 10^{-6} m^2/s and Pr= 5.42, calculate

i) the heat transfer coefficient from the tube surface to the water,

ii) the heat transferred

iii) the length of the tube.

18. (a) (i) Derive the relationship for radiative heat transfer between two very large flat parallel plates. The plates are of emissivity ζ_1, ζ_2 and are maintained at a temperature T_1 and T_2, respectively. CO3- Rem (8)

(ii)Two large parallel plates with grey surfaces are 70 mm apart. One plate has an emissivity 0.75 at a temperature 365 K and the other plate an emissivity 0.45 at a temperature 275 K. Calculate the net rate of heat exchange by radiation. Stefan-Boltzmann constant=5.67×10^{-8} $W \cdot m^{-2} \cdot K^{-4}$ CO3- App (8)

Or

(b) A chamber for heat-curing large aluminium sheets, lacquered black on both sides, operates by passing the sheets vertically between two steel plates 150 mm apart. One of the plates is at 300^0C and the other, exposed to the atmosphere, is at 25 ^{0}C. CO3- App (16)

(i) What is the temperature of the lacquered sheet?

(ii) What is the heat transferred between the walls when equilibrium has reached?

Neglect convection effects. Emissivity of steel is 0.56; emissivity of lacquered sheets is 1.0.

19. (a) With a neat sketch, explain the working of a triple-effect, forward-feed evaporator. CO4-Rem (16)

Or

(b) A single effect evaporator is to be designed to concentrate 10000 kg/h of a chemical solution from 10 to 20 solids by weight. Feed enters at 30°C. Saturated steam at 110^0C (latent heat of 540 CO4 -App (16)

kcal/kg) is available. Condensate leaves at saturation temperature. The solution boils at 45 ^{0}C (latent heat = 570 kcal/kg).Specific heats of all solutions may be taken as 1.0. Overall heat transfer coefficient may be taken as 1800 kcal/h m^{0}C. Calculate:

(i) Steam consumption in kg/h

(ii) Heat transfer area**.**

20. (a) Crude oil flows at the rate of 10000 kg/h through the inside pipe of a double pipe heat exchanger and is heated from 32^{0}C to 90^{0}C. The heat is supplied by a petroleum fraction initially at 230^{0}C, flowing through the annual space. If the temperature of the heating fluid falls down to 100 ^{0}C inside the heat exchanger, compare the performances of parallel and counter-current exchangers with respect to the heat transfer area and fluid flow rates. Overall heat transfer coefficient is 400 kcal/h.m^{2}^{0}C. Specific heats of crude oil and petroleum fraction are 0.56 and 0.60 kcal/kg ^{0}C respectively. CO5- App (16)

Or

(b) With a neat sketch, discuss in detail about the procedure for the design of a double-pipe heat exchanger. CO5- U (16)