GIET MAIN CAMPUS AUTONOMOUS GUNUPUR – 765022

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4^{th} Semester Regular Examination-April-May 2019

BCHPC4030 HEAT TRANSFER

(Regulations 2017) CHEMICAL ENGG.

Time : 3 Hours Maximum : 100 Marks

Answer ALL Questions

The figures in the right hand margin indicate marks.

PART – A: (Multiple Choice Questions) 10 x 2=20 Mark

Q.1. Answer *All* Questions.

a The thermal conductivity is minimum for: [CO1] [PO1]
(a) Silver (b) Chromium-nickel steel (c) Aluminum (d) Carbon steel

b Heat transfer occurs by natural convection because change in temperature causes difference in [CO 2] [PO1]
(a) Viscosity (b) Density (c) Thermal conductivity (d) Heat Capacity

c The critical radius of insulation on a pipe is given by [CO 4] [PO2]
(a) r = 2k/h (b) r = k/h (c) r = k/ (2h) (d) r = h/k

d Grashof number is associated with [CO 2] [PO1]
(a) buoyancy effect (b) free convection (c) forced convection (d) high temperature difference

e The advantage of using a 1-2 Shell and tube heat exchanger over a 1-1 Shell and tube heat exchanger is [CO 3] [PO2]
(a) Lower tube side pressure drop
(b) Lower shell side pressure drop
(c) Higher tube side heat transfer coefficient
(d) Higher shell side heat transfer coefficient

f Thermal radiative flux from a surface of emissivity 0.4 is 22.68 kW/m^2. The approximate surface temperature (K) is [CO 4] [PO2]
(a) 1000 (b) 727 (c) 800 (d) 1200
Boltzmann's constant is 5.5×10^{-8} $W/m^2.K^4$

g A multiple effect evaporator as compared to a single effect evaporator of the same capacity has [CO 3] [PO1]
(a) Lower heat transfer area (b) Lower steam economy (c) Higher steam economy (d) Higher solute concentration in the product

h The advantage of backward-feed multiple evaporator over forward-feed unit is such as [CO 3] [PO1]
(a) Heat sensitive material can be handled
(b) There is no additional cost of pumping
(c) Most concentration liquor is at highest temperature
(d) Equal heat transfer coefficient exit in various effects

i The hydrodynamic and thermal boundary layers will merge when [CO 2] [PO2]
(a) Pr = 1 (b) Schmidt number tends to infinity (c) Nusselt number tends to infinity (d) Pr < 1

j In heat exchanger, floating head is provided to (a) Facilitate cleaning of heat exchanger (b) Increase the heat transfer area (c) Relieve stress cause by thermal expansion (d) Increase the LMTD [CO 3] [PO1]

PART – B: (Short Answer Questions) 10x2=20 Marks

Q.2. Answer *ALL* questions

a	What is the difference between heat transfer and thermodynamics? What do you understand by conductance?	[CO 1] [PO1]
b	How the arithmetic logarithmic mean radius for a cylinder is determined and write-down the linear relation between thermal conductivity and temperature.	[CO 1] [PO1]
c	Draw Wilson plot to determine film heat transfer coefficient. In which case the normal diameter is replaced by equivalent diameter?	[CO 1] [PO2]
d	State the equation used for predicting heat transfer coefficient for turbulent flow in tubes or pipes and if viscosity of the fluid near the wall is taken into account.	[CO 2] [PO1]
e	What are the major disadvantages of double pipe heat exchanger? How the tube pitch and Clearance is defined?	[CO 3] [PO1]
f	What do you understand by 25 % cut segmental baffle and where it is used?	[CO 3] [PO2]
g	Difference between single pass and multi-pass shell and tube heat exchanger.	[CO 3] [PO2]
h	What is steam economy and how it can be increased?	[CO 3] [PO1]
i	Define grey body? State an expression for net heat transfer coefficient for radiation from a grey body from temperature T_1 to a black surrounding at temperature T_2.	[CO 4] [PO1]
j	Calculate the rate of heat transfer by radiation from an unplugged steam pipe, 80 mm, O.D.at 393 K to air at 293. Assume emissivity = 0.9	[CO 4] [PO2]

PART – C: (Long Answer Questions) 4x15=60 Marks

Answer *ALL* questions

Q.3

a	An exterior wall of a house may be approximated by a 4-in layer of common brick (k = 0.7 W/m .^{o}C) followed by a 1.5 in layer of gypsum plaster (k = 0.48 W/m .^{o}C). What thickness of loosely packed rock-wool insulation (k = 0.065 W/m .^{o}C) should be added to reduce the heat loss or gain through the wall by 80 %?	8	[CO 1] [PO 2]
b	Calculate the critical radius of insulation for asbestos (k = 0.17 W/m .^{o}C) surrounding a pipe and exposed to room air at 20 ^{o}C with h = 3.0 W/m^2 .^{o}C. Calculate the heat loss from 200 ^{o}C, 5.0 cm dia. pipe when covered with a critical radius of insulation and without insulation. Consider that the inside radius of insulation is 50 % of the dia. of pipe.	7	[CO 1] [PO 1]

OR

c	Derive an expression for the thermal resistance through a hallow spherical shell of inside radius r_i and outside radius r_o having a thermal conductivity k.	8	[CO 1] [PO 1]
d	A material 2.5 cm thick with a cross-sectional area of 0.1 m^2, has one side maintained at 35 ^{o}C and the other at 95 ^{o}C. The temperature at the center plane of the material is 62 ^{o}C and the flow through the material is 1kW. Obtain an expression for the thermal conductivity of the material as a function of temperature.	7	[CO 1] [PO 1]

Q.4

a	Calculate the inside heat transfer coefficient for a fluid flowing at a rate of 300 cm^3/s through 20 mm inside diameter tube of heat exchanger. Viscosity of flowing fluid = 0.8 N.s/m^2. Density of flowing fluid = 1.1 g/cm^3 Specific heat of fluid = 1.26 kJ/kg .K Thermal conductivity of fluid = 0.384 W/ m.K Viscosity at wall temperature = 1.0 N.s/m2 Length of heat exchanger = 5 m	8	[CO 2] [PO 2]
b	(i) Discuss about different steps of boiling phenomena with figure. (ii) What do you understand by effectiveness of a heat exchanger?	7	[CO 2] [PO 2]

OR

c A vertical plate 30/30 cm is exposed to a steam at atmospheric pressure. The plate is at 371 K. Calculate the mean heat transfer coefficient and the heat transfer rate and mass of steam condensed per hour. 8 [CO 2] [PO 2]
The properties of condensate at the film temperature are given below:
$\mu = 2.82 \times 10^{-4}$ kg/m.s
$\rho = 960$ kg/m3
$\lambda = 2255$ kJ/kg
k = 0.68 W/mK
Saturation temperature = 100 ^{o}C

d How the Film wise condensation and Drop-wise condensation is different? 7 [CO 2] [PO 2]

Q.5

a Hot oil at 100 ^{o}C is used to heat air in a shell and tube heat exchanger. The oil makes six tube passes and the air makes one shell pass: 2.0 kg/s of air are to be heated from 20 to 80 ^{o}C. The specific heat of the oil is 2100 J/kg .^{o}C and flow rate is 3.0 kg/s. Calculate the area required for the heat exchanger for U = 200 W/m^2. ^{o}C. 8 [CO 3] [PO 2]

b How the performance of an evaporator is calculated? Derive the material and energy balance of a triple effect evaporator. 7 [CO 3] [PO 2]

OR

c Write down the working principles, advantages, disadvantages and applications of Rising and Falling film evaporators. 7 [CO] [PO 2]

d An evaporator is operating at atmospheric pressure. It is desired to concentrate the feed from 5 % solute to 20 % solute by weight at a rate of 5000kg/h. Dry saturated steam at a pressure corresponding to saturation temperature of 399 K is used. The feed is at 298 K and boiling point rise is 5 K. Overall heat transfer coefficient is 2350 W/m^{2}K. Calculate economy of evaporator and area of heat transfer to be provided. If pure water is the treating solution and latent heat of condensation is 2185 kJ/kg at 399 K and latent heat of vaporization at 373 K is 2257 kJ/kg. Specific heat of feed is 4.187 kJ/kg.K 8 [CO 3] [PO 2]

Q.6

a The space between the two concentric spherical vessels is completely evacuated. The inner sphere contains air at -197 ^{o}C. The ambient temperature is 300 K. The surface of the sphere are highly polished (e = 0.4). Find the rate of evaporation of liquid air per hour. Dia. of inner sphere is 270 mm and outer sphere is 360 mm. Latent heat of vaporization of air is 200 kJ/kg 8 [CO 4] [PO 1]

b Two very large parallel plates are maintained at uniform temperatures T_1= 800 K and T_2 = 500 K and have emissivities 0.2 and 0.7, respectively. Determine the net rate of radiation heat transfer between the two surfaces per unit surface area of the plates. 7 [CO 4] [PO 2]

OR

c Calculate the rate of heat loss from a thermoflask if the polished silver surfaces have emissivity 0.05, the liquid in the flask is at 95 ^{o}C and the casting is at 293 K. Calculate the loss if both surfaces were black. 8 [CO 4] [PO 2]

d The inner sphere of a flask is 30 cm dia. and outer sphere is 36 cm dia. Both sphere are coated for which emissivity is 0.05. Determine the rate at which liquid oxygen (latent heat = 21.44 kJ/kg) would evaporate at 90 K when outer sphere temperature is 293 K. Assume that the other mode of heat transfer are absent. 7 [CO 4] [PO 2]

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