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No. Of Printed Pages: 2

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SARDAR PATEL UNIVERSITY
EXTERNAL EXAMINATION, APRIL 2016
M.Sc. INDUSTRIAL CHEMISTRY-SEMESTER 2
HEAT TRANSFER OPERATIONS & STOICHIOMETRY- PS02CICH09

6th April,2016 **Max.Marks:70**

Time:10.30 a.m-1.30 p.m

Answer all the questions. **Figures to the right side indicate marks**

Q1 .Write the number of the correct statement. All questions carry 1 mark each. (8 *1=8marks)

a. The unit of thermal conductivity is
i. W/ m^2 K ii. W/ m K iii. W/sec K iv. W/sec m

b. Fins serve the purpose of
i. decreasing heat transfer rate iii.decreasing heat transfer area
ii. increasing heat transfer area iv.increasing thermal conductivity

c. Natural Convection is characterized by

i.Peclet number ii.Grashoffs number iii.Reynolds number iv.Stanton Number

d. Double pipe heat exchanger falls under the category of
i. regenerators ii.recuperators iii. Evaporators iv.None of these

e. ----- increases turbulence in a heat exchanger
i. fins ii. baffles iii. Tube sheet iv. None of these

f. Wall made of series of layers of different material is called---
i.conduction wall ii.composite wall iii.annular wall iv.eddy wall

g.The effect of scale formation is to ------ the heat transfer co-efficient

i. increase ii. decrease iii.rotate iv. none of these

h.The unit of heat transfer co-efficient is----------
i. Kcal/hr m^2 K ii.Kcal/hr m K iii.Kcal/hr K iv.Kcal/hr m

Q2. **Answer <u>any seven</u> (each question carry two marks)** **(7*2=14 marks)**

a. Define black body and opaque body
b. In which side (tube/shell) will you take corrosive fluid in a shell & tube exchanger? Justify your answer.
c. Distinguish between pitch and clearance
d. Why are tie rods and spacers used in heat exchangers?
e. Enlist the conditions when maximum heat transfer rate occurs in a heat exchanger
f. Define the term NTU used in heat exchanger calculations
g. Define LMTD of parallel & counter flow heat exchangers
h. Distinguish between limiting reactant and excess reactant
i. Define selectivity and yield of reaction

Q3.

a.State & explain Newtons law of cooling ,Fouriers law of conduction and Stefan Boltzmans law**(06)**

b.With the help of a neat diagram, explain the working of a double pipe heat exchanger. **(06)**

OR

b. With the help of a neat diagram, explain the working of a shell and tube heat exchanger **(06)**

Q4.

a. Calculate the heat transfer co-efficient for mercury pumped through a 0.015 m ID tube with a velocity of 12070 m/hr using the following details **(06)**

ρ=13500 kg/m^3 Cp =0.138 kJ/kg K μ=5.4 kg/hr m k=31.4 kJ/hr mK

b. Calculate the surface area required for a heat exchanger which has to cool 55000 kg/hr of alcohol from 66 ^{0}C to 40 ^{0}C using 40000 kg/hr of water entering at 5^{0}C.U based on outer tube area is 2088 kJ/hr m^{2}K. Cp of alcohol is 3.76 kJ/kg K and that of water is 4.18 kJ/kg K **(06)**

Consider any one of the following arrangements

A parallel S & T exchanger

OR

A counter S & T exchanger

Q5.

a. Ethylene oxide is produced by the oxidation of ethylene. 100 kmol ethylene is fed to a reactor and the product is found to contain 80 kmol ethylene oxide and 10 kmol CO_2. Calculate the % conversion of ethylene and % yield of ethylene oxide. **(06)**

$$C_2H_4 + 0.5\,O_2 = C_2H_4O$$
$$C_2H_4 + 3O_2 = 2\,CO_2 + 2H_2O$$

b. A tray drier is fed with 1000 kg of wet orthonitro aniline containing 10 % water. The dried product contains 99.5 % orthonitro aniline and the rest water. Find the % of water removed. **(06)**

OR

b. Spent lye from a soap manufacturing unit contains 9.6 % glycerol and 10.3 % salt. It is concentrated at a rate of 4000 kg/h until the final solution contains 80 % glycerol and 6 % salt. Assume that 5 % glycerol is lost in entrainment. Calculate the evaporation rate and the amount of salt crystallised in the evaporator **(06)**

Q6.

a. 4 kmol of HCL reacts with 35 % excess air to produce Chlorine gas. The reactants enter the reactor at 318 K .If the oxidation is 80 % complete and if the products leave at 350 K, calculate the heat that is to be removed from the system. ΔH_R^0 =28600 J/kmol **(06)**

$$4\,HCl + O_2 \rightarrow 2Cl_2 + 2H_2O$$

Cp (J/kmol K)	HCl	O_2	N_2	Cl_2	H_2O
318 K-298 K	30.308	26.025	29.59		
350 K-298 K	30.8	26.5	30	32.49	32.92

b. Chlorinated diphenyl is heated from 313 K to 533 K at a rate of 4000 kg/h.Calculate the heat to be supplied .The heat capacity of diphenyl is given by **(06)**

$C_p = 0.7511 + 1.465 \times 10^{-3}T$ kJ/kg K

OR

b. Calculate the heat needed to raise the temperature of 17 kg ammonia from 311 K to 422 K **(06)**

Cp of NH_3 between 311 K - 298 K =35.8641 kJ/kmol K
Cp of NH_3 between 422 K and 298 K =37.7063 kJ/kmol K

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