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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 = 8 marks)

- 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 any seven (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 Boltzmanns 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)

$$\rho=13500 \text{ kg/m}^3 \quad C_p=0.138 \text{ kJ/kg K} \quad \mu=5.4 \text{ kg/hr m} \quad k=31.4 \text{ kJ/hr mK}$$

b. Calculate the surface area required for a heat exchanger which has to cool 55000 kg/hr of alcohol from 66 °C to 40 °C using 40000 kg/hr of water entering at 5 °C. U based on outer tube area is 2088 kJ/hr m²K. 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

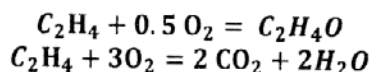
A parallel S & T exchanger

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 CO₂. Calculate the % conversion of ethylene and % yield of ethylene oxide. (06)



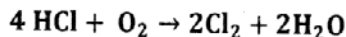
b. A tray drier is fed with 1000 kg of wet orthonitro aniline containing 10 % water. The dried product contains 99.5 % orthonitro aniline and the rest water. Find the % of water removed. (06)

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. $\Delta H_R^0 = 28600 \text{ J/kmol}$ (06)



Cp (J/kmol K)	HCl	O ₂	N ₂	Cl ₂	H ₂ O
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)

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

OR

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

Cp of NH₃ between 311 K - 298 K = 35.8641 kJ/kmol K

Cp of NH₃ between 422 K and 298 K = 37.7063 kJ/kmol K

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