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(15) **SARDAR PATEL UNIVERSITY**

**EXTERNAL EXAMINATION, APRIL 2014**

**M.Sc INDUSTRIAL CHEMISTRY-SEMESTER 2**

**UNIT OPERATIONS II & STOICHIOMETRY- PS02CICH01**

**18th April,2015** **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.** In a shell & tube heat exchanger,

i. square pitch gives more heat transfer area than triangular pitch.
ii. triangular pitch gives more heat transfer area than square pitch.
iii. both square & triangular pitch give same heat transfer area
iv. cleaning facility is same in both square & triangular pitch

**b.** Identify the correct relation.

i. 1 W = 1 J/s ii. 1W =1 kcal/s iii.1 W = 1 cal/s iv.1 W = 1cal/hr

**c.** The --------------component is always present in less than its stoichiometric proportion with respect to other reacting components.

i.excess reactant ii.stoichiometric reactant iii. limiting reactant iv.none of these

**d.** Heat transfer occurs by natural convection because change in temperature causes difference in----

i. viscosity ii.thermal conductivity iii.heat capacity iv.density

**e.** Fouling factor of a heat exchanger depends on

i. length of fins ii.thickness of fins iii.scales formed **iv.**density of cold fluid

**f.** The overall resistance for heat transfer through a series of flat resistance is the ----- of the resistances

i. average ii. Product iii.geometric mean iv.sum

**g.** The temperature average used in heta exchanger calculation is -----temperature difference

i.arithmetic mean ii.geometric mean iii. Logarithmic mean iv. None of these

**h.** Multipass heat exchangers are used ------------------

i. Because of simplicity of fabrication
ii. For low heat load
iii. To obtain high heat transfer co-efficient & shorter tube
iv. To reduce pressure drop

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

a. Define white body and opaque body
**b.** In which side (tube/shell) will you take viscous fluid in a shell & tube exchanger? Justify your answer.
c. Distinguish between triangular and square pitch
d. Why are extended surfaces used in heat transfer?
e. Enlist the conditions when maximum heat transfer rate occurs in a heat exchanger
f. Define effectiveness of a heat exchanger
g. Define adiabatic flame temperature
h. Distinguish between sensible heat and latent heat
i. Define % conversion and yield of reaction

**Q3.**

a.Discuss the significance of the following dimensionless numbers **(06)**

- Nusselts Number
- Grashoffs Number
- Prandtls Number

b.With the help of neat diagrams, distinguish between parallel and counter flow heat exchangers. **(06)**

**OR**

b. Citing examples, distinguish between free and forced convection **(06)**

**Q4.**

**a.** A fluid (Cp=4 kJ/kg K) flowing at 23000 kg/hr passes through a counter current heat exchanger at 130°C.Water (Cp=4.18 kJ/kg K) flowing at 52000 kg/hr and entering at 25°C is used to cool the fluid .If the heat transfer area is 11 $m^2$ and the overall heat transfer co-efficient is 3500 kJ/hr $m^2$K,find the exit temperatures of fluid and water using NTU method. **(06)**

**b.** A multi pass Shell & Tube heat exchanger is required to heat 25000 kg/hr of cold water entering at 25 °C using 20,000 kg/hr of hot water entering at 100°C and leaving the exchanger at 80 °C. The cold water flow through 10 tubes each of OD 0.01m and ID 0.008 m. The hot water flows through the annulus between tubes and a shell of dia 0.25 m. The thermal conductivity of the tube material is 60 kJ/hr m K. The properties of water are given below **(06)**

$\rho$=1000 kg/$m^3$ Cp =4.18kJ/kg K $\mu$=3.6 kg/hr m k=2.9 kJ/hr mK

calculate the length of the heat exchanger if it is

A parallel exchanger

**OR**

A counter exchanger

**Q5.**

**a.** Methane undergoes the following oxidation reactions.

$$CH_4 + O_2 = HCHO + H_2O$$

$$CH_4 + 2O_2 = CO_2 + 2H_2O$$

100 kmol of methane is charged to the reactor and the product stream contains 10 kmol Carbondioxide and 40 kmol formaldehyde. Calculate the % conversion of methane and % yield of formaldehyde. **(06)**

**b.** 2000 kg of wet solids containing 70 % solids by weight are fed to a tray drier where it is dried by hot air.The product obtained is found to contain 1 % moisture by weight. Calculate **(06)**

- kg of water removed from wet solids
- kg of product obtained

**OR**

**b.**An evaporator is fed with 15000 kg/h of a solution containing 10 % NaCl,15 % NaOH and rest water. During the process, water is evaporated and NaCl is precipitated as crystals. The thick liquor leaving the evaporator contains 45 % NaOH,2 % NaCl and the rest water. Calculate **(06)**

- kg /h of water evaporated
- kg/h of salt precipitated
- kg/h of thick liquor

**Q6.**

**a.** Calculate the heat to be transferred to a liquid stream of ethanol at its normal boiling point to generate 100 kg/h of saturated ethanol vapour. $\lambda$=842.3 kJ/kg **(06)**

**b.** A stream flowing at the rate of 15 kmol/h containing 25 % $N_2$ and 75 % $H_2$ is to be heated from 298 K to 473 K.Calculate the heat that must be transferred using the Cp data given below. **(06)**

| Gas | a | b | c | d |
|---|---|---|---|---|
| $N_2$ | 29.59 | $-5.41*10^{-3}$ | $13.183*10^{-6}$ | $-4.97*10^{-9}$ |
| $H_2$ | 28.61 | $1.019*10^{-3}$ | $-0.147*10^{-6}$ | $0.769*10^{-9}$ |

**OR**

**b.** Chlorine is manufactured using the reaction $4HCl + O_2 \rightarrow 2Cl_2 + 2H_2O$ where 35 % excess air is used.If the feed contains 4 kmol HCl and if the oxidation is 80 % complete,calculate the heat that must be removed so that the products emerge at 600 K. The dry air and HCl enter at 560 K.
$\Delta H^0_R$ = -28600 kJ/mol **(06)**

| Cp (KJ/mol K) | HCl | $O_2$ | $N_2$ | $Cl_2$ | $H_2O$ |
|---|---|---|---|---|---|
| (560- 298 K) | 24.85 | 25.98 | 29.08 | | |
| (600-298 K) | 30.31 | 26.02 | 29.59 | 28.08 | 31.05 |

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