SEAT No.________ **No. of Printed Pages : 03**

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SARDAR PATEL UNIVERSITY
EXTERNAL EXAMINATION, APRIL 2017
M.Sc. INDUSTRIAL CHEMISTRY-SEMESTER 2
HEAT TRANSFER OPERATIONS & STOICHIOMETRY- PS02CICH09

13th April,2017 **Max.Marks:70**

Time:10.00 a.m-1.00 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. Identify the correct relation.

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

b. The --------------component is always present in less than its stoichiometric proportion .

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

c. Natural Convection is characterized by

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

d. The centre-centre distance between 2 tubes is called

i. tube clearance ii.tube pitch iii.tube sheet iv.tie rods

e. ----- increases turbulence in a heat exchanger

i. fins ii. baffles iii. Tube sheet iv. None of these

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

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

g. Grashoffs number is defined as

i.$L^2\rho^2 g\,\beta\,\Delta T/\mu^2$ ii. $L^3\rho\, g\,\beta\,\Delta T/\mu^2$ iii.$L^3\rho^2 g\,\beta\,\Delta T/\mu$ iv.$L^3\rho^2 g\,\beta\,\Delta T/\mu^2$

h. Which is most suitable for the evaporation of cold viscous feed?

i. Forward feed ii.Backward feed iii.Mixed feed iv.Parallel feed

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

a. Define fouling factor in heat exchanger
b. Distinguish between individual and overall heat transfer co-efficient
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.A fluid of density 13500 kg/m^3 and at 80^{0}C is pumped through a pipe of 0.02 m ID kept at 30 ^{0}C at 15000 m/hr . At the average temperature of 55 ^{0}C, the properties of fluid are as follows. Calculate the heat transfer co-efficient. **(06)**

Cp (kJ/kg K):0.14	k (kJ/hr m K):29	μ (kg/ hr m K):3

b. A pipe 0.15 m dia & 1 m length and at temperature of 573 K is covered with 2 layers of insulation. The first layer is o 0.05m thick with a k value of 0.062 W/m K and the second layer is 0.06 m thick with a k value of 0.8 W/m K. The outer surface of second layer covering is at a temperature of 330 K. Calculate the heat loss and the interface temperature. **(06)**

OR

b. A horizontal cylinder 0.025 m dia and 0.6 m long is suspended in water at 20 ^{0}C.Calculate the heat transfer co-efficient if the cylinder surface is at 55 ^{0}C. **(06)**

ρ (kg/m^3)	Npr	k (kJ/hr mK)	β(K^{-1})	μ(kg/hr m)
992	4.64	2.376	3.96 * 10^{-4}	2.47

Q4.

a. A fluid (Cp=3.3 kJ/kg K) flowing at 20000 kg/hr enters a parallel flow heat exchanger of 40 % efficiency at 120 ^{0}C.Water (Cp= 4.186 kJ/kg K) flowing at 50000 kg/hr which is used as the coolant enters at 20 ^{0}C. If a heat transfer area of 10 m^2 is available, what will be the heat transfer co-efficient? **(06)**

b. Find the length of a double pipe exchanger required to heat 4000 kg/hr of oil from 10 ^{0}C to 20 ^{0}C using hot water at 70 ^{0}C flowing at 690 kg/hr. The hot water flows through the inner pipe of ID 0.018 m and OD 0.021 m. The ID of the outer pipe is 0.03 m. k for pipe= 0.008 kJ/hr m K. **(06)**

	Cp(kJ/kgK)	k (kJ/hr mK)	ρ(kg/m^3)	μ(kg/hr m)
Water	4.18	2.376	1000	1.458
Oil	1.885	0.504	850	2.163

Do the calculation for

A parallel flow exchanger

OR

A counter flow exchanger

Q5.

a. 100 kg of a solution containing 55 % benzene, 28 % toluene, and 17 % xylene by weight is in contact with its vapour at 373 K.Calculate the total pressure and molar composition in liquid phase. **(06)**

	Benzene(MW:78)	Toluene (MW:92)	Xylene(MW:106)
Vap. Pr (kpa)	178.6	74.6	28

b. A combustion reactor is fed with 50 kmol/h of butane and 2000 kmol/h of air.
$C_4H_{10} + 6.5\ O_2 \rightarrow 4CO_2 + 5H_2O$.
Calculate the % excess air and the composition of gases leaving the combustion reactor assuming complete combustion . **(06)**

OR

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

Q6.

a.100 moles of methane is oxidized with 50 % excess air to produce formaldehyde as per the reaction

$CH_4 + O_2 \rightarrow HCHO + H_2O$

All the reactants enter at 311 K with 60 % conversion of methane. Calculate the heat that must be removed for the product stream to emerge at 478 K. **(06)**

Component	Cp (311- 298 K) J/mol K	Cp (478-298 K) J/mol K	
CH_4	36.044	40.193	Std. heat of reaction = -283000 J/mol
O_2			
N_2			
HCHO		41.2902	
H_2O		34.2396	

b .Calculate the standard heat of reaction of the following reaction **(06)**

$4\ NH_3 + 5O_2 \rightarrow 4\ NO + 6\ H_2O$

Component	NH_3	NO	H_2O
ΔHf (kJ/mol)	-45.94	90.25	-241.82

OR

b. 100 kg/h of methanol liquid at 303 K is to be obtained by removing heat from saturated methanol vapour. Find the amount of heat to be removed **(06)**

Boiling point of methanol = 337.8 K,
Cp of methanol =2.7235 kJ/kg K

Latent heat of condensation = 1101.7 kJ/kg

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