RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FOURTH SEMESTER EXAMINATION, AUGUST 2021

SECOND YEAR (BATCH 2019-22)

Date : 07/08/2021 **INDUSTRIAL CHEMISTRY (Honours)**

Time : 11.00 am – 1.00 pm **Paper : VIII [CC 8]** Full Marks : 50

Answer **any five** questions [5×10]

Symbols are of usual significance

1. Choose the right answer [2×5]

a) Cracked gas from petroleum refinery has the following composition by volume at a temperature of 754^{o}C. Find the average molecular weight of the gas. Methane: 45%; Ethane: 10%; Ethylene: 30%; Propylene: 8%; Propane: 7%

i) 29.32 g/mol ii) 25.04 gmol iii) 16.0 g/mol iv) None of these

b) 1.2 g atoms of Carbon and 1.5 g moles of Oxygen are reacted to give 1 g mole of Carbon dioxide, what is the % of excess air supplied.

i) 20 ii) 25 iii) 22 iv)18

c) For a steady state system

i) The rate of input is zero ii) The rate of generation is zero

iii) The net rate of consumption is zero iv) The rate of accumulation is zero

d) Pure ethanol vapour is fed to a reactor with alumina catalyst at 50 kmol/hr. The reactor product comprise is given below,

Ethylene: 47.5 kmol/hr; Water vapour: 48.75 kmol/hr; Diethyl ether: 1.25 kmol/hr

Reactions are given

$C_2H_5OH \rightarrow C_2H_4 + H_2O$

$2\ C_2H_5OH \rightarrow C_2H_5\text{-}O\text{-}C_2H_5 + H_2O$

The percentage of conversion of ethanol is

i)100% ii) 98% iii) 96% iv) 2.5%

e) A hydrocarbon is brunt with excess air. The Orsat analysis of the flue gases shows 10.81% CO_2; 3.78% O_2 and 85.41% N_2. Calculate the excess air used,

i)10.4 ii) 9.6 iii) 25.4 iv) 15.7

2. a) A closed vessel contain a mixture of 40% NO_2 and 60% N_2O_4 at the temperature of 38^{o}C and pressure of 3990 mmHg when the temperature is increased at 60^{o}C some of N_2O_4 dissociates to NO_2 and the pressure rises to 5100 mmHg. Calculate the composition of gases at 60^{o}C.

b) 100 kg/hr of a thermic fluid to be used as heat transfer medium, is being indirectly heated in a heater from 380K to 550K. Calculate the heat load on the heater in kW. The heat capacity equation for the thermic fluid is

$C_p = 1.436 + 0.00218T$ where C_p in kJ/kg K [6+4]

3. a) In manufacture of acetic acid by oxidation of acetaldehyde. 100 kmol of acetaldehyde are fed to the reactor per hour. The product leaving the reactor contains 14.81% acetaldehyde, 59.26% acetic acid and rest oxygen (mol basis). Find the % of conversion of acetaldehyde.

b) Methanol is produced by the reaction of CO with H_2 as

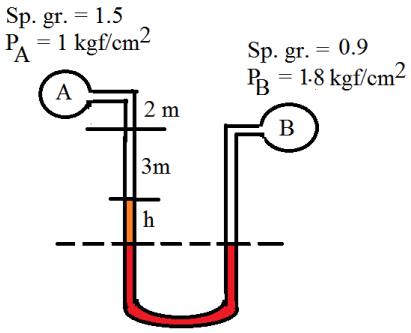
$CO + 2H_2 \rightarrow CH_3OH$

Only 15% of the CO entering the reactor is converted to methanol. The methanol product is condensed and separated from the unreacted gases, which are recycled. The fresh feed contains 2 kgmole of H_2 for every kgmole of CO. The fresh feed enters at 35^oC and 300 atm. To produce 6600 kg/hr of methanol, calculate (a) volume of the fresh feed gas and (b) The recycle ratio. [5+5]

4. a) Define (i) ideal and real fluid; (ii) Newtonian and non-Newtonian fluid.

b) Explain why pseudoplastic fluid is called shear thinning fluid?

c) A differential manometer is connected at the two points A and B of two points as shown in figure. Find the difference in mercury level in the differential manometer. [2+2+6]



5. a) Write the significance of Reynolds number.

b) An oil of viscosity 9 poise and specific gravity 0.9 is flowing through horizontal pipe of 60 mm diameter. If the pressure drop in 100 m length of the pipe is 1800 kN/m^2, determine

i. The rate of flow of oil;

ii. The centre-line velocity;

iii. Frictional drag over 100 m length;

iv. Reynolds number of the flow;

v. Friction factor. [3+7]

6. a) Write the assumptions necessary to derive the Bernoulli's equation.

b) Write the Bernoulli's equation and explain each terms.

c) Discuss the relative merits and demerits of venturimeter with respect to orifice meter.

d) A horizontal venturimeter with inlet and throat diameters 30 cm and 15 cm respectively, is used to measure the flow of water. The reading of differential manometer connected to the inlet and throat is 20 cm. Determine the rate of flow.

Given, $C_d = 0.98$ [1.5+1.5+3+4]

7. a) State and explain the Fick's law of diffusion.

   b) Show that $D_{AB} = D_{BA}$.

   c) An ethanol water solution is in contact at 20^oC with an organic liquid of film thickness 0.4 cm in which water is insoluble. The Conc. of ethanol at the interface is 6.8 wt.% and at the otherside of film it is 10.8 wt.%. The densities are 0.9981 gm/cc and 0.9728 gm/cc respectively for 6.8 wt.% and 10.8 wt.% ethanol solution. Calculate the steady state flux kgmol/m^2s.

   Given $D_{ethanol\text{-}water} = 74 \text{ X } 10^{-5}$ cm^2/s. [2+3+5]

8. a) Differentiate (i) Adsorption and desorption; (ii) Extraction and leaching.

   b) Write the advantages of tray column and packed column.

   c) Write the names of few industrial packing materials.

   d) In an oxygen-nitrogen gas mixture at 1 atm, 25^oC, the Conc. of oxygen at the two planes 0.2 cm apart are 10% and 20% (by vol.) respectively. Calculate the flux of oxygen when (i) nitrogen is non-diffusing; (ii) there is equimolal counter diffusion.

   Given, $D_{oxygen\text{-}nitrogen} = 0.215$ cm^2/s. [3+2+1+4]

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