RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College under University of Calcutta)

B.A./B.SC. FOURTH SEMESTER EXAMINATION, MAY 2015

SECOND YEAR

Date : 22/05/2015 **INDUSTRIAL CHEMISTRY (Honours)**

Time : 11 am – 2 pm **Paper :** IV Full Marks : 75

[Use a separate Answer Book for each group]

Group - A

1. Answer **any six** questions from the following: [6×1]

   a) Dimension of kinematic viscosity is

   i) MLT^{-1} ii) $L^2 T^{-1}$ iii) $L^2 T$ iv) $L^2 T^2$

   b) Reynolds Number is the ratio of

   i) Viscous force to gravity force ii) Inertia force to viscous force iii) Viscous force to inertia force iv) Inertia force to gravity force.

   c) Stoke's law is valid when Reynold's no is less than

   i) 2 ii) 100 iii) 700 iv) 2100

   d) Prandtl number is given

   i) $C_p \mu/D$ ii) h D/K iii) $C_p \mu/K$ iv) $\mu/h\ C_p$

   e) The simple pitot tube measures the pressure

   i) Static ii) Dynamic iii) Total iv) None of these

   f) Which of the following flow measuring devices is an area meter?

   i) Venturimeter ii) Orifice meter iii) Rotameter iv) Anemometer

   g) Maximum heat transfer rate is achieved in …..…. flow

   i) Co-current ii) Counter Current iii) Turbulent iv) Laminar

   h) Gaseous diffusivity at atmospheric pressure is of the order of …….. cm^2 /second

   i) 1 ii) 1 to 5 iii) 5 to 10 iv) >10

   i) Which of the following crushing laws is most accurately applicable to the fine grinding of materials :

   i) Bond's crrushing law

   ii) Kick's Law

   iii) Riltinger's Law

   iv) None of these

   j) Which are used in case of heat flow by conduction through a cylinder :

   i) Logarithmic mean area

   ii) Arithmetic mean area

   iii) Geometric mean area

   iv) None of these

2. Answer **any five** questions from the following: [5×2]

   a) Show that Prandtl number is a ratio of two diffusivity terms

   b) Check the dimension homogeneity of the following equations

   i) $Q = C_d\, a \sqrt{(2gH)}$ where C_d is constant, a = area, g = acceleration due to gravity, H = height of water, Q=volumetric discharge.

   ii) $H_f = \dfrac{4f\ell v^2}{2gd}$ where f = constant, v = velocity, g = acceleration due to gravity, ℓ = length, d = diameter , H_f = head loss (dimension is L)

   c) Show that $D_{AB} = D_{BA}$

d) Explain the following terms
   i) yield and conversion ii) limiting reactant and excess reactant.

e) What is vena contracta? Explain with a sketch.

f) i) What is the relation between kinematic viscosity and absolute viscosity.
   ii) Find the kinematic viscosity of an oil in stokes whose sp. Gravity is 0.95 and viscosity is 0.011 poise.

g) State and explain Stefan Boltzman law for radiation heat transfer.

h) What is meant by overall heat transfer coefficient? Write the design equation of a heat exchanger equipment. Explain briefly the importance of overall heat transfer coefficient. Give its unit.

i) What are meant by the terms used in pumping of fluids?
   i) Water hammer ii) NPSH

3. Answer **any three** questions of the following: [3×13]

a) i) State and explain Bernoulli's equation. [2]

   ii) State the assumptions necessary for deriving the Bernoulli's equation. [1]

   iii) Show that for the laminar incompressible real fluid in a horizontal circular pipe follows the relation [4]

   $\frac{u}{u_{max}} = \left(1 - \frac{r^2}{r_o^2}\right)$ where, u = velocity at any radius r, u_{max} = maximum velocity at the centre, r = o, r_o = radius of the pipe.

   iv) A venturimeter with 150 mm diameter at inlet and 100 mm at throat is laid with its axis horizontal and is used for measuring the flow of oil Sp. Gravity 0.9. The oil mercury differential manometer shows a gauge difference of 200 mm. Assume the co-efficient of meter is 0.98. Calculate the discharge per minute. [6]

b) i) Ethylene oxide is produced by oxidation of ethylene. 100 Kg mole of ethylene fed to a reactor and product is found to contain 80 Kg mole ethylene oxide and 10 Kg mole CO_2. Calculate. [3]
   a) Conversion of ethylene.
   b) Yield of ethylene oxide.

   ii) The spent acid from a nitrating process contains 33% H_2SO_4 and 36% HNO_3 and 31% water by weight. This acid is to be strengthened by the addition of concentrated sulphuric acid containing 95% H_2SO_4 and concentrated nitric acid containing 78% HNO_3. The strengthened mixed acid is to contain 40% H_2SO_4 and 43% HNO_3. Calculate the quantities of spent and concentrated acid that should be mixed together to yield 1500 Kg of the desired mixed acid. [5]

   iii) The sulphate process for the production of hydrochloric acid is described by the following reaction $2NaCl + H_2SO_4 = Na_2SO_4 + 2HCl$.

   Calculate the heat of reaction and the consumption of coke oven gas for the production of 500 Kg HCl. The heat of formation in MJ/Kmol are:

   NaCl – 410.9, H_2SO_4 – 811.3, Na_2SO_4 – 1384.0, HCl – 92.3 The calorific value of the coke oven gas is 19.0 MJ/m^3. [5]

c) i) State and explain Fourier's law of heat conduction. [2]

   ii) A refrigerant at -50^o C flow in a copper pipe (k = 401 w/mk) of inside diameter 1cm and wall thickness 2 mm. To reduce losses a 5 cm thick shell of thermocol type of materiel (k = 0.026w/mk) is put around the pipe. Calculate the heat leakage to refrigerent per meter length of the pipe. The internal and external heat transfer coefficients are 500 and 13 w/m^2k respectively and the ambient temperature is 40°C. [5]

   iii) By condensing dry saturated steam at 1.41 Kg/cm^2 at 110^oC, 9100 Kg of ethyl alcohol is heated per hour from 10^oC to 80^oC. The overall coefficient of heat transmission varies linearly with temperature from 97 $Kcal/m^2$ hr ^0C at 10^0C to 390 at 80^0C. Obtain the surface area of the heat exchanger. Specific heat of absolute alcohol = 0.65 Kcal/Kg ^0C. [6]

d) i) State Fick's first law of diffusion, explaining the symbols used in the law. [2]

ii) What is meant by Interphase Mass Transfer? Explain it with a sketch. [4]

iii) Methane diffuses at steady state through a tube containing Helium. At point 1, the partial pressure of methane is P_{A_1} = 55 KPa and at point 2, 0.03m apart, P_{A_2} =15KPa. The total pressure is 101.32 KPa and the temperature is 298 K.

At this pressure and temperature, the value of diffusivity is $6{\cdot}75 \times 10^{-5}$ m^2/s.

A) Calculate the flux of CH_4 at steady state for equimolar Counter diffusion.

B) Calculate the partial pressure at a point 0·02m apart from point 1. [7]

e) i) State and explain (in connection with crushing and grinding) [3]

a) Rittinger's Law

b) Bond's Law

ii) Give the classification of size reduction equipment according to the size of feed. [2]

iii) Discuss close circuit grinding operation. [3]

iv) Calculate the energy required to crush 100 tonnes per hour of limestone if 80% of the feed passes through a screen 3.75cm aperture. The work index for lime stone is 12.74, when the capacity is expressed in tonnes per minute and energy required in HP and size of feed and product in feet and 80% of the product passed through a screen of width 0·03 cm aperture. [5]

f) i) Describe various types of biochemical reactions. [3]

ii) Write briefly the advantages and disadvantages of the following types of reactors -

Batch reactor, CSTR, Fed batch reactor, Air lift reactor. [5]

iii) For carrying out a reaction in a highly viscous medium, what type of reactor you will select to carry out the operation? [5]

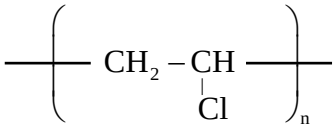
Group – B

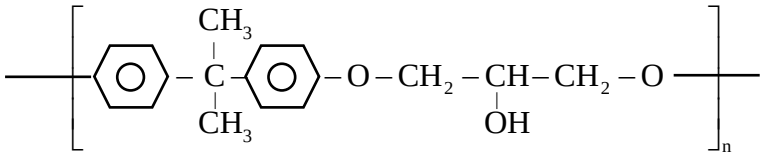
4. Answer **any four** questions : [4×5]

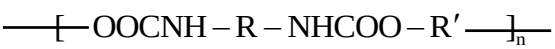
a) Discuss in brief four industrial methods of polymerisation giving examples of commercial polymers under each method. [5]

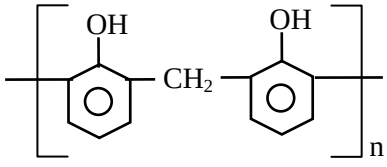
b) Distinguish between straight chain polymer & cross linked polymer with one example of each. [5]

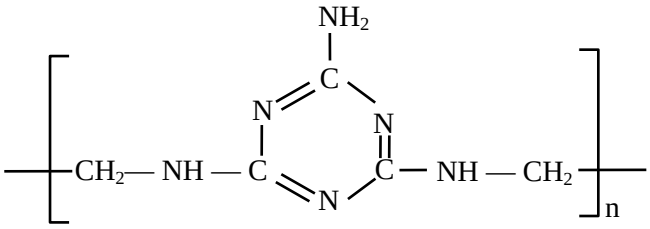
c) Identify the polymers shown below giving name, monomers' name, nature of reaction – whether step or chain growth, and one important use with chemical equations. [1×5]

(i) 

(ii) 

(iii) 

(iv) 

(v) 

d) Describe in short Karl Ziegler's process of synthesis of HDPE.
Compare structure, properties and gradation between LDPE and HDPE [2.5×2]

e) Write short notes on synthesis, properties, and application (end use) of [2.5×2]
(i) Polymethyl Methacrylate
(ii) Polystyrene

f) What is adeponitrile ? Can you suggest one in daily use? [5]

g) Describe process of recovery of Natural Rubber from Hevea tree and subsequent compounding and vulcanization into finished ready-to-use Rubber product. [5]