RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College under University of Calcutta)

B.A./B.Sc. FOURTH SEMESTER EXAMINATION, MAY 2014

SECOND YEAR

Date : 23/05/2014 **INDUSTRIAL CHEMISTRY (Honours)**

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

[Use a Separate Answer Book for each group]

Group – A

1. Choose the correct alternatives for **any six** of the following questions. [6×1]

   a) Prandtl number is given as

   i) $\frac{C_p\mu}{D}$ ii) $\frac{hD}{K}$ iii) $\frac{C_p\mu}{K}$ iv) $\frac{\mu}{hC_p}$

   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) Dimension of thermal diffusivity, α is—

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

   d) Mass transfer coefficient (K) and diffusivity (D) are related to according to film theory as—

   i) $K \propto D$ ii) $K \propto \sqrt{D}$ iii) $K \propto D^{1.5}$ iv) $K \propto D^2$

   e) The diffusivity (D) in a binary gas mixture is related to pressure(P) as—

   i) $D \propto P^{0.5}$ ii) $D \propto \frac{1}{P^{0.5}}$ iii) $D \propto \frac{1}{P}$ iv) $D \propto \frac{1}{P^{1.5}}$

   f) Which of the following crushing law is most accurately applicable to the fine grinding of materials—

   i) Bond's Crushing law ii) Kick's law iii) Rittinger's law iv) none of these

   g) In Fourier's law, the proportionality constant is called—

   i) heat transfer coefficient ii) thermal conductivity

   iii) thermal diffusivity iv) Stefan-Boltzman constant

   h) Boiling and also condensation process occur at—

   i) ΔT is small but h is very high ii) ΔT is very high but h is very high

   iii) ΔT is moderate but h is moderate iv) none of these

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

   a) Show that the Prandtl's number is a ratio of diffusivity terms.

   b) State phase rule. What is an eutectic mixture?

   c) State and explain Bond's law of crushing.

   d) State and explain Stefan-Boltzman law.

   e) State and explain Fick's law of diffusion.

   f) Why pseudoplastic liquid is termed as shear thining liquid?

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

   h) Define and explain black body and gray body.

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

3. a) Derive Hagen Poiseulle equation for laminar flow through pipe. [6]

   b) Explain the limitations of Bernoulli's equation. [3]

   c) Draw a neat sketch of a rotameter and explain why it is called variable area meter. [4]

4. a) A venturimeter with 150 mm diameter at inlet and 100mm at throat is laid with its axis horizontal and is used to measuring the flow of oil of sp. gravity 0·9. The oil mercury differential manometer shows a gauge difference of 200mm. Assume coefficient of the metre is 0·98. Calculate the discharge per minute. [6]

b) Write the classification of Pump. [3]

c) A centrifugal pump with an efficiency of 50% is driven by an electric motor with an efficiency of 90%. The pump delivers 250 kg of water per minute against a total head of 25m. What is the power required by the motor and what is power delivered by the motor? [4]

5. a) What is dirt factor? Explain its importance in design of heat exchanger. [2]

b) The wall of a drying chamber are built up of a layer of red brick (K = 0·7 w/mk) of thickness 200mm and a layer of felt (k = 0·046 w/mk) of thickness 25 mm. The temperature inside the drying chamber is 120°C and outside the felt layer is 30°C. Calculate the heat loss from the wall.
[Given, convective coefficient at the outside of the felt layer = 8 w/m^2k] [4]

c) Crude oil flows at the rate of 1000kg/hr through the inside pipe of a double pipe heat exchanger and heated from 30°C to 90°C. The heat is supplied by kerosene initially at 200°C flowing through the annular space. If the outlet temperature of kerosene is 100°C, calculate the heat transfer area required for co-current flow and kerosene flow rate.
Given : C_P for crude oil = 0·5 KCal/kg °C
C_P for kerosene = 0·6 KCal/Kg °C
U = 400 KCal /hr m^2 °C [7]

6. a) Estimate the consumption of 96% NaCl and 93% H_2SO_4 for the production of 500kg HCl if the conversion is 92%. Also calculate the amount of Na_2SO_4 produced during the process.
HCl is produced according to the following reaction : [6]

$$2NaCl + H_2SO_4 = Na_2SO_4 + 2HCl$$

b) On the basis of the data and the chemical reactions given below, find the heat of formation of $ZnSO_4$ from elements.

i) $Zn + S(rhomb) \rightarrow ZnS$ $\quad \Delta H = -44\,KCal/Kg\,mol$

ii) $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$ $\quad \Delta H = -221{\cdot}88\,KCal/Kg\,mol$

iii) $2SO_2 + O_2 \rightarrow 2SO_3$ $\quad \Delta H = -46{\cdot}88\,KCal/Kg\,mol$

iv) $ZnO + SO_3 \rightarrow ZnSO_4$ $\quad \Delta H = -55{\cdot}10\,KCal/Kg\,mol$ [7]

7. a) Show that : $D_{AB} = D_{BA}$ [3]

b) Ammonia gas (A) diffuses through nitrogen gas (B) under steady state conditions with nitrogen non diffusing. The total pressure of gas is $1{\cdot}013\times10^5$ pa and temperature is 298 K. The diffusion path is 0·15m and the partial pressure of ammonia at one point is $1{\cdot}5\times10^4$ pa and at the other point is 5×10^3 pa. Calculate the flux of ammonia. [4]

c) Calculate the energy required to crush 100 tones/hr of limestone if 80% feed passed through a screen with 3·75 cm aperture and 80% of the product passes through a screen with 0·03 cm aperture. The work index for limestone is 12·74 when the capacity is expressed in tonnes per minute energy required in HP and size of the feed and product in feet. [6]

8. a) Write notes on the advantages and disadvantages of the following types of reactors [10]
i) Batch reactor
ii) CSTR
iii) Air lift reactor
iv) Plug flow reactor
v) Fed batch reactor

b) Name the various types of Bioreactors used in industry. [3]

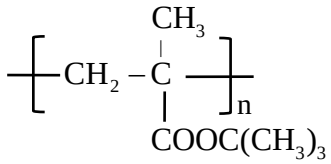
[All symbols are of usual significance]

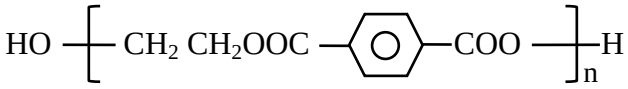
Group – B

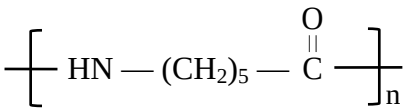
Answer **any four** questions : [4×5]

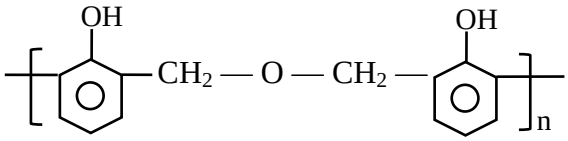
1. Deduce Carother's equation including extent of Polymerisation when $DP \to \infty$.
   62·5 g pure vinyl chloride is polymerised for 6 hour and degree of polymerisation was found to be 10,000. Calculate how many molecules of PVC are formed? [3+2]

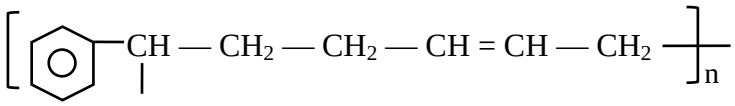
2. Identify the polymers from their repeat units given below mentioning the names of the monomers and one major use of each polymer. [(0·5+0·5)×5]

   a) 

   b) 

   c) 

   d) 

   e) 

3. Write short notes (**any two**) : [2×2·5]
   a) CoPolymerisation
   b) Recovery of NR from Hevea Brasiliensis
   c) Chemistry of Vulcanisation of Rubber
   d) Tacticity in Polypropylene

4. Briefly narrate the synthesis, properties and uses of following polymers (**any two**) : [2×2·5]
   a) Polychloroprene Rubber
   b) Nylon 66
   c) Polyvinyl chloride
   d) Melamine-Formaldehyde condensation

5. Write differences (**any two**) : [2×2·5]
   a) LDPE vs. HDPE
   b) Novolac vs. Resol
   c) Addition Polymerisation vs. Condensation polymerisation
   d) Thermosetting polymers vs. Thermoplastic polymers

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