

RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College under University of Calcutta)

B.A./B.SC. FOURTH SEMESTER EXAMINATION, MAY 2012

SECOND YEAR

INDUSTRIAL CHEMISTRY (Honours)

Date : 21/05/2012

Time : 11 am – 2 pm

Paper : IV

Full Marks : 75

[Use Separate Answer Books for each group]

Group – A

1. Answer **any six** questions :

[6×1]

a) Kinematic viscosity has the unit of :

- i) centipoise ii) m^2/s iii) Pa.S iv) none of these

b) Energy associated in a system while calculating energy balance may be in the form of :

- i) position ii) motion iii) internal iv) all of the above

c) $f = \frac{16}{N_{\text{Re}}}$ is valid for :

- i) Turbulent flow ii) Laminar flow through a circular pipe
iii) Laminar flow through a open channel iv) none of these

d) Prandtl number is :

- i) $C_p\mu / D$ ii) hD / K iii) $C_p\mu / K$ iv) μ / hC_p

e) In a heat exchanger where the hot and cold fluids are in same direction and parallel, it is called :

- i) Co-current ii) counter-current iii) cross-flow iv) all of these

f) Maximum heat transfer rate is achieved in :

- i) Co-current ii) counter-current iii) Turbulent iv) Laminar flow

g) Crushing operations may follow :

- i) Rittinger's Law ii) Kick's Law iii) Bond's Law iv) all of these

h) Which of the following is used in case of heat flow by conduction through a cylinder :

- i) Log mean area ii) Arithmetic mean area iii) geometric mean area iv) none of these

i) Boundary Layer concept may be utilized in :

- i) heat transfer ii) mass transfer iii) momentum transfer iv) all of these

2. Answer **any five** questions :

[5×2]

a) Write the expressions of the following dimensionless numbers and briefly state their physical significance :

- i) Reynold's number ii) Nusselt number

b) Mention what different pipe fittings are used in a fluid flow line?

c) What are non-Newtonian fluids?

d) What is a fluidised bed reactor?

e) Check dimensional homogeneity of the equation : $Q = C_d \cdot a \cdot \sqrt{2gH}$

where, Q = Discharge, C_d = Venturi constant, a = Area, H = Height.

f) Write down Dittus-Boelter Equation.

g) State Ficks law of dissusion.

h) Explain the concept of LMTD in engineering operations.

i) What is an inclined manometer?

j) Why is filtration called a mechanical operation?

3. Answer **any three** questions :

[3×13]

a) i) Derive Hagen-Poiseuille Equation for laminar flow in a pipe.

[7]

ii) A pipe (ID 7.5 cm) is carrying water at 20°C. A venturimeter is fitted in the pipe which has a throat diameter 2.0 cm. If the differential manometer shows a reading of 50.0 cm, calculate water flow rate in the pipe. Assume $C_d = 0.98$.

[6]

- b) i) An oil having kinematic viscosity of 21.4 stokes is flowing through a pipe of 30 mm diameter. Determine the type of flow if the discharge through the pipe is 15 lit/sec. [5]
- ii) The spent acid from a nitrating process contains 33% H_2SO_4 , 36% HNO_3 and 31% water by weight. This acid is to be strengthened by the addition of concentrated H_2SO_4 (35%) and concentrated HNO_3 (78%). The strengthened mixed acid should finally contain 40% H_2SO_4 and 43% HNO_3 . Calculate the quantities of spent and concentrated acids that should be mixed together to yield 1500 Kg of the desired mixed acid. [8]
- c) i) Derive the Equation for overall heat transfer coefficient from the individual film coefficients considering basic equation for heat transfer through convection under steady state.
- ii) Determine the rate of heat loss through a wall of red brick ($K = 0.7 \text{ W/m.k}$), 5m in length, 4m in height and 0.25 m in thickness if the wall surfaces are maintained at 100°C and 30°C respectively. [4]
- iii) Determine the net radiant interchange between two parallel oxidized iron plates, placed at a distance of 25 mm having sized $3\text{m} \times 3\text{m}$. The surface temperature of two plates are at 100°C and 40°C respectively. Emissivity of the plates are equal, $\epsilon_1 = \epsilon_2 = 0.736$. [5]
- d) i) With the help of a neat sketch, analyze the steps in an interphase mass transfer. [5]
- ii) Hydrochloric acid (A) diffuses through a film of water (B) 4.0 m of thickness at 283K. The concentration of the acid at point 1 boundary of the film is 12% w/w and $P_1 = 1060.7 \text{ kg/m}^3$ whereas on the other boundary at point 2 is 4% w/w and $P_2 = 1020.15 \text{ kg/m}^3$. The diffusivity of the acid in water is $2.5 \times 10^{-9} \text{ m}^2/\text{s}$. Calculate the acid flux considering the water to be stagnant. [8]
- e) i) Derive Bernoulli's Equation for an incompressible fluid. [5]
- ii) Crude oil flows at the rate of 1000 kg/hr through the inside pipe of a double pipe heat exchanger and is heated from 30°C to 90°C . The heat is supplied by kerosene initially at 200°C flowing through annular space. If the temperature of approach (minimum temperature difference) is 10°C , determine the heat transfer area for co-current flow and kerosene flow rate. Given : C_p for crude oil = $0.5 \text{ KCal/kg}^\circ\text{C}$, C_p for kerosene = $0.6 \text{ KCal/kg}^\circ\text{C}$ and $V_0 = 400 \text{ Kcal/hr}$. [8]
- f) i) Describe various types of biochemical reactors. [3]
- ii) Write a note on advantages and disadvantages of the following types of reactors.
Batch reactor, CSTR, Fed batch reactor, Air lift reactor [8]
- iii) If you were to carry out a reaction in a highly viscous medium, would you prefer a plug flow reactor or a stirred tank reactor? Explain your answer. [2]

Group – B

4. Answer **any four** questions : [4×5]
- a) Classify polymers according to origin, thermal response, method of formation and structure with examples in each case.
- b) Distinguish between HDPE and LDPE in respect of structure, properties and application.
- c) Outline manufacture of PVC. How gradation of PVC is done? Name some PVC stabilizers.
- d) Discuss the synthesis and curing mechanism of epoxy resin.
- e) Define – vulcanization. Explain with equation the mechanism of vulcanization with sulphur, sulphur chloride and zinc oxide.
- f) Write short notes on : Silicone, LLDPE.
- g) Explain with sketch the technique involved from production of plastic goods by the process mentioned below (**any two**) :
Compression moulding, Roto-moulding, Injection moulding, Thermoforming.

