M.Sc. 1st Semester Examination, 2010

CHEMISTRY

(*Industrial Chemistry*)

PAPER—CEM-104

Full Marks : 40

Time : 2 hours

Answer any **four** questions

The figures in the right-hand margin indicate marks

Candidates are required to give their answers in their own words as far as practicable

Illustrate the answers wherever necessary

1. (*a*) Explain the terms (*i*) Dynamic viscosity and (*ii*) Kinematic viscosity. Give their dimensions.

(*b*) Define Newtonian and non-Newtonian fluids.

(*c*) Define and explain Newton's law of viscosity.

(*d*) A plate 0·025 mm distance from a fixed plate, moves at 60 cm/s and requires a force of 2 N/m^2 to maintain this speed. Determine the fluid viscosity placed between the plates. 2 + 2 + 2 + 4

2. (*a*) Differentiate between (*i*) absolute and gauge pressure, (*ii*) simple manometer and differential manometer.

(*b*) What is the difference between U-tube differential manometers and inverted U-tube differential manometers ? Where are they used ?

(*c*) Determine the gauge and absolute pressure at a point which is 2·0 m below the surface of water. Take atmospheric pressure as 10·1043 N/cm^2. 3 + 3 + 4

3. (*a*) Define equivalent length of a piping component.

(*b*) Explain the principle of venturimeter with a neat sketch. Derive the expression for the rate of flow of fluid through it. 2 + 8

4. (*a*) Derive Euler's equation of motion along a stream line for an ideal fluid stating clearly the assumptions.

(*b*) A pipe of diameter 400 mm carried water at a velocity of 25 m/sw. The pressures at the two ends are 29·43 N/cm^2 and 22·563 N/cm^2 respectively. The two ends are situated above the datum plane of 28 m and 30 m respectively. Calculate the loss of head between two ends. 5 + 5

5. (*a*) In production of SO_3 100 kgmole of SO_2 and 200 kgmole of O_2 are fed to reactor. The product stream is found to contain 80 kgmole of SO_3. Find the % conversion of SO_2.

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

$$CO + H_2 \rightarrow CH_3OH$$

Only 15% of CO entering the reactor is converted to methanol. The methanol formed is condensed and removed completely. The unconverted CO and H_2 are recycled back to

the reactor. The fresh feed will contain H_2 and CO in the molar ratio of 2 : 1. The 3200 kg/hr of methanol produced, calculate (*i*) kmole/kg of fresh feed, (*ii*) kmole/kg of recycle feed.

(*c*) 1000 kg/hr of a thermic fluid to be used as a heat transfer medium, is being indirectly heated in a heater from 380 K to 550 K. Calculate the heat load on the heater in kW.
Given $C_p = 1{\cdot}436 + 0{\cdot}00218T$. 2 + 5 + 3

6. (*a*) Write down the basic relation for heat flow by conduction and explain the meaning of the terms involved.

(*b*) For heat flow through a hollow cylinder arrive at the expression

$$q = \frac{k\,\bar{A}_L\,(T_i - T_0)}{r_0 - r_i}$$

where the notations have their usual meanings.

(*c*) A layer of pulverised cork 6 in thick is used as a layer of thermal insulation in a flat wall. The temperature of the cold side of the cork is 40 °F and that of the warm side is 180 °F.

The thermal conductivity of the cork at 32 °F is 0·021 Btu/ft.h. °F and that at 200 °F is 0·032. The area of the wall is 25 ft². What is the rate of heat flow through the wall in Btu per hour? 2 + 4 + 4

7. (*a*) Name four nitrating agents used for technical nitration and show how active nitrating species are formed in the reaction medium using the nitrating agents mentioned above.

(*b*) Define the terms D.V.S and nitric ratio.

(*c*) Glycerine containing 1 percent moisture is nitrated with a mixed acid having the following composition

Actual H_2SO_4 .... 49·90%
Actual HNO_3 .... 52·38%
H_2O .... -2·40%

Assuming the value of nitric ratio to be 2·30 calculate the D.V.S. for this nitration.

(*d*) Explain how D.V.S controls the stability of nitrator charge. 1 + 1 + 5 + 3

8. Write short notes on any *two* of the following : 5 x 2

(*i*) Hydrogenation

(*ii*) Black body radiation

(*iii*) Dressing of ore

(*iv*) Benificiation of ore.