PG/IS/CEM-104/13

M.Sc. 1st Semester Examination, 2013

CHEMISTRY

PAPER—CEM - 104

Full Marks : 40

Time : 2 hours

Answer any **five** questions

The figures in the right-hand margin indicate marks

1. (*a*) What is an ideal fluid ? State with reason whether Newtonian fluid is an ideal fluid or not. 2

   (*b*) Graphically illustrate shear stress-rate of shear profiles for the following fluids mentioning respective mathematical expressions : Bingham plastic, Pseudoplastic and Dilatant. Provide examples in each case. 2 + 2 + 2

2. (*a*) Explain the concept of Boundary layer in

fluid flow. For a Newtonian fluid with Reynold's number 1523, the boundary layer exists all through the conduit—Explain the statement. 3 + 2

(*b*) State the importance of momentum balance in fluid flow. Why a momentum correction factor is necessary for the momentum balance ? 2 + 1

3. (*a*) State Bernoulli's equation for fluid flow for frictional loss and the pump work and explain each term. 2

(*b*) For a Newtonian fluid derive the shear stress distribution function when the fluid flows inside a cylindrical tube. Also derive an expression for the local velocity at the central part of the tube. 3 + 3

4. The wall of a cold storage consists of three layers - an outer layer of ordinary bricks, 25 cm thick, a middle layer of cork, 10 cm thick and an inner layer of cement, 6 cm thick. The thermal

conductivities of the materials are - brick : 0·7, cork : 0·043 and cement : 0·72 W/m °C. The temperature of the outer surface of the wall is 30°C and that of the inner is −15°C. Calculate (*a*) the steady state rate of heat gain per unit area of the wall (*b*) the temperatures at the interfaces of the composite wall (*c*) the percentages of the total heat transfer resistance offered by the individual layers. What additional thickness of cork should be provided to make the rate of heat transfer 30 % less than the present value ? 8

5. (*a*) Derive an expression for the overall heat transfer coefficient between fluids separated by a solid wall. 4

(*b*) The steady state temperature distribution in a 0·2 m thick wall is known to be $T = 250 - 2750\,x^2$ where x is the position in the wall in meter and T is in °C. The thermal conductivity of the material of the wall is 1·163 W/m °C. The wall loses heat to an ambient at 30°C. (*i*) Calculate the heat

transfer coefficient at the surface of the wall at $x = 0{\cdot}2$ m (*ii*) What can be said about the same at the other surface of the wall ? 4

6. (*a*) Derive the heat transfer equation for steady state heat transfer through a cylinder. 6

(*b*) State the significance of log-mean surface area. 2

7. (*a*) State Stefan-Boltzman law for heat radiation. 2

(*b*) Define black body and gray body. 2

(*c*) Distinguish between natural convection and forced convection. 2

(*d*) What are the forces responsible for fluid motion in natural convection ? 2

8. (*a*) A close vessel contains a mixture of 40 % NO_2 and 60 % N_2O_4 at a temperature of 38 °C and a pressure of 3990 mm Hg. When the temperature is increased to 60 °C, some

of N_2O_4 dissociates to NO_2 and a pressure raises to 5100 mm Hg. Calculate the composition of gases at 60 °C. 5

(*b*) 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 650 K. Calculate the heat load on the heater in kW. The heat capacity of the thermic fluid is

$C_p = (1{\cdot}436 + 0{\cdot}00218T)$ kJ/kgK and T is in K. 3

9. (*a*) "Hydrotreating used to eliminate undesirable characteristics in the feed" explain. 4

(*b*) What is the purpose of hydrogenation of fats ? 2

(*c*) Write the catalyst and operating condition used for

(*i*) the selective hydrogenation of acetylene in the purification of ethylene.

(*ii*) Hydrotreating of gasoline. 2

10. (*a*) Write a note on the concentration of ore using physical methods. 4

(*b*) Write the principles of magnetic separator. 4