Total number of printed pages – 6 **B. Tech**

CPCH 7406

Eighth Semester Examination – 2008

TRANSPORT PHENOMENA

Full Marks – 70

Time : 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2×10

   (a) Compare Newton's law of viscosity with Hooke's law of elasticity.

   (b) How does the viscosity vary with temperature and pressure for

      (i) Dilute gases

      (ii) Liquids.

   (c) What is the range of applicability of Stokes's law ?

   (d) What precautions have to be taken in using formulas with friction factors taken from reference books and original sources ?

   (e) Compare Fourier's law of heat conduction with Newton's law of viscosity.

   (f) Would you expect wood to have the same thermal conductivity in all three directions ?

   (g) What is the momentum-transport analog of a heat source ?

   (h) What is diffusion ? What factors may cause diffusion to occur ?

   (i) When is mass fraction equal to mole fraction ?

   (j) Compare and contrast homogeneous and heterogeneous chemical reactions.

2. (a) Derive a relation that enables one to get the viscosity of a fluid by measuring the steady-state rate of fall of a sphere in the fluid. 5

(b) One method of determining the radius of a capillary tube is to measure the rate of flow of a viscous fluid through the tube. Find the radius of a capillary from the following flow data :

Length of capillary	$= 50.02$ cm
Kinematic viscosity of fluid	$= 4.03 \times 10^{-5}$ m^2 sec^{-1}
Density of fluid	$= 0.9552 \times 10^3$ kg m^{-3}
Pressure drop across (horizontal) capillary tube	$= 4.829 \times 10^5$ newtons m^{-2}
Mass rate of flow through tube	$= 2.997 \times 10^{-3}$ kg sec^{-1}

What is a major drawback to this method ? 5

3. Determine the velocity and shear stress distribution for the tangential laminar flow of an incompressible fluid between two vertical coaxial cylinders, the outer one of which is rotating with an angular velocity. End effects may be neglected. 10

4. Derive an equation for calculating the maximum temperature rise and average temperature for a system of heat conduction with an electrical heat source. 10

5. A steel pipe 25 mm inside diameter and 33 mm outside diameter and insulated with rockwool carries steam at 178 °C. If the surrounding air temperature is 21 °C, calculate the rate of heat loss from one meter length of pipe. The thickness of insulation is 38 mm. Thermal conductivity of steel

and rockwool are 10.74 and 0.0418 cal/sec-m °C respectively. The inside and outside heat transfer coefficients are 1356.17 and 2.7133 cal/sec m^2 °C respectively. Contact resistance between the pipe and insulation may be neglected. 10

6. Calculate the value of D_{AB} for mixtures of argon (A) and oxygen at 293.2 K and 1 atm total pressure. 10

Data given :

$\frac{\varepsilon_A}{k} = 124$ K; $\sigma_A = 3.418$ Å; $M_A = 39.944$

$\frac{\varepsilon_B}{k} = 113$ K; $\sigma_B = 3.433$ Å; $M_B = 32$

The value of $\Omega_{D,\,AB} = 1.003$ for a value of $kT/\varepsilon_{AB} = 2.47$.

7. Derive an equation for determining the flux of a liquid diffusion through a stagnant gas film. 10

8. Write short note on any *two* : 5 × 2

(a) Mechanism of mass transport

(b) Velocity distribution in turbulent flow

(c) Forced convection

(d) Science of rheology.

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