



RN-7321

B. E. - IV (Sem. VII) (Chemical) Examination
May / June - 2010
Transport Phenomena

Time : 3 Hours]

[Total Marks : 100

Instructions :

(1)

नीचे दर्शाविएल निशानीवाणी विगतो उत्तरवडी पर अवश्य लपनी. Fillup strictly the details of signs on your answer book.	Seat No. :
Name of the Examination :	<input type="text"/>
<input type="text" value="B. E. - 4 (Sem. 7) (Chemical)"/>	<input type="text"/>
Name of the Subject :	<input type="text"/>
<input type="text" value="Transport Phenomena"/>	<input type="text"/>
Subject Code No. : <input type="text" value="7"/> <input type="text" value="3"/> <input type="text" value="2"/> <input type="text" value="1"/>	<input type="text"/>
Section No. (1, 2,.....) : <input type="text" value="1&2"/>	<input type="text"/>
	Student's Signature

- (2) Answers to each section must be written in **separate** answer books.
- (3) Figures to the right indicate full marks.
- (4) All the notations carry their usual meaning.
- (5) Make suitable assumptions wherever necessary and state them clearly.

SECTION - I

- 1 (a) Answer the following : 5×2=10
- (i) State the equation for determining viscosity of a pure monoatomic gas of molecular weight M and in terms of the Lennard-Jones parameters.
- (ii) Define thixotropic fluids with examples.
- (iii) Which of the following does not follow Newton's Law of viscosity?
- (a) Rubber Latex
- (b) Water
- (c) Coconut oil
- (d) Glycerol.
- (iv) Write the shell mass balance for any homogeneous chemical reaction.

(v) Write the equation for Ellis model explaining each term.

(b) Discuss the molecular theory of the viscosity of gases at low density. 8

2 Answer any **two** of the following : **8×2=16**

(i) Predict the viscosity of the following gas mixture at 1 atm. and 293°K from the given data on the pure components at 1 atm. and 293° K.

Species	Mole fraction x	Molecular Wt. M	Viscosity μ (g cm ⁻¹ sec ⁻¹)
1 CO ₂	0.133	44.01	1462 × 10 ⁻⁷
2 O ₂	0.039	32.00	2031 × 10 ⁻⁷
3 N ₂	0.828	28.01	1754 × 10 ⁻⁷

(ii) A viscous fluid is in laminar flow in a slit formed by two parallel walls a distance 2B apart. Make a differential momentum balance and obtain the expressions for the distributions of momentum flux and velocity.

$$\tau_{xz} = \left(\frac{\rho_O - \rho_L}{L} \right) x$$

$$v_z = \frac{(\rho_O - \rho_L) B^2}{2 \mu L} \left[1 - \left(\frac{x}{\beta} \right)^2 \right]$$

where $\rho = p + \rho gh = p - \rho gz$. What is the ratio of average to maximum velocity in the slit?

(iii) Derive the momentum flux distribution for Bingham flow in a circular tube, also derive velocity distribution profile and Buckingham-Reiner equation.

3 Any **two** of the following : **8×2=16**

(i) Classify two parameter and three parameter models and explain Bingham model and Reiner-Philippoff model in detail.

(ii) Derive the velocity distribution profiles for adjacent flow of two immiscible fluids.

(iii) Derive the equation of continuity and equation of mechanical energy in the rectangular coordinates for laminar flow.

SECTION - II

4 (a) Answer the following : 5×2=10

- (i) What is Lorenz number? Explain its importance.
- (ii) Give the expression for Nernst Einstein equation with its importance.
- (iii) Give the advantages of dimensional analysis of equation of changes.
- (iv) How the equation of energy for laminar flow can be modified to obtain similar equation for turbulent flow?
- (v) How will you use the equation of continuity and the equation of motion to solve the problems of viscous flow under isothermal conditions?

(b) An oil is acting as a lubricant for a pair of cylindrical surfaces, the angular velocity of the outer cylinder is 7908 RPM. The outer cylinder has a radius of 5.06 cm and the clearance between the cylinders is 0.027 cm. The inner cylinder is stationary. What is the maximum temperature in the oil if both walls are kept at 80° C ?

$$\mu = 135 \text{ cp}, \quad \rho = 1.20 \text{ kg/lit}$$

$$K = 0.0055 \text{ Cal/sec cm}^\circ\text{C}$$

5 Answer any two : 8×2=16

- (i) Derive the equation for continuity which describes the concentration profile for binary diffusing system of two components A and B. Consider density and diffusivity of A and B constant.
- (ii) Calculate the heat loss from a rectangular fin attached to a hot wall in atmospheric air for following given conditions :

Air temperature 170°C

Wall temperature 260°C

Length of the Fin 10 cm

Width of the Fin 30 cm

Thickness of the Fin 0.5 cm

Heat transfer coefficient 2400 kJ/m² hr °C

Thermal conductivity of fin 360 kJ/m hr °C

- (iii) Derive the equation for velocity profile for laminar free convection flow between two vertical plates at two different temperatures.

6 Answer any two : 7×2=14

- (i) Derive the equation for concentration profile for the case of gas absorption with chemical reaction in an agitated vessel. Gas A reacts with liquid B contained in vessel. A undergoes an irreversible first order chemical reaction $A + B \rightarrow AB$.
- (ii) What is the evaporation rate for chloropicrin in air, considering chloropicrin in a long vertical tube at 25°C.

Data :

Total pressure	790 mm Hg
Diffusivity	0.088 cm ² /sec
Vapour pressure	23.8 mm Hg
Distance from liquid level to top of tube	12.14 cm
Density of chloropicrin	1650 kg/m ³
Surface area of liquid exposed for evaporation	3.29 cm ²

- (iii) Consider a catalytic reactor in which the demerization reaction $2A \rightarrow A_2$ is being carried out. The reactor is fixed bed horizontal reactor containing spherical catalyst pellets. Derive the equation for local rate of demerization per unit area of catalyst surface.