7/12/2024 CHEMICAL SEM-V C SCHEME TP QP CODE: 10066627

Time: 3 Hours **Marks: 80**

N. B.: **(1) Question No. 1 is compulsory.**
(2) Attempt any three questions from remaining five questions.
(3) Assume suitable data if necessary.

Q. 1 Answer any four questions **(20)**

a) Estimate the viscosity of N_2 at 50^0C and 854 atm, given M = 28 gm/gmole, Pc = 33.5 atm, and Tc = 126.2 K Write the different equations for determination of viscosity.

b) Derive Newton's law of viscosity.

c) Write Fick's law of diffusion in three dimensional forms.

d) Explain the analogy between momentum transfer and heat transfer.

e) What is thermal conductivity and thermal diffusivity?

Q. 2

a) Derive an equation of continuity for an isothermal system. **(10)**

b) Derive an expression for flow of Newtonian fluid over an inclined plate. **(10)**

Q. 3

a) The distance between two parallel plates is 0.00914 m and the lower plate is being pulled at a constant velocity 0.366 m/s faster relative to the top plate. The fluid filled between the plates is glycerol at 293 K having a viscosity 1.069 Kg/m·s. Calculate the shear stress and the shear rate. **(10)**

b) Heavy oil is passed through a pipe of 5.08×10^{-2} m diameter. The pressure drop over the pipe is 68.958 KN/m^2. The viscosity of oil is 200 Cp and density is 800 kg/m^3. The length of the pipe is 3.048 m.

i) Calculate the volumetric flow rate of oil in lit/min.

ii) Calculate and plot momentum flux profile across the pipe. **(10)**

Q. 4

a) A copper wire 10 mm diameter and 4.6 m long have a voltage drop of 0.6 volts, find the maximum temperature in the wire if the ambient air temperature is 298.15 K and the heat transfer coefficient h is 32.37 W/m^2 K

Lorenz constant for copper = 223×10^{-8} volt^2/K^2

Thermal conductivity of copper at 298.15 K = 384.1 W/m K **(10)**

(b) For an electrically heated cylindrical wire, show that the temperature distribution is

$$T - T_0 = \frac{S_e R^2}{4K}\left[1-\left(\frac{r}{R}\right)^2\right] \quad \text{And} \quad T_{max} - T_0 = \frac{S_e R^2}{4K}$$ **(10)**

Q. 5

a) A value of D_{AB} = 0.151 cm^2/sec has been found for the system CO_2-Air at 293K and 1atm. Calculate D_{AB} at 1500K by the following methods.

a) Slattery Equations, b) Chapman Enskog Equation

Data: For non-polar gas pairs, b=1.823, $(\Omega_{DAB})_{1500K} = 0.734$, $(\Omega_{DAB})_{293K} = 1.047$ **(10)**

b) Derive an expression for diffusion through stagnant gas film. **(10)**

Q. 6

(a) Derive an expression for flow through the circular tube. **(10)**

(b) Write

i) General momentum balance equation,

ii) General procedure for setting up and solving viscous flow problems, and

iii) Boundary conditions. **(10)**

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