

On oil of viscosity 10 poise flows between two parallel fixed plates which are kept at a distance of 50 mm apart. Find the rate of flow of oil b/w the plates if the drop of pressure in a length of 1.2 m be  $0.3 \text{ N/cm}^2$ . The width of plate is 200 mm

Soln: Given that

$$\mu = 10 \text{ poise}$$

$$= \frac{10}{10} \text{ Ns/m}^2 = 1 \text{ Ns/m}^2$$

$$d = 50 \text{ mm} = 0.05 \text{ m}$$

$$P_1 - P_2 = 0.3 \text{ N/m}^2 = 0.3 \times 10^4 \text{ N/m}^2$$

$$L = 1.20 \text{ m}$$

$$B = 200 \text{ mm} = 0.20 \text{ m}$$

Find Q, rate of flow

$$\text{Pressure difference } P_1 - P_2 = \frac{12 \mu \bar{u} L}{d^2}$$

$$0.3 \times 10^4 = \frac{12 \times 1 \times \bar{u} \times 1.20}{0.05 \times 0.05}$$

$$\bar{u} = \frac{0.3 \times 10^4 \times 1 \times 0.05 \times 0.05}{12 \times 1.20} = 0.52 \text{ m/sec}$$

$$\text{Rate of flow} = \bar{u} \times \text{Area}$$

$$= 0.52 \times 0.20 \times 0.05$$

$$= 0.0052 \text{ m}^3/\text{sec}$$

$$= 0.0052 \times 10^3 \text{ lit/sec}$$

$$= 5.2 \text{ lit/sec} \quad \underline{\underline{Ans}}$$

Q Calculation. (i) the pressure gradient along flow  
 (ii) the avg velocity and (iii) discharge for an oil of viscosity  
 $0.02 \text{ NS/m}^2$  flowing b/w two stationary parallel plate  
 1m wide maintained 10mm apart. the velocity midway  
 b/w the plate is 2m/s

Sol Given that

Viscosity  $\mu = 0.02 \text{ NS/m}^2$

width  $b = 1 \text{ m}$

Distance b/w plate  $t = 10 \text{ mm} = 0.01 \text{ m}$

Velocity midway b/w the plate  $U_{\text{man}} = 2 \text{ m/s}$

(i) Pressure gradient  $\left(\frac{dP}{dx}\right)$

$$U_{\text{man}} = -\frac{1}{8\mu} \cdot \frac{dP}{dx} t^2$$

$$2 = -\frac{1}{8 \times 0.02} \left(\frac{dP}{dx}\right) (0.01)^2$$

$$\frac{dP}{dx} = \frac{2 \times 8 \times 0.02}{0.01 \times 0.01} = -3200 \text{ N/m}^2 \text{ per m } \underline{\underline{\text{Ans}}}$$

(ii) Average velocity ( $\bar{u}$ ).

$$\frac{U_{\text{man}}}{\bar{u}} = \frac{3}{2}$$

$$\bar{u} = \frac{2U_{\text{man}}}{3} = \frac{2 \times 2}{3} = 1.33 \text{ m/sec}$$

(iii) Discharge (Q) = Area of flow  $\times \bar{u}$   
 $= b \times t \times \bar{u} = 1 \times 0.01 \times 1.33 \text{ m}^3/\text{sec}$   
 $= 0.0133 \text{ m}^3/\text{sec}$

Q Determine (i) the Pressure gradient (ii) the Shear Stress at the two horizontal Parallel plate and (iii) the discharge per meter width for the lamina flow of oil with a maximum velocity of 2 m/s b/w two horizontal Parallel fixed plate which are 100 mm apart Given  $\mu = 2.4525 \text{ N/m}^2$

Soln

$$U_{\text{max}} = 2 \text{ m/s}, t = 100 \text{ mm} = 0.1 \text{ m}, \mu = 2.4525 \text{ N/m}^2$$

Find (i) Pressure gradient,  $\frac{dp}{dx}$

(ii) Shear Stress at the wall,  $\tau_0$

(iii) Discharge per meter width,  $Q$

(i) Pressure gradient  $\frac{dp}{dx}$

$$\text{Maximum velocity } U_{\text{max}} \text{ is } U_{\text{max}} = -\frac{t}{8\mu} \cdot \frac{dp}{dx} t^2$$

$$2 = -\frac{t}{8 \times 2.4525} \times \frac{dp}{dx} \times (0.1)^2$$

$$\frac{dp}{dx} = \frac{-2 \times 8 \times 2.4525}{0.1 \times 0.1} = -3924 \text{ N/m}^2 \text{ per m}$$

(ii) Shear Stress at the wall  $\tau_0$

$$\tau_0 = -\frac{1}{2} \cdot \frac{dp}{dx} \times t = -\frac{1}{2} (-3924) \times 0.1 = 196.2 \text{ N/m}^2$$

~~(iii) Shear Stress at the wall  $\tau_0$~~

(iii) Discharge per meter width  $Q$

$$= \text{mean velocity} \times \text{Area}$$

$$= \frac{2}{3} U_{\text{max}} \times (t \times L)$$

$$= \frac{2}{3} \times 2 \times 0.1 \times 1 = 0.133 \text{ m}^3/\text{Sec}$$