Q. Water at 15°C flows b/w two large parallel plates at a distance of 1.6 mm apart determine (i) the maximum velocity (ii) the pressure drop per unit length and (iii) the shear stress at the walls of the plate if the avg velocity is 0.2 m/s. the viscosity of water at 15°C is given as 0.01 Poise

Solution Given that

$$t = 1.6 \text{ mm} = 1.6 \times 10^{-3} \text{ m}$$

$$= 0.0016 \text{ m}$$

$$\bar{u} = 0.2 \text{ m/sec} = \text{~~0~~}$$

(i) Maximum velocity $U_{max} = \frac{3}{2}\bar{u} = 1.5 \times 0.2 = 0.3 \text{ m/sec}$

(ii) the pressure drop $(P_1 - P_2) = \frac{12\mu\bar{u}L}{t^2}$

Pressure drop per unit length $= \frac{12\mu\bar{u}}{t^2}$

$$\frac{\partial p}{\partial x} = 12 \times \frac{0.1}{10} \times \frac{0.2}{(0.0016)^2} = 937.44 \text{ N/m}^2\text{/m} = 937.44 \text{ N/m}^3$$

(iii) Shear stress at the wall

$$\tau_0 = -\frac{1}{2}\frac{\partial p}{\partial x} \times t$$

$$= \frac{1}{2} \times 937.44 \times 0.0016$$

$$\boxed{\tau_0 = 0.749 \text{ N/m}^2}$$

Q There is a horizontal crack 40 mm wide and 2.5 mm deep in a wall of thickness 100 mm water leak through the crack find the rate of leakage of water through crack if the difference of pressure b/w the two ends of the crack is 0.02943 N/cm², take viscosity of water equal to 0.01 poise

Sol Given that

Width of crack $b = 40\text{ mm} = 0.04\text{ m}$

Depth of crack $d = 2.5\text{ mm} = 0.0025\text{ m}$

Length of crack $L = 100\text{ mm} = 0.1\text{ m}$

$$P_1 - P_2 = 0.02943\ \text{N/cm}^2$$

$$= 0.02943 \times 10^4\ \text{N/m}^2$$

$$= 294.3\ \text{N/m}^2$$

$$\mu = 0.01\ \text{poise} = \frac{0.01\ \text{NS}}{10\ \text{m}^2}$$

$$(P_1 - P_2) = \frac{12 \mu \bar{u} L}{t^2}$$

$$294.3 = 12 \times \frac{0.01}{10} \times \frac{\bar{u} \times 0.1}{(0.0025 \times 0.0025)}$$

$$\bar{u} = \frac{294.3 \times 10 \times 0.0025 \times 0.0025}{12 \times 0.01 \times 0.1} = 1.5328\ \text{m/sec}$$

Rate of leakage $= \bar{u} \times$ Area of C.S. of crack

$$= 1.538 \times (b \times t)$$

$$= 1.538 \times 0.04 \times 0.0025\ \text{m}^3/\text{s}$$

$$= 1.538 \times 10^{-4} \times 10^3\ \text{lit/sec}$$

Rate of leakage = 0.1538 lit/sec

KINETIC ENERGY CORRECTION FACTOR →

it is a factor defined as the ratio of the kinetic energy of the flow per second based on actual velocity across a section to the kinetic energy of the flow per second based on average velocity across the same section.

it is denoted by α

$$\alpha = \frac{\text{K.E/sec based on actual velocity}}{\text{K.E/sec based on avg velocity}}$$

MOMENTUM ENERGY CORRECTION Factor →

it is a factor defined as the ratio of momentum of the flow per second based on actual velocity to the momentum of the flow per second based on avg velocity across a section.

it is denoted by β

$$\beta = \frac{\text{Momentum per second based on actual velocity}}{\text{Momentum per second based on avg velocity}}$$