Rate of Flow →

Quantity of liquid (fluid) flowing per second through a section of a pipe or a channel.

for incompressible fluid the rate of flow or discharge is expressed as the volume of fluid flowing across the section.

(i) Liquid → unit → m^3/s or lit/sec

(ii) gases → unit → kgf/s or Newton/s

* it is denoted by Q.

Consider a liquid is flowing across the section (pipe).

So, A = cross-section area of pipe
V = Avg velocity of fluid across section

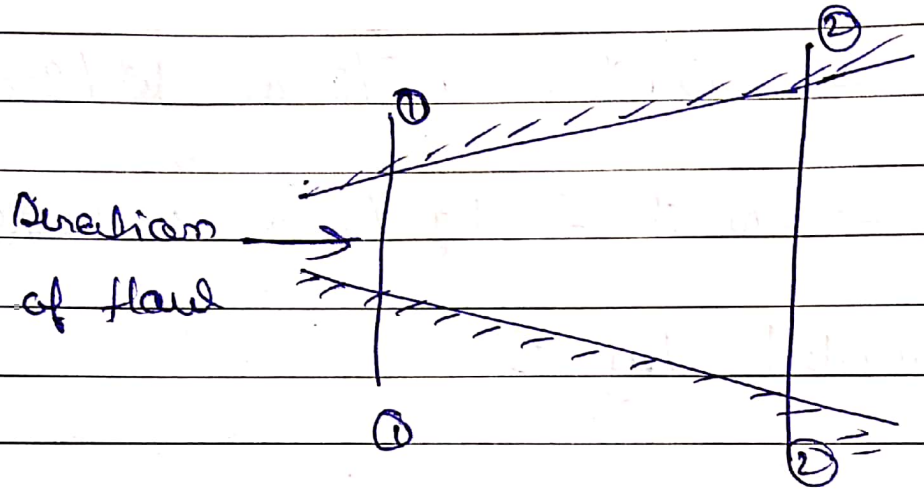
then $\boxed{Q = A \times V}$ m^3/sec or kgf/s

CONTINUITY EQUATION →

Equation based on Principle of Conservation of mass

↓ means

fluid flowing through the pipe at all the cross-section, the quantity of fluid per second is constant



Consider two section of a pipe in above fig (1-1) & (2-2)

Let V_1 = Avg. Velocity at Sec 1-1

ρ_1 = density at Sec 1-1

A_1 = Area of pipe 1-1

So

V_2, ρ_2, A_2 = Corresponding value at Section 2-2

Rate of flow at Section 1-1 = $\rho_1 A_1 V_2$

Rate of flow at Section 2-2 = $\rho_2 A_2 V_2$

ABC^{n} to law of conservation of mass

Rate of flow at Sec^{n} 1-1 = Rate of flow at Sec^{n} 2-2

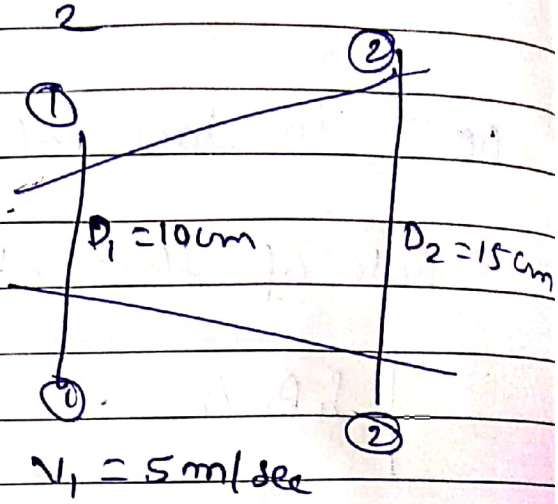
$$\rho_1 A_1 V_1 = \rho_2 A_2 V_2 \quad \text{— (1)}$$

eq^{n} (1) is applicable for Compressible or incompressible fluid

if the fluid is Compressible

$$A_1 V_1 = A_2 V_2$$

Q dia of pipe at section 1 and 2 are 10cm and 15 cm, find the discharge through the pipe, if the velocity of water flowing through the pipe at section 1 is 5m/s. Determine velocity at section 2



Sol

At section (1)

$D_1 = 10cm = 0.1m$

$A_1 = \frac{\pi}{4}(0.1)^2 = 0.007854 m^2$

$V_1 = 5 m/s$

section (2)

$D_2 = 15cm = 0.15m$

$A_2 = \frac{\pi}{4}(.15)^2 = 0.01767 m^2$

Apply Continuity eqn

$A_1 V_1 = A_2 V_2$

$0.007854 \times 5 = 0.01767 \times V_2$

$\boxed{V_2 = 2.22}$ m/sec