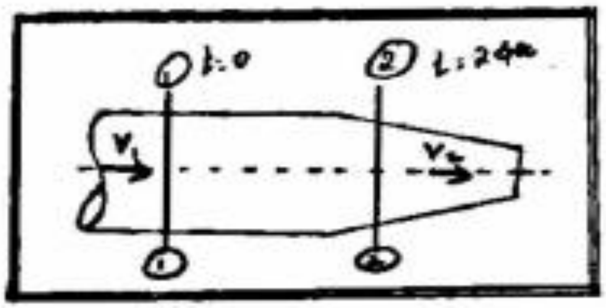
Momentum Equation :



Fig

⇒ Momentum equation is based on Newton's 2nd law of motion. According to the Newton's 2nd law of motion, the force applied on the body is equal to the rate of change of momentum in the direction of force.

⇒ We know that, Mathematically,

$$\text{Momentum} = M \times V$$

where M = Mass of the fluid
V = Velocity of the fluid

The rate of change of momentum $= \frac{d}{dt}(MV)$

According to 2nd Law:

The force acting on fluid $F = \frac{d}{dt}(MV)$

Mass of fluid M = Constant

$$F = M\frac{dV}{dt} \quad \rightarrow (1)$$

$$F = M \frac{(\text{final velocity} - \text{initial velocity})}{\text{Time taken}}$$

$$= M \frac{(V_2 - V_1)}{t} = \frac{M}{t}(V_2 - V_1) = m \Delta V \rightarrow (2)$$

where, m = mass flow rate = $\frac{M}{t}$ kg/s

= ρQ (Continuity equation)

ΔV = Change of velocity of the fluid.

$$F = \rho Q \cdot \Delta V \rightarrow (3)$$

From equ (2), we obtain

$$\boxed{F \cdot dt = M \cdot dv} \rightarrow (4)$$

> Equ (3) is known as the momentum principle & it expresses that the rate of change in linear momentum of flow in any direction is equal to the net force acting on the fluid mass in that direction. It is known as momentum equation.

$$F \cdot dt = M \cdot dv$$

> L.H.S of equ (4) represents impulse of force [F acting over a short period of time (dt)] & R.H.S gives the change in momentum in the direction of force & hence it is known as "Impulse - momentum equation".