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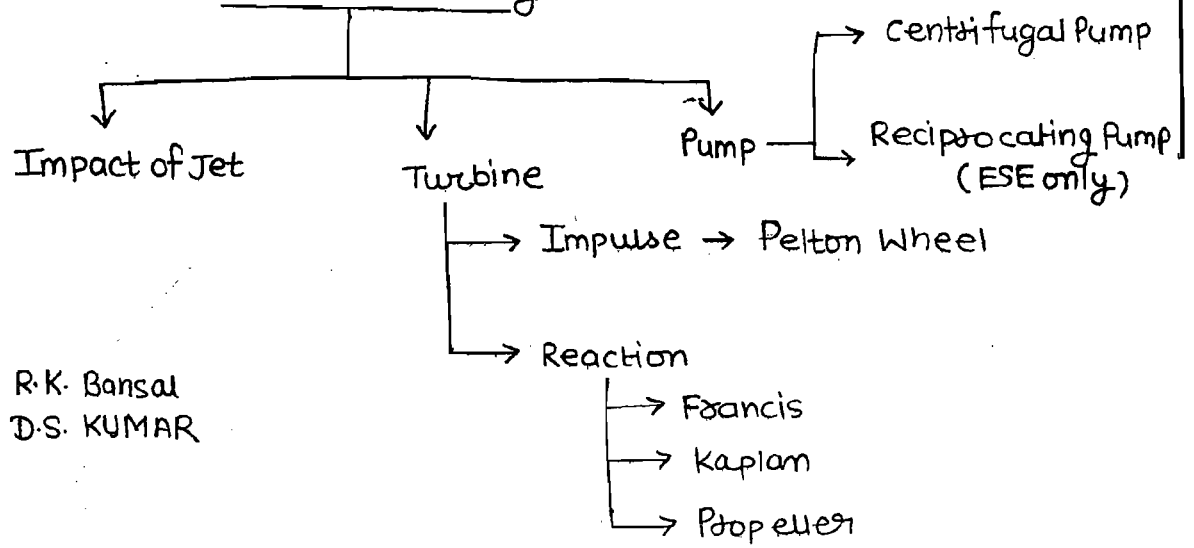
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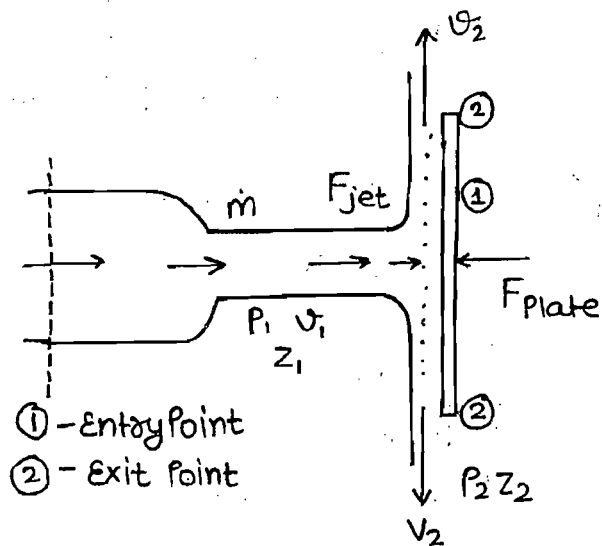
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Fluid Machinery



Book:- R.K. Bansal
D.S. KUMAR

Impact of Jet : →



Newton's II Law

$F_{\text{Plate}} = \text{Rate of change in Linear Momentum of jet}$

$F_{\text{Plate}} = (\text{Final} - \text{Initial}) \text{ momentum of water}$

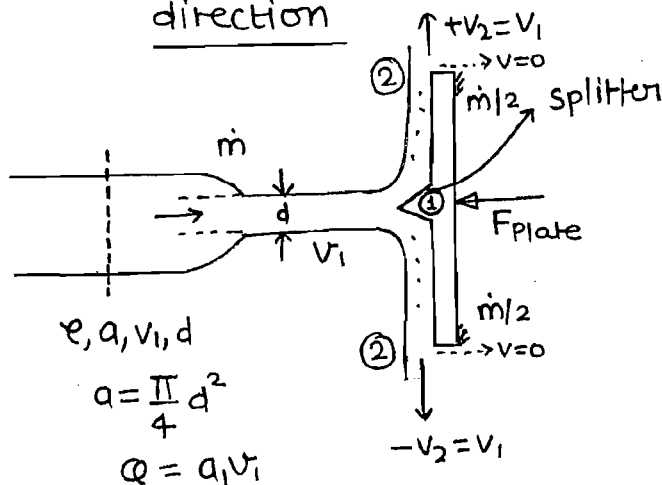
$$F_{\text{jet}} = -F_{\text{plate}} = \dot{m}\vec{V}_1 - \dot{m}\vec{V}_2$$

\dot{m} = mass flow rate of water which strikes the plate/body.

Water → Reaction force
Plate → Initial force

Case: I

Jet strikes Stationary flat Plate in Normal direction



$$P_1 = P_2 = P_{\text{atm}} \\ z_1 = z_2$$

$$\rightarrow F_x = F_N = \dot{m} V_1 \\ = \rho a V_1^2 N$$

$$\rightarrow F_y = F_T = \dot{m} \times 0 - \left[\frac{\dot{m}}{2} \times V_2 + \frac{\dot{m}}{2} (-V_2) \right]$$

$$F_y = F_T = 0$$

- Smooth Plate ($V_2 = V_1$)
- Rough Plate ($V_2 < V_1$)

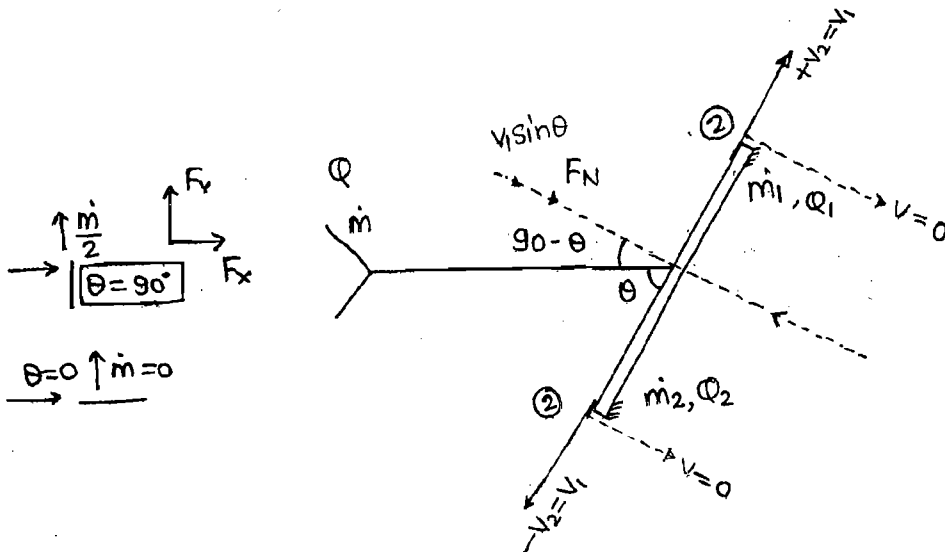
$$\dot{m} = \rho a V_1 = \rho Q$$

$$\rightarrow F_x = F_N = \dot{m} V_1 - \left[\frac{\dot{m}}{2} \times 0 + \frac{\dot{m}}{2} \times 0 \right]$$

NOTE → When Jet strikes over a ^{Flat} Plate then it will apply the force only in Normal direction to Plate, there will not be any force in tangential direction to Plate.

case: II

Jet Strikes stationary Inclined Plate



$$\dot{m} = \dot{m}_1 + \dot{m}_2 \Rightarrow \boxed{\Omega = \Omega_1 + \Omega_2} \rightarrow (I)$$

$$\boxed{\dot{m} = \rho a V_1 = \rho \Omega}$$

$$F_N = \dot{m} V_1 \sin \theta = [\dot{m}_1 x_0 + \dot{m}_2 x_0]$$

$$F_N = \dot{m} V_1 \sin \theta = \rho a V_1^2 \sin \theta$$

$$F_x = F_N \sin \theta = \rho a V_1^2 \sin^2 \theta$$

$$F_y = F_N \cos \theta = \rho a V_1^2 \sin \theta \cdot \cos \theta$$

$$\dot{m}_1, \dot{m}_2 / \Omega_1, \Omega_2 = ?$$

$$\therefore \boxed{F_T = 0}$$

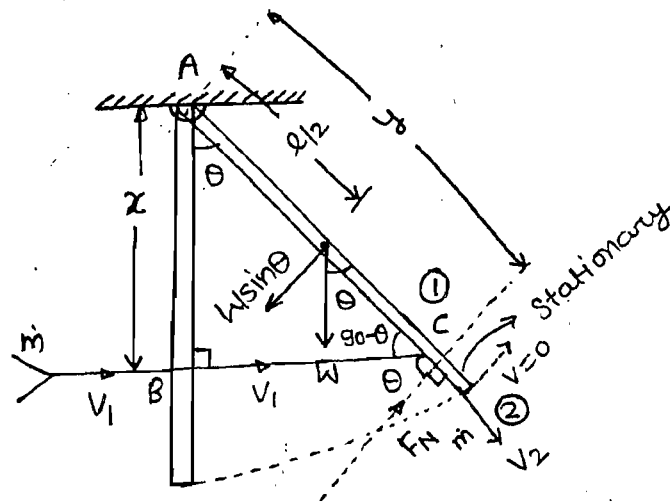
$$\rightarrow \dot{m} V_1 \cos \theta - (\dot{m}_1 x V_1 + \dot{m}_2 x (-V_1)) = 0$$

$$\Omega \cos \theta - \Omega_1 + \Omega_2 = 0 \rightarrow (II)$$

$$\Omega = \Omega_1 + \Omega_2 \rightarrow (I)$$

Case-III

Jet Strikes Vertical Hanging Plate



l = length of Plate

W = Weight of Plate = Mg

$$\rightarrow \sum M_A = 0$$

$$\rightarrow F_y \cdot y = W \sin \theta \cdot \frac{l}{2}$$

$$\rightarrow \dot{m} = \rho a v_1$$

$$\rightarrow F_N = \dot{m} v_1 \cos \theta - \dot{m} \times 0$$

$$\boxed{F_N = \rho a v_1^2 \cos \theta} \quad (\text{Newton})$$

ΔABC

$$\cos \theta = \frac{x}{y} \Rightarrow y = \frac{x}{\cos \theta}$$

$$\frac{\rho a v_1^2 \cos \theta \cdot \frac{x}{\cos \theta}}{\cos \theta} = W \sin \theta \cdot \frac{l}{2}$$

$$\boxed{\sin \theta = \frac{2 \rho a v_1^2 \cdot x}{W l}}$$