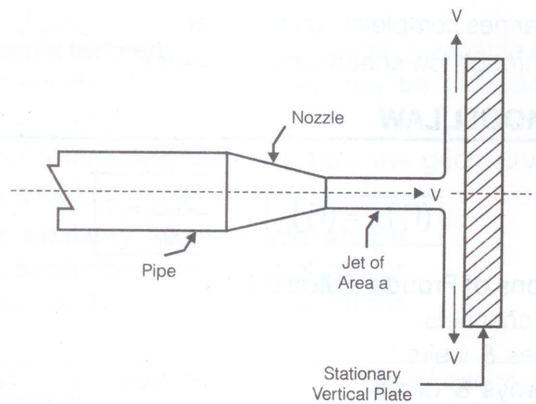
13. IMPACT OF JETS

Impact of jet means the force exerted by a jet on a plate which may be stationary or moving. This force is obtained from ***impulse-momentum*** equation.

FORCE EXTERTED BY JET ON A STATIONARY PLATE

- **Plate is vertical to the jet**

  Jet Strikes normal to the flat stationary plate.



Force exerted by the jet normal to the plate

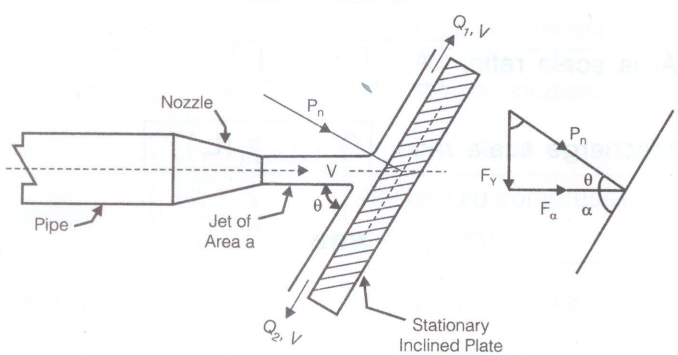
$P_n = \rho a V^2$

a = area of jet

V = velocity of jet

- **Plate is inclined to the jet**

  Jet strikes on an inclined stationary plate.



Force exerted by the jet normal to the plate

$$P_n = \rho a V^2 . \sin\theta \qquad Q_1 = \frac{Q}{2}(1+\cos\theta)$$

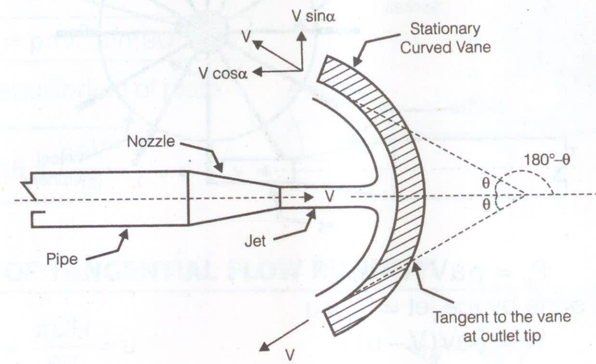
$$Q_2 = \frac{Q}{2}(1-\cos\theta) \qquad \frac{Q_1}{Q_2} = \frac{1+\cos\theta}{1-\cos\theta}$$

$$P_x = \rho a V^2 \sin^2\theta$$

$$P_y = \rho a V^2 \sin\theta \cos\theta$$

- **Plate is curved**

  Jet striking on a symmetrical stationary curved plate



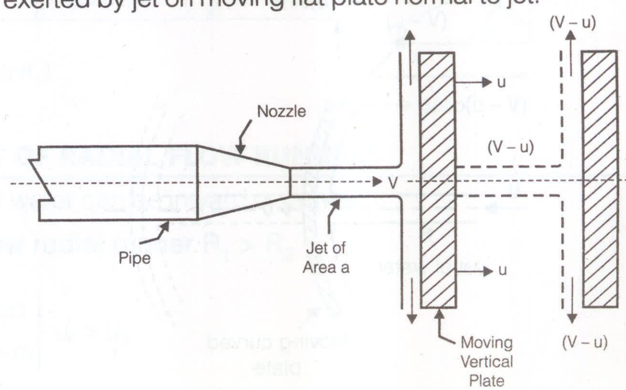
$$P_n = \rho a V^2 (1+\cos\theta)$$

- Force exerted by a jet in its direction of flow on a curved vane is ***always greater*** than that exerted on a flat plate.
- Angle of deflection = (180 – θ°)

FORCE EXERTED BY JET ON A MOVING PLATE

- **Plate is vertical to the jet**

  Force exerted by jet on moving flat plate normal to jet.



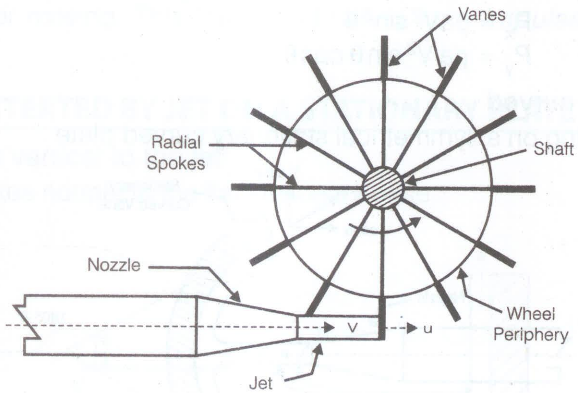
u = plate velocity

$$P_n = \rho a(V-u)^2$$

Work done per second (W) $= P_n \times u = \rho a[V-u]^2 \times u$

- **Plate mounted on the periphery of wheel**

  Jet strikes on series of flat plat mounted on the periphery of wheel.



$$P_n = \rho aV(V-u)$$

Work done by the jet $= P_n \times u$

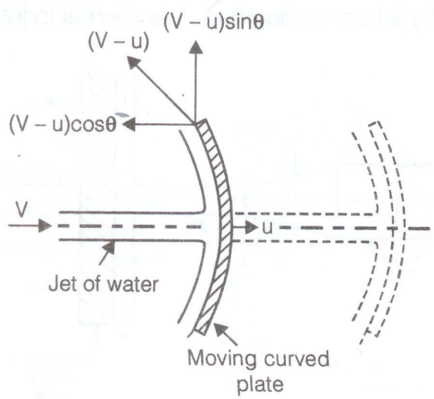
$$W = \rho aV(V-u)u$$

Efficiency of the work done of wheel $\eta = \dfrac{2u(V-u)}{V^2}$

When peripheral velocity will be half of the velocity of jet i.e.

$u = \dfrac{V}{2}$ then efficiency will be maximum i.e. η_{max} = 50%

- **Curve plate when the plate is moving in the direction of jet**



Force exterted by the jet of water on the curved plate in the direction of the jet.

$$P = \rho a(V-u)^2(1+\cos\theta)$$

Work done by the jet on the plate per second

$$W = \rho a(V-u)^2 \times u[1+\cos\theta]$$

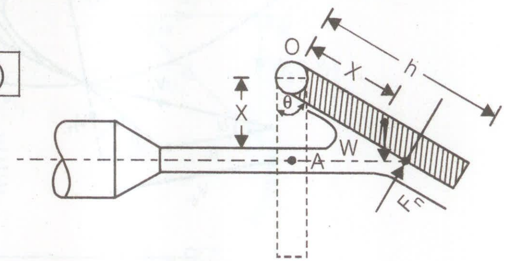
FORCE EXERTED BY A JET ON A HINGED PLATE

- Force due to jet of water, normal to the plate

$$P_n = \rho aV^2 \sin(90° - \theta)$$

- For equilibrium of plate

$$\sin\theta = \frac{\rho aV^2}{W}$$



CONCEPT OF TANGENTIAL FLOW RUNNERS

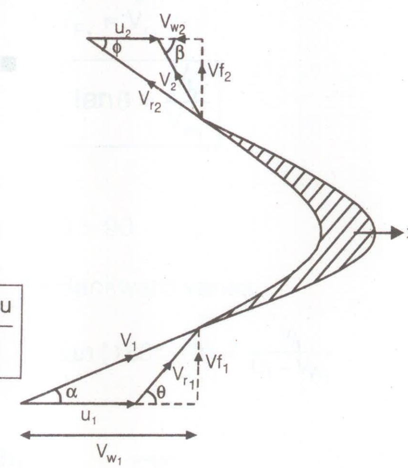
$$u_1 = u_2 = \frac{\pi DN}{60} = u$$

$$P = \dot{m}\left(V_{w_1} + V_{w_2}\right)u$$

$$\eta = \frac{\text{Power obtained}}{\text{Power provided}}$$

$$\eta_{system} = \frac{P}{\frac{1}{2}\dot{m}_{nozzle}V_1^2} = \frac{\dot{m}\left(V_{w_1}+V_{w_2}\right)u}{\frac{1}{2}(\rho av_1)V_1^2}$$

$(\dot{m} = \rho avr_1)$

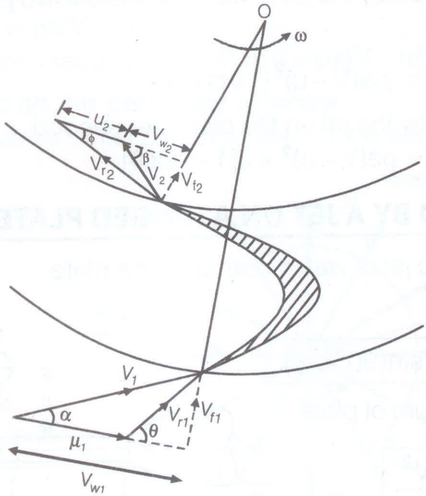


CONCEPT OF RADIAL FLOW RUNNERS

Flow of water can be inward or outward.

Inward flow radial runner $R_1 > R_2$

$$\left.\begin{aligned} u_1 &= R_1\omega \\ u_2 &= R_2\omega \end{aligned}\right\} u_1 > u_2$$



$$\boxed{\dot{w} = m\left(V_{w_1}u_1 + V_{w_2}u_2\right)}$$

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