ANJUMAN-I-ISLAMS
KALSEKAR TECHNICAL CAMPUS
(AIKTC)

Course: Applied Hydraulics (CE-C503)

Prof. Suhail Ahmad

COURSE OUTECOME:

Analyze the force exerted on different types of vanes and blades

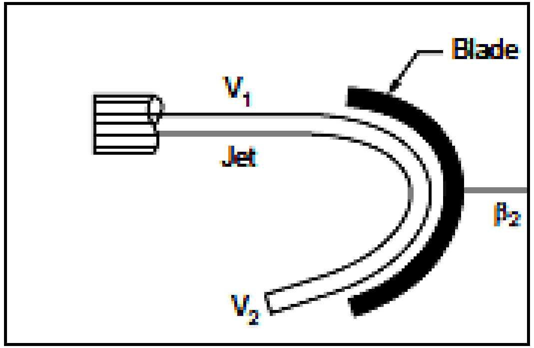
MODULE NO-03

IMPACT OF JET

INTRODUCTION

Jet refers to a stream of fluid emerging from a nozzle

The force is exerted by jet on solid body which is obtained from the **Newton's second law of motion or impulse-momentum principle.**



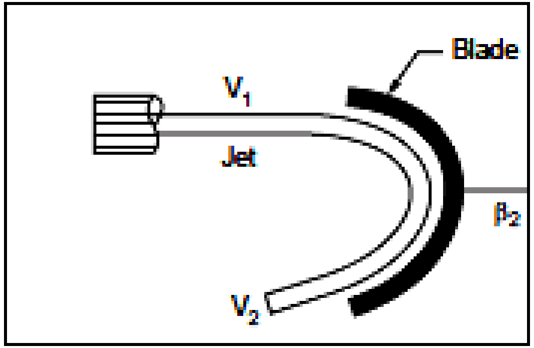
According to impulse-momentum principle, state of rest or uniform motion of a body changes in the direction of an externally applied force, and that the magnitude of the force equals to the rate of change of momentum

INTRODUCTION

$$F = \frac{d}{dt}(mv) = m\frac{dv}{dt} + v\frac{dm}{dt}$$

For constant mass dm = 0. change in momentum may occurs due to a change in the magnitude of velocity or in its direction or due to both.

$$F = m\frac{dv}{dt} = \frac{m}{t}(v_2 - v_1)$$



According to Newton's third law of motion, action and reaction are equal and opposite, therefore, **the force exerted by fluid on the body is**

$$F = (\rho Q)(V_1 - V_2) = (\rho a V)(V_1 - V_2)$$

FORCE EXERTED BY THE JET ON A PLATE

Impact of Jets

The jet is a stream of liquid comes out from nozzle with a high velocity under constant pressure. When the jet impinges on plates or vanes, its momentum is changed and a hydrodynamic force is exerted. Vane is a flat or curved plate fixed to the rim of the wheel

1. **Force exerted by the jet on a stationary plate**
   a) Plate is vertical to the jet
   b) Plate is inclined to the jet
   c) Plate is curved
2. **Force exerted by the jet on a moving plate**
   a) Plate is vertical to the jet
   b) Plate is inclined to the jet
   c) Plate is curved

FORCE EXERTED BY THE JET ON A STATIONARY FLAT PLATE

Plate is vertical to the jet

$$F = ma = m\frac{da}{dt} = \frac{d}{dt}(momentum)$$

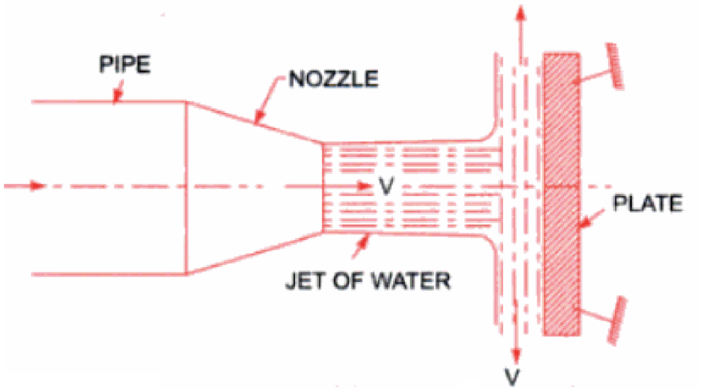
$$F = \frac{Initial\ momentum - Final\ momentum}{dt}$$

$$F = \frac{m}{dt}(V_1 - V_2)$$

$$F = \rho aV(V_1 - V_2) \qquad (\frac{m}{dt} = \bar{m} = \rho aV)$$

$$F = \rho aV(V - 0)$$

$$F = \rho aV^2$$



Force exerted by jet on vertical plate.

FORCE EXERTED BY THE JET ON A STATIONARY INCLINED FLAT PLATE

Plate is Inclined to the jet

$$F = \bar{m}\,(V_1 - V_2)$$

$$F = \rho a V (V_1 - V_2) \qquad (\bar{m} = \rho a V)$$

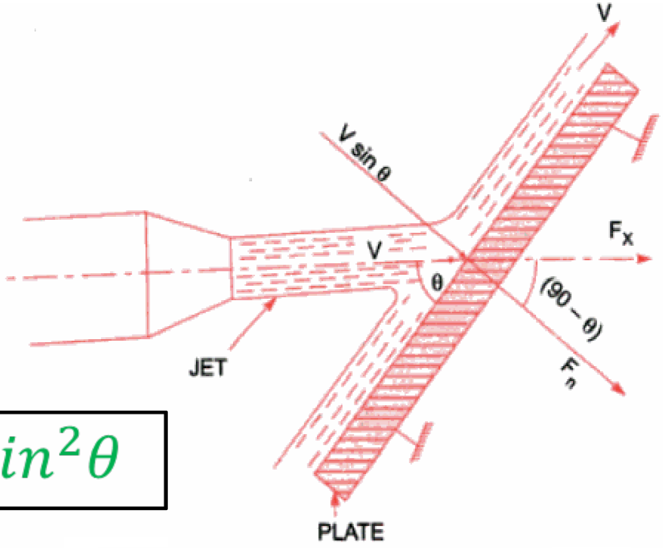
$$F_n = \rho a V (V Sin\theta - 0)$$

$$\boxed{F_n = \rho a V^2 Sin\theta}$$

$$F_X = F_n\, Sin\theta = \rho a V^2 Sin^2\theta \qquad \boxed{F_X = \rho a V^2 Sin^2\theta}$$

$$F_Y = F_n\, Cos\theta = \rho a V^2\, Sin\theta\, Cos\theta$$

$$\boxed{F_Y = \frac{\rho a V^2}{2}\, Sin2\theta} \qquad \boxed{F_Y = \rho a V^2\, Sin\theta\, Cos\theta}$$



Jet striking stationary inclined plate.

FORCE EXERTED BY THE JET ON A STATIONARY CURVED PLATE

Plate is Curved and jet impinges at Centre

$$F = \bar{m}\,(V_1 - V_2)$$

$$F = \rho a V (V_1 - V_2) \qquad (\bar{m} = \rho a V)$$

$$F_X = \rho a V[V - (-V Cos\theta)]$$

$$F_X = \rho a V[V(1 + Cos\theta)]$$

$$F_X = \rho a V^2(1 + Cos\theta)$$

$$F_Y = \rho a V[0 - (V Sin\theta)]$$

$$F_Y = -\rho a V^2 Sin\theta$$

$$F_X = \rho a V^2(1 + Cos\theta)$$

$$F_Y = -\rho a V^2 Sin\theta$$

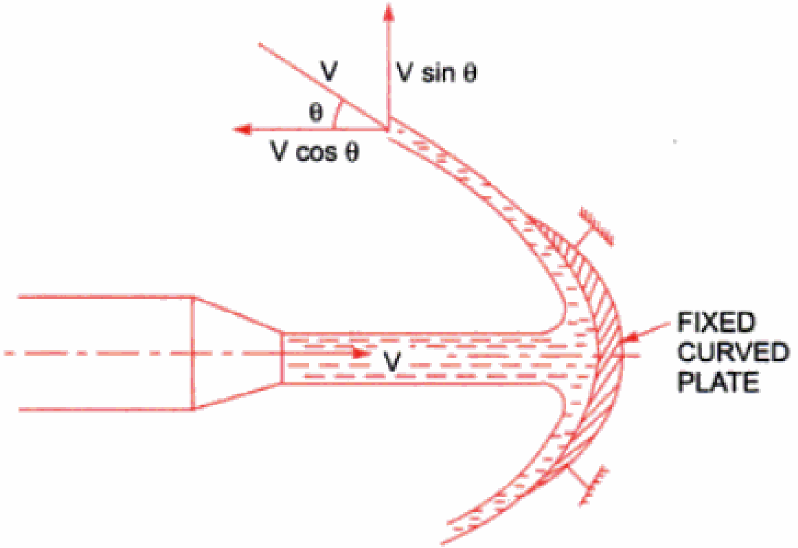


Fig. 17.3 *Jet striking a fixed curved plate at centre.*

FORCE EXERTED BY THE JET ON A STATIONARY CURVED PLATE TANGENTIALLY (SYMMETRICAL)

Plate is Curved and jet impinges at one end tangentially

$$F = \bar{m}(V_1 - V_2)$$

$$F = \rho a V(V_1 - V_2) \qquad (\bar{m} = \rho a V)$$

$$F_X = \rho a V[VCos\theta - (-VCos\theta)]$$

$$F_X = \rho a V[VCos\theta + VCos\theta)]$$

$$F_X = 2\rho a V^2 Cos\theta$$

$$F_X = 2\rho a V^2 Cos\theta$$

$$F_Y = \rho a V[VSin\theta - VSin\theta]$$

$$F_Y = 0$$

$$F_Y = 0$$

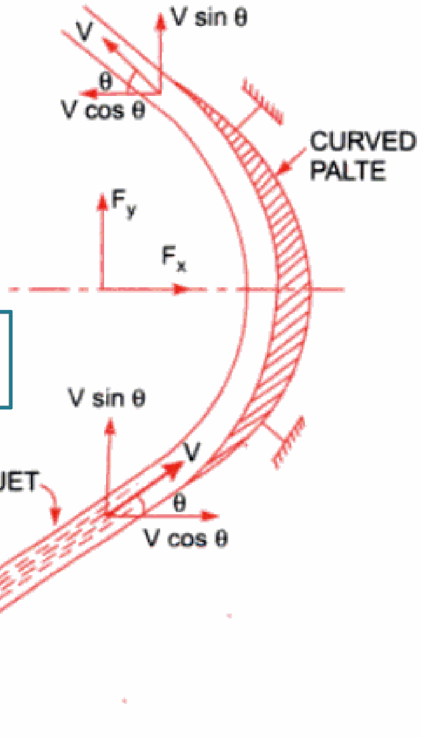


Fig. 17.4 *Jet striking curved fixed plate at one end.*

FORCE EXERTED BY THE JET ON A STATIONARY CURVED PLATE TANGENTIALLY (UNSYMMETRICAL)

Plate is Curved and jet impinges at One end and plate is unsymmetrical

$$F = \bar{m}\,(V_1 - V_2)$$

$$F = \rho a V (V_1 - V_2) \qquad (\bar{m} = \rho a V)$$

$$F_X = \rho a V[V Cos\theta - (-V Cos\emptyset)]$$

$$F_X = \rho a V[V Cos\theta + V Cos\emptyset)]$$

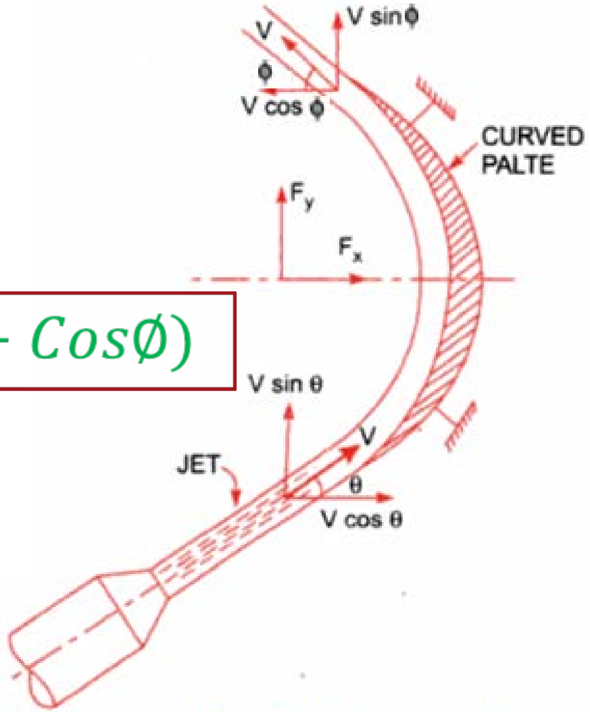
$$F_X = \rho a V^2 (Cos\theta + Cos\emptyset)$$

$$\boxed{F_X = \rho a V^2 (Cos\theta + Cos\emptyset)}$$

$$F_Y = \rho a V[V Sin\theta - V Sin\emptyset]$$

$$F_Y = \rho a V^2 (Sin\theta - Sin\emptyset)$$

$$\boxed{F_Y = \rho a V^2 (Sin\theta - Sin\emptyset)}$$



Jet striking curved fixed plate at one end.

FORCE EXERTED BY THE JET ON A MOVING VERTICAL PLATE

Plate is moving in the direction of jet at “u” Velocity

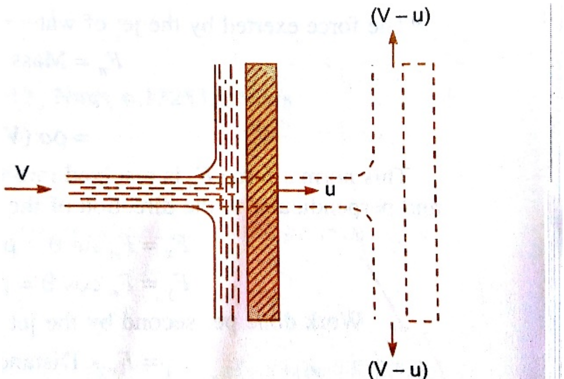


Fig. 17.10 *Jet striking a flat vertical moving plate.*

V $= Absolute\ Velocity\ of\ jet$

(V–u) $=$ Velocity of jet w. r. t. Plate

$Mass\ flow\ rate\ per\ second\ striking\ on\ Plate = \bar{m} = \rho a(V-u)$

F $= \bar{m}\ (V_1 - V_2)$ $\quad [\bar{m} = \rho a(V-u)]$

F $= [\rho a(V-u)]\ (V_1 - V_2)$

F $= \rho a(V-u)[(V-u) - 0]$

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

FORCE EXERTED BY THE JET ON A MOVING INCLINED PLATE

Plate is moving in the direction of jet at "u" Velocity

$$F = \bar{m}\,(V_1 - V_2) \qquad [\bar{m} = \rho a(V-u)]$$

$$F_X = \rho a(V-u)^2 Sin^2\theta$$

$$F_n = [\rho a(V-u)]\,(V_1 - V_2)$$

$$F_Y = \rho a(V-u)^2\, Sin\theta\, Cos\theta$$

$$F_n = \rho a(V-u)\big((V-u)Sin\theta - 0\big)$$

$$F_n = \rho a(V-u)^2 Sin\theta$$

$$F_X = F_n\, Sin\theta = \rho a(V-u)^2 Sin^2\theta$$

$$F_Y = F_n\, Cos\theta = \rho a(V-u)^2\, Sin\theta\, Cos\theta$$

$$F_Y = \frac{\rho a(V-u)^2}{2}\, Sin2\theta$$

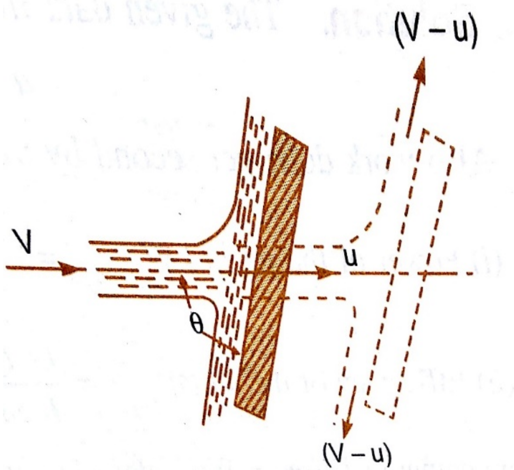


Fig. 17.11 Jet striking an inclined moving plate.

FORCE EXERTED BY THE JET ON A MOVING CURVED PLATE

Plate is moving in the direction of jet at "u" Velocity and jet impinges at centre

$$F = \bar{m}\,(V_1 - V_2) \qquad [\bar{m} = \rho a(V-u)]$$

$$F_X = [\rho a(V-u)]\,(V_1 - V_2)$$

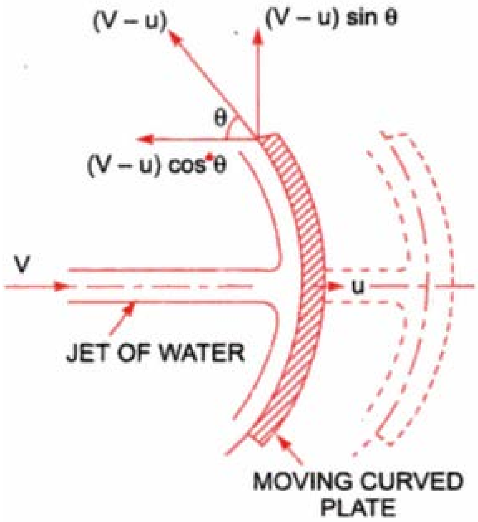
$$F_X = \rho a(V-u)\big((V-u) - (-(V-u)Cos\theta\big)$$

$$F_X = \rho a(V-u)\big((V-u)(1+Cos\theta)\big)$$

$$F_X = \rho a(V-u)^2(1+Cos\theta)$$

$$F_Y = \rho a(V-u)\,[0-(V-u)Sin\theta]$$

$$F_Y = -\rho a(V-u)^2 Sin\theta$$



$$F_X = \rho a(V-u)^2(1+Cos\theta)$$

$$F_Y = -\rho a(V-u)^2 Sin\theta$$

FORCE EXERTED BY THE JET ON A MOVING CURVED PLATE

Plate is moving in the horizontal direction at “u” Velocity and jet impinges at one end tangentially

V_1 =Velocity of jet at inlet.

V_{r1} =Relative velocity of jet & plate at inlet.

V_{W1} =Velocity of whirl at inlet.

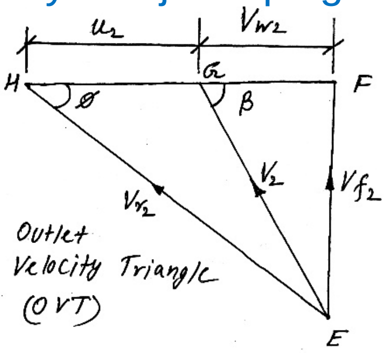
V_{f1} =Velocity of flow at inlet.

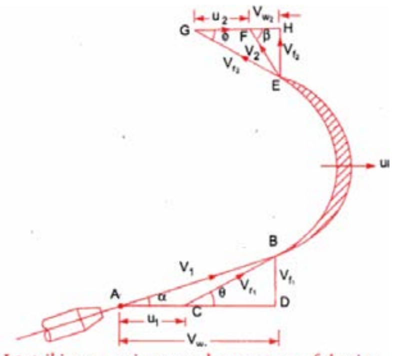
u=velocity of plate.

α=Angle between direction of jet and direction of motion of plate (Guide blade angle) at inlet.

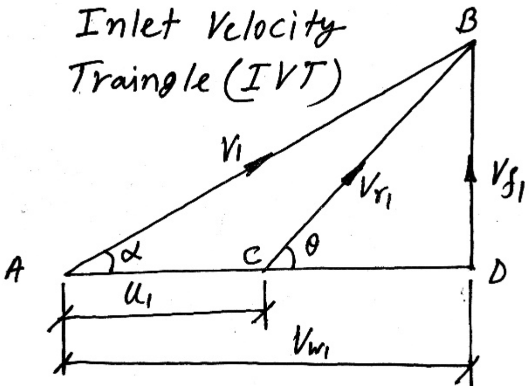
θ=Angle between relative velocity & direction of motion of plate (Vane angle) at inlet.

u_1=velocity of plate at inlet.





Jet striking a moving curved vane at one of the tips.



FORCE EXERTED BY THE JET ON A MOVING CURVED PLATE

Plate is moving in the horizontal direction at “u” Velocity and jet impinges at one end tangentially

V_2 =Velocity of jet at outlet.

V_{r2} =Relative velocity of jet & plate at outle

V_{W2} =Velocity of whirl at outlet.

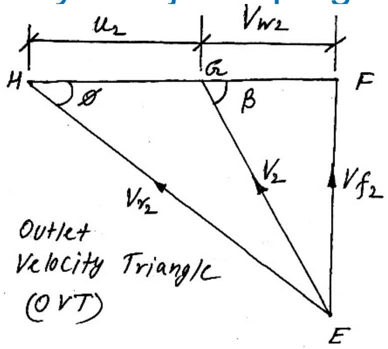
V_{f2} =Velocity of flow at outlet.

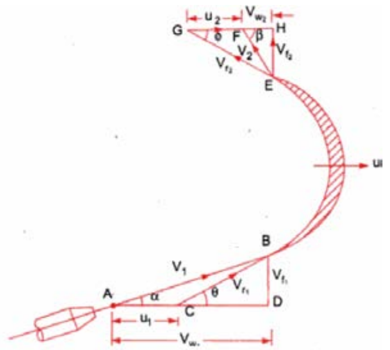
u=velocity of plate at outlet.

β=Angle between direction of jet and direction of motion of plate (Guide blade angle) at outlet.

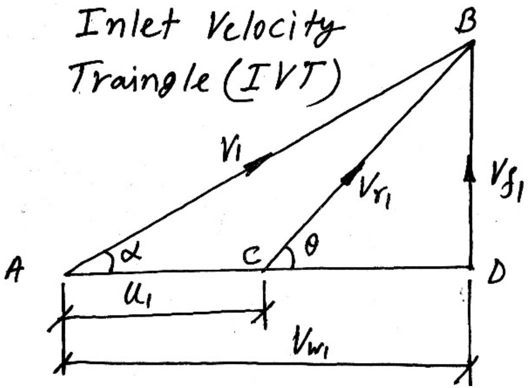
$\emptyset$=Angle between relative velocity & direction of motion of plate (Vane angle) at outlet.

u_2=velocity of plate at outlet.





Jet striking a moving curved vane at one of the tips.



FORCE EXERTED BY THE JET ON A MOVING CURVED PLATE

Plate is moving in the horizontal direction at "u" Velocity and jet impinges at one end tangentially

IVT (ΔADB)

$AB = V_1$

$AD = V_{w1} = V_1 Cos\alpha$

$DB = V_{f1} = V_1\ Sin\alpha$

$AC = u_1$

$CD = V_{w1} - u_1$

$CB = V_{r1}$

$<BAD = \alpha$

$<BCD = \theta$

OVT (ΔEFH)

$EG = V_2$

$GF = V_{w2}$

$EF = V_{f2}$

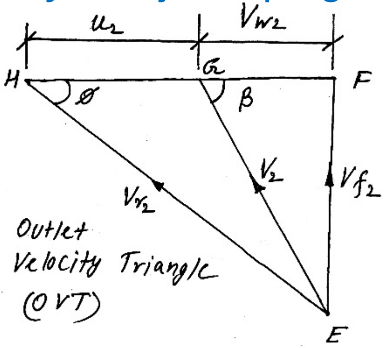
$GH = u_2$

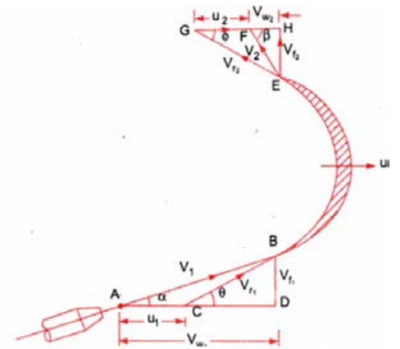
$FH = V_{w2} + u_2$

$EG = V_{r2}$

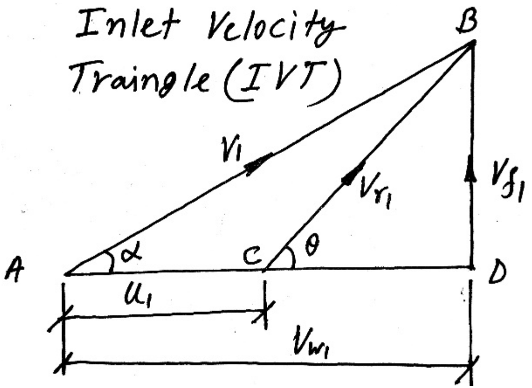
$<EGF = \beta$

$<EHG = \emptyset$





Jet striking a moving curved vane at one of the tips.



FORCE EXERTED BY THE JET ON A MOVING CURVED PLATE

Plate is moving in the horizontal direction at "u" Velocity and jet impinges at one end tangentially

$$F = \bar{m}\,(V_{x1/y1} - V_{x2/y2})$$

$$F_X = [\rho a V_{r1}][V_{x1} - V_{x2}] \qquad [\bar{m} = \rho a V_{r1}]$$

$$F_X = [\rho a V_{r1}][CD - FH]$$

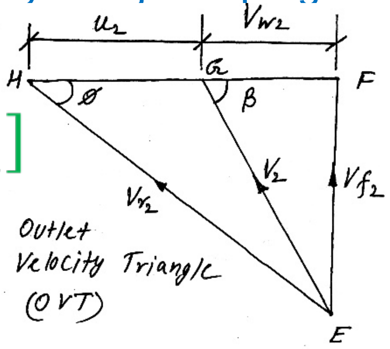
$$CD = V_{w1} - u_1 \qquad FH = V_{w2} + u_2$$

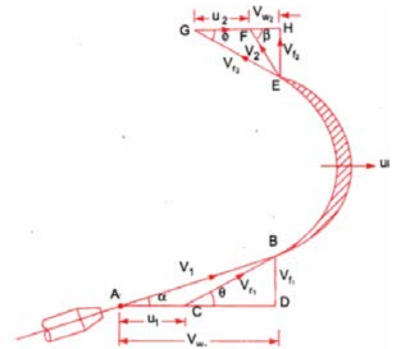
$$F_X = [\rho a V_{r1}][(V_{w1} - u_1) - \{-(V_{w2} + u_2)\}]$$

$$F_X = [\rho a V_{r1}][V_{w1} - u_1 + V_{w2} + u_2)]$$

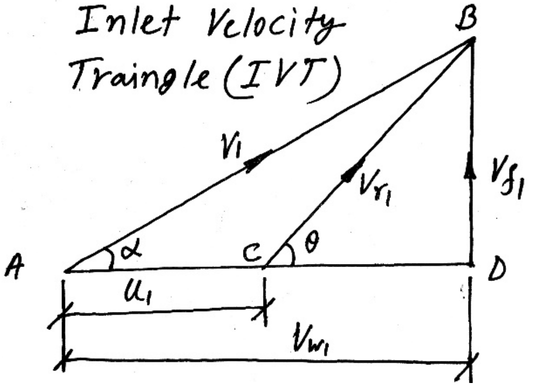
$$F_X = [\rho a V_{r1}][V_{w1} + V_{w2}] \qquad (\beta \text{ is acute angle})$$

$$\boxed{F_X = [\rho a V_{r1}][V_{w1} \mp V_{w2}]}$$





Jet striking a moving curved vane at one of the tips.



Force exerted by the jet on a moving plate

Considering Relative Velocity, $F_X = [\rho a V_{r1}][V_{x1} - V_{x2}]$

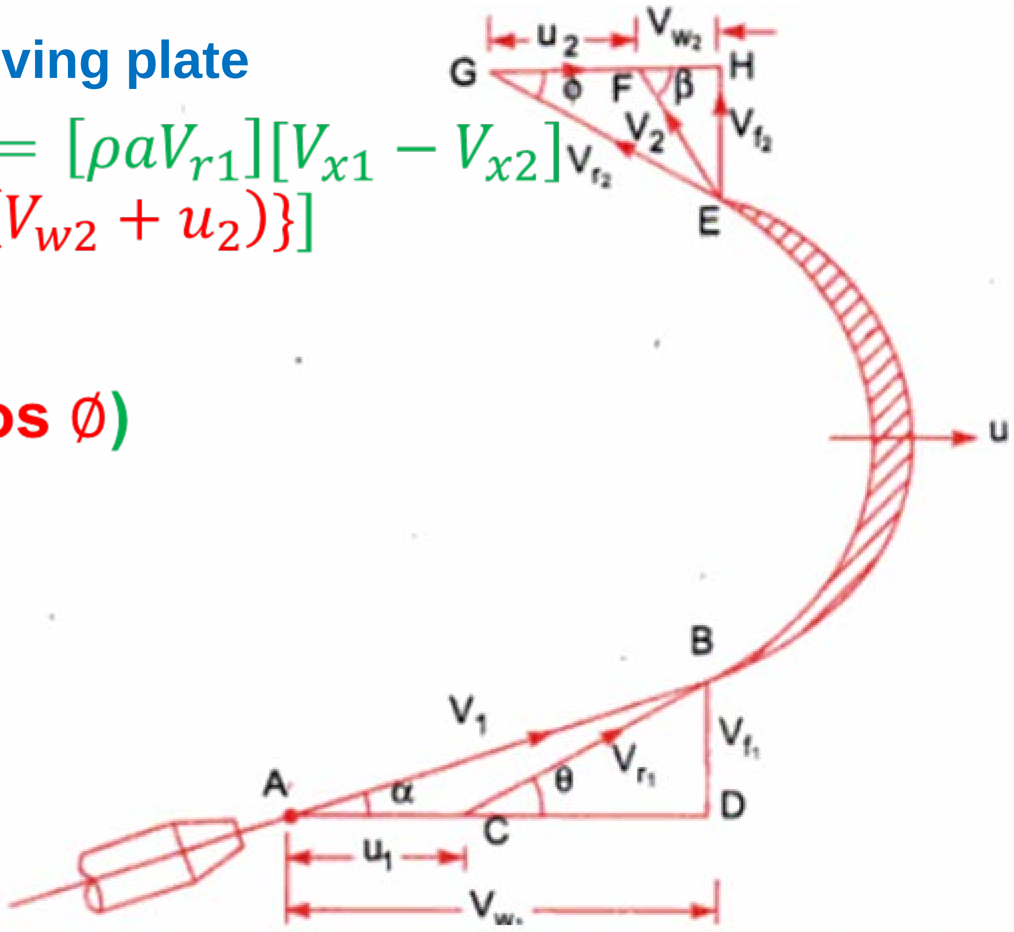
$$F_X = [\rho a V_{r1}][(V_{w1} - u_1) - \{-(V_{w2} + u_2)\}]$$

If $\beta < 90^0$

$$F_x = \rho a V_{r1} (V_{r1} \cos\theta + V_{r2} \cos\emptyset)$$

OR

$$F_x = \rho a V_{r1} (V_{W1} + V_{W2})$$



Jet striking a moving curved vane at one of the tips.

Force exerted by the jet on a moving plate

Considering Relative Velocity,

$$F_X = [\rho a V_{r1}][V_{x1} - V_{x2}]$$

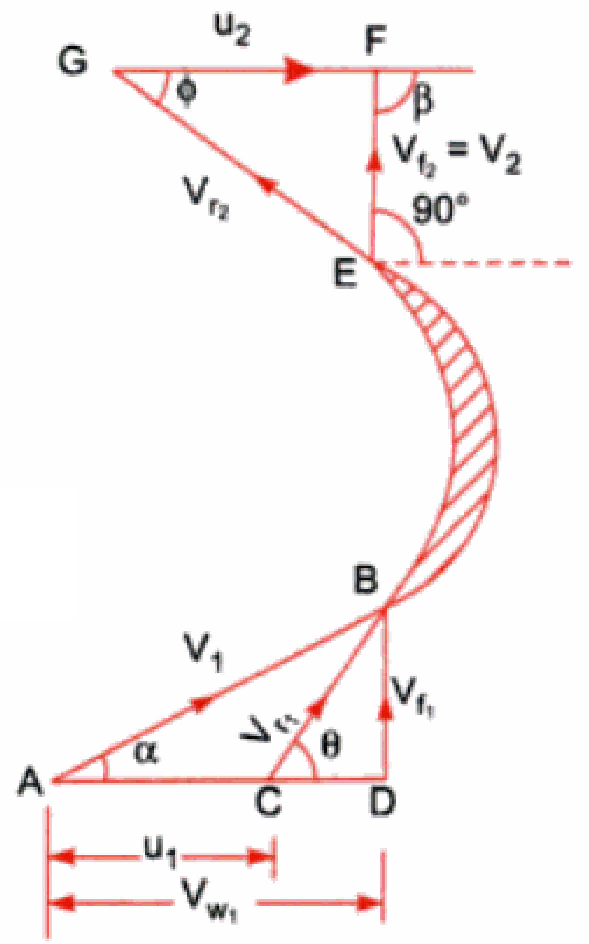
$$F_X = [\rho a V_{r1}][(V_{w1} - u_1) - \{-(0 + u_2)\}]$$

If $\beta = 90^0$

$$F_x = \rho a V_{r1} (V_{r1} \cos\theta - V_{r2} \cos\phi)$$

OR

$$F_x = \rho a V_{r1} (V_{W1})$$



Force exerted by the jet on a moving plate

Considering Relative Velocity,

$$F_X = [\rho a V_{r1}][V_{x1} - V_{x2}]$$

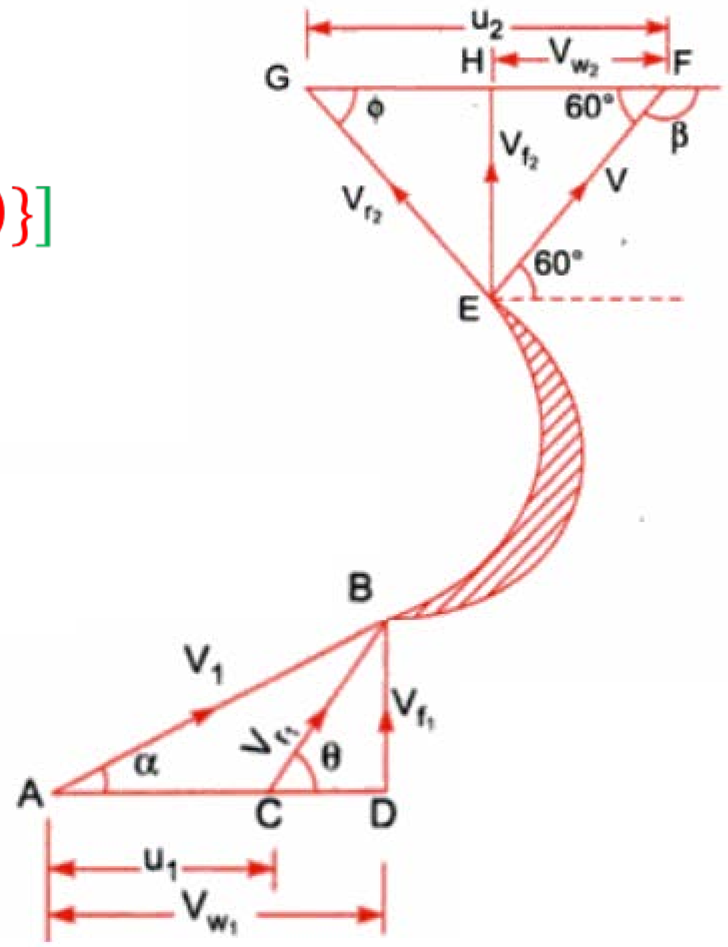
$$F_X = [\rho a V_{r1}][(V_{w1} - u_1) - \{-(u_2 - V_{w2})\}]$$

If $\beta > 90^0$

$$F_x = \rho a V_{r1} (V_{r1} \cos\theta - V_{r2} \cos\phi)$$

OR

$$F_x = \rho a V_{r1} (V_{W1} - V_{W2})$$

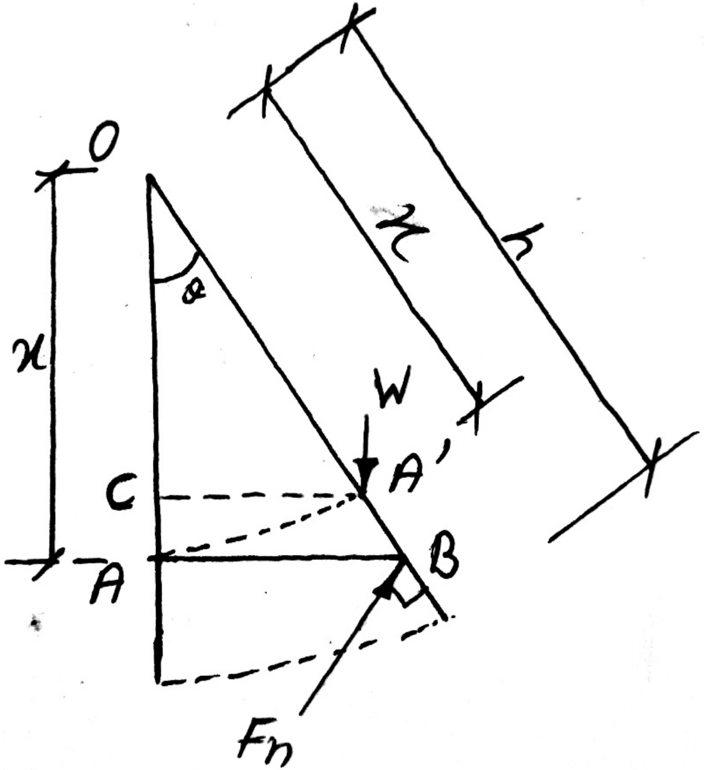


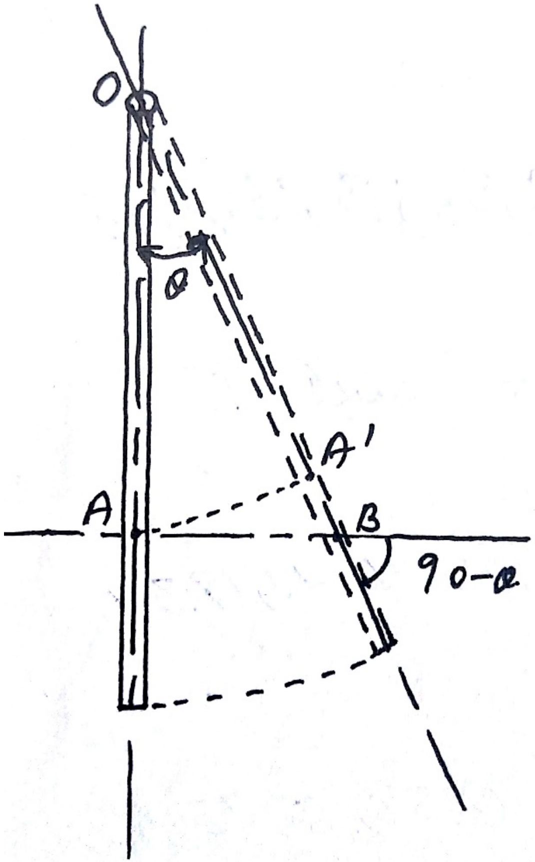
FORCE EXERTED BY THE JET ON A HINGED PLATE

Force exerted by the jet on a hinged plate

$$Sin\theta = \frac{\rho a V^2}{W}$$

$$\theta = \sin^{-1}\frac{\rho a V^2}{W}$$





FORCE EXERTED BY THE JET ON A SERIES OF VANES

Impact of jet on a series of flat vanes mounted radially on the periphery of a circular wheel

$$F = \bar{m}\,(V_1 - V_2) \qquad (\bar{m} = \rho a V)$$

$$V_1 = (V - u)$$

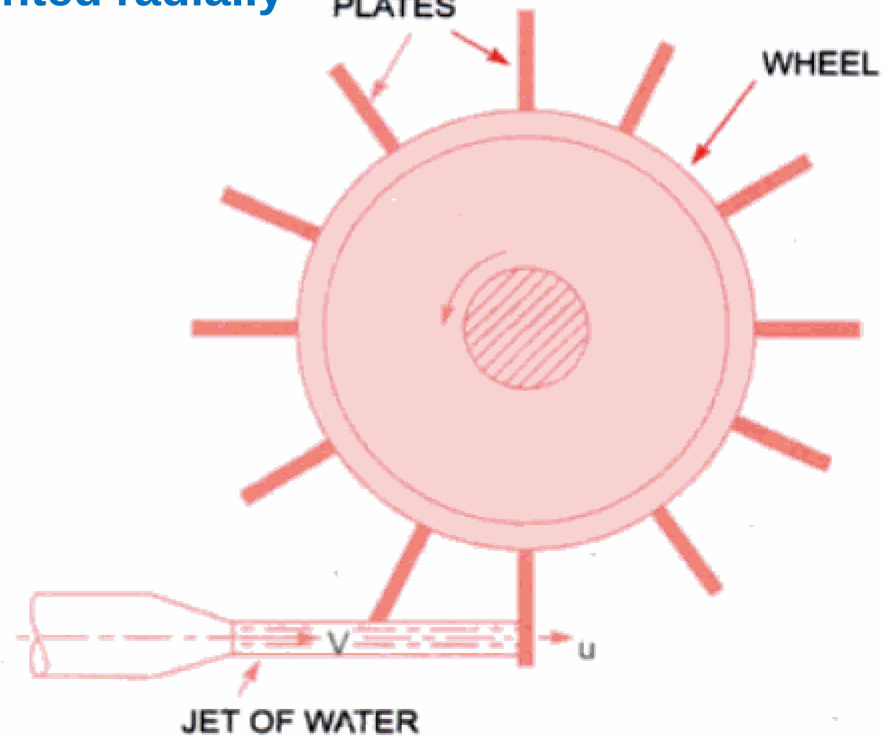
$$F_X = [\rho a V][(V - u) - 0]$$

$$F_X = [\rho a V][(V - u)]$$

$$\frac{Work\ Done}{Sec} = (W) = F_X \times u$$

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

$$\eta = \frac{Output}{Input} = \frac{W}{\frac{1}{2}\bar{m}V^2} = \frac{\rho a V u (V - u)}{\frac{1}{2} \times \rho a V \times V^2}$$



Jet striking a series of vanes.

FORCE EXERTED BY THE JET ON A SERIES OF VANES

Impact of jet on a series of flat vanes mounted radially on the periphery of a circular wheel

$$\eta = \frac{2u(V-u)}{V^2}$$

For Maximum Efficiency (η)

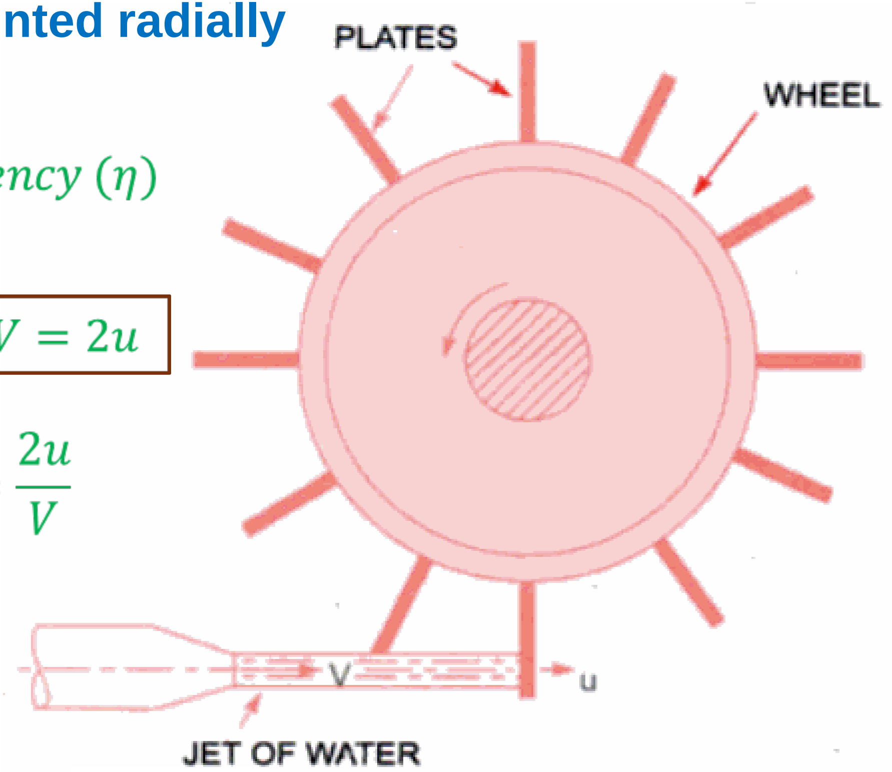
$$\frac{d\eta}{du} = \frac{d}{du}\left[\frac{2Vu}{V^2} - \frac{2u^2}{V^2}\right] = \frac{d}{du}\left[\frac{2u}{V} - \frac{2u^2}{V^2}\right]$$

$$V = 2u$$

$$0 = \frac{2}{V} - \frac{2\times 2u}{V^2} \Rightarrow \frac{2}{V} = \frac{2\times 2u}{V^2} \Rightarrow 1 = \frac{2u}{V}$$

$$\eta = \frac{2u(V-u)}{V^2} = \frac{2u(2u-u)}{4u^2} = \frac{1}{2}$$

$$\eta = 50\%$$



Jet striking a series of vanes.

FORCE EXERTED BY JET ON SERIES OF RADIAL CURVED VANES

$u_1 = \omega R_1$ $u_2 = \omega R_2$ *Where,* $\omega = Angular\ Velocty$

If $\beta < 90^0$

$Mass\ flow\ rate = \bar{m} = \rho a V_1$

$Momentum\ per\ sec\ striking\ the\ plate\ at\ inlet = \bar{m} \times V_{W1} = \rho a V_1 V_{W1}$

$Momentum\ per\ sec\ striking\ the\ plate\ at\ outle = -\rho a V_1 \times V_{W2}$

$Angular\ Momentum\ per\ sec\ at\ inlet = \rho a V_1 \times V_{W1} \times R_1$

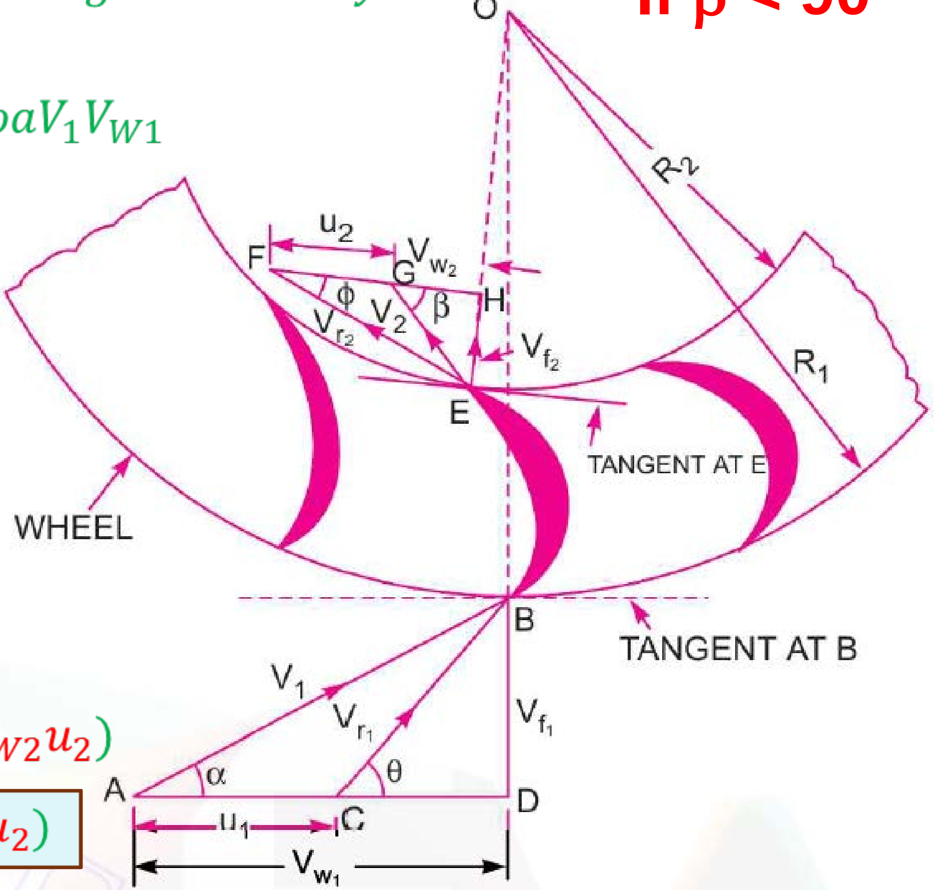
$Angular\ Momentum\ per\ sec\ at\ outlet = -\rho a V_1 \times V_{W2} \times R_2$

$Torque = T = Rate\ of\ change\ of\ angular\ Momentum$

$T = \rho a V_1 (V_{W1} R_1 + V_{W2} R_2)$

$Work\ done\ /sec = T \times \omega = \rho a V_1 (V_{W1} u_1 + V_{W2} u_2)$

$$W = \rho a V_1 (V_{W1} u_1 + V_{W2} u_2)$$



FORCE EXERTED BY JET ON SERIES OF RADIAL CURVED VANES

$u_1 = \omega R_1$ $\quad u_2 = \omega R_2$ $\quad$ Where, ω = Angular Velocty

Mass flow rate $= \bar{m} = \rho a V_1$

Momentum per sec striking the plate at inlet $= \bar{m} \times V_{W1} = \rho a V_1 V_{W1}$

Momentum per sec striking the plate at outle $= 0$

Angular Momentum per sec at inlet $= \rho a V_1 \times V_{W1} \times R_1$

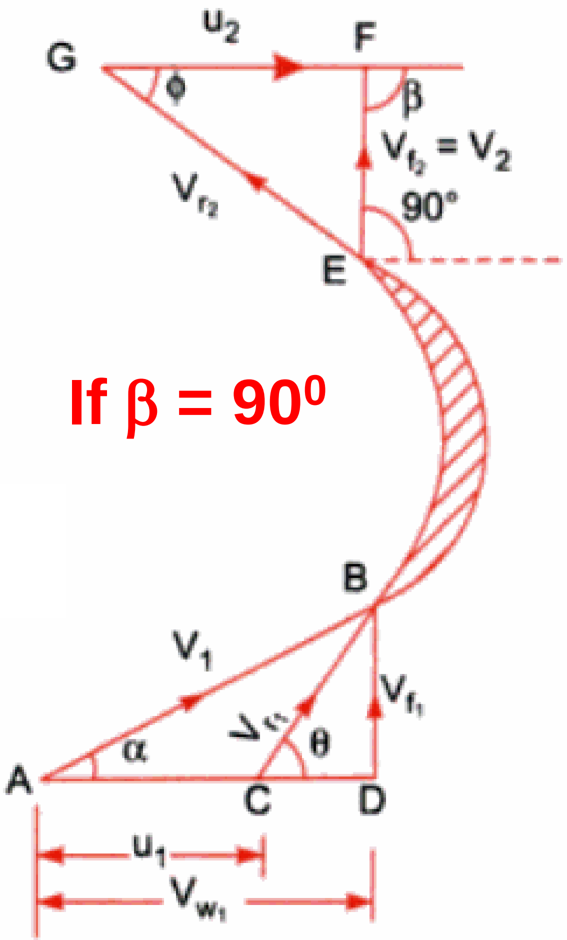
Angular Momentum per sec at outlet $= 0$

Torque $= T =$ Rate of change of angular Momentum

$T = \rho a V_1 (V_{W1} R_1 - 0)$

Work done /sec $= T \times \omega = \rho a V_1 V_{W1} u_1$

$$W = \rho a V_1 V_{W1} u_1$$



FORCE EXERTED BY JET ON SERIES OF RADIAL CURVED VANES

If $\beta > 90^0$

$u_1 = \omega R_1$ $\quad u_2 = \omega R_2$ $\quad Where, \omega = Angular\ Velocty$

$Mass\ flow\ rate = \bar{m} = \rho a V_1$

$Momentum\ per\ sec\ striking\ the\ plate\ at\ inlet = \bar{m} \times V_{W1} = \rho a V_1 V_{W1}$

$Momentum\ per\ sec\ striking\ the\ plate\ at\ outle = +\rho a V_1 \times V_{W2}$

$Angular\ Momentum\ per\ sec\ at\ inlet = \rho a V_1 \times V_{W1} \times R_1$

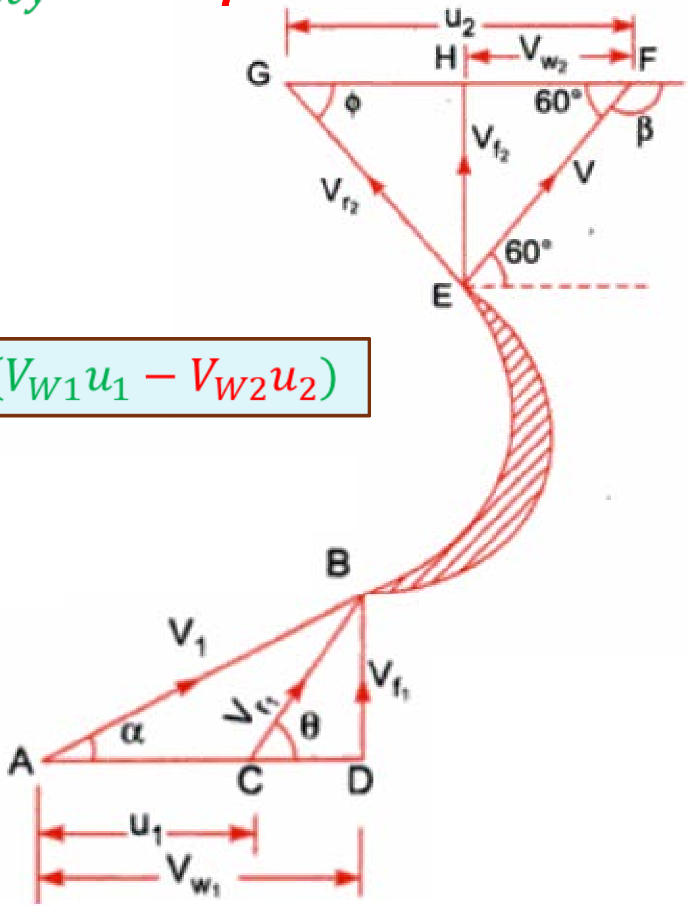
$$W = \rho a V_1 (V_{W1} u_1 - V_{W2} u_2)$$

$Angular\ Momentum\ per\ sec\ at\ outlet = +\rho a V_1 \times V_{W2} \times R_2$

$Torque = T = Rate\ of\ change\ of\ angular\ Momentum$

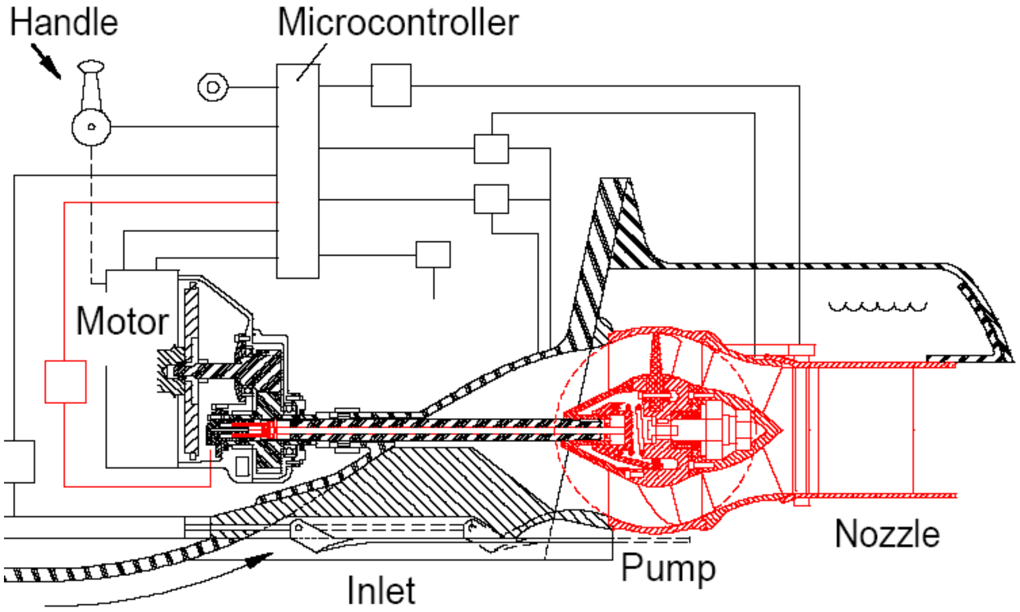
$T = \rho a V_1 (V_{W1} R_1 - V_{W2} R_2)$

$Work\ done\ /sec = T \times \omega = \rho a V_1 (V_{W1} u_1 - V_{W2} u_2)$



JET PROPULSION

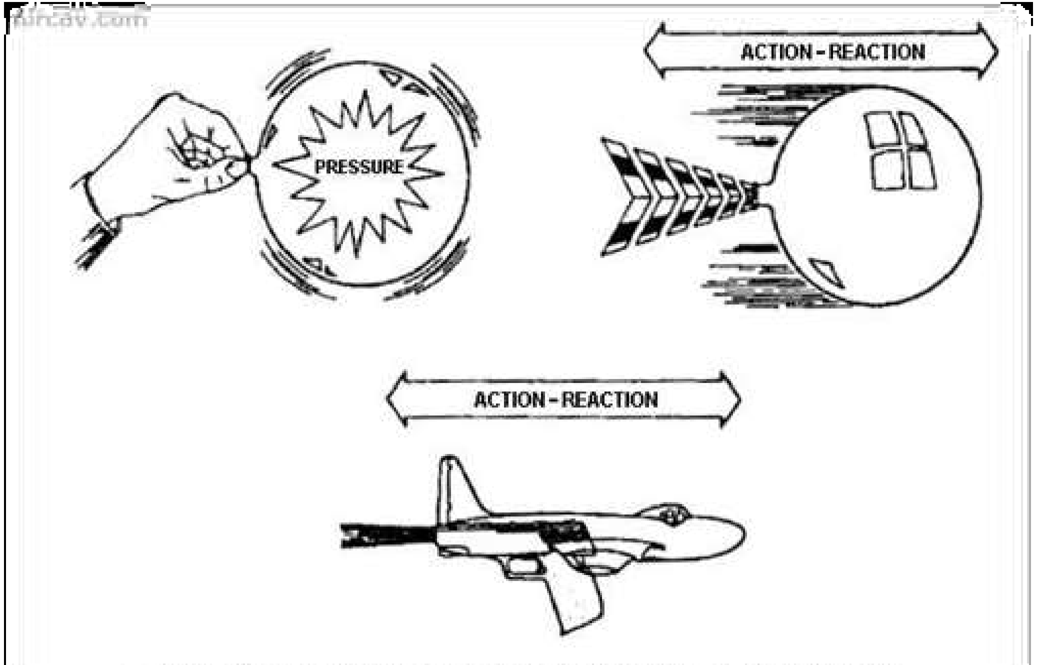
- The driving forward of a body by means of jet of gas or fluid.
- The reaction of high velocity jet issuing from the nozzle provides the necessary thrust.
- Is employed in propelling the ships, aircrafts and missiles.
- Used for flights, to hydraulic jet propulsion for high speed boats and pleasure craft.



PRINCIPLE OF JET PROPULSION

- Works on principle of Newton's third law of motion.

- The reaction of jet coming out at the back of the ship propels the ship in the opposite direction of jet.



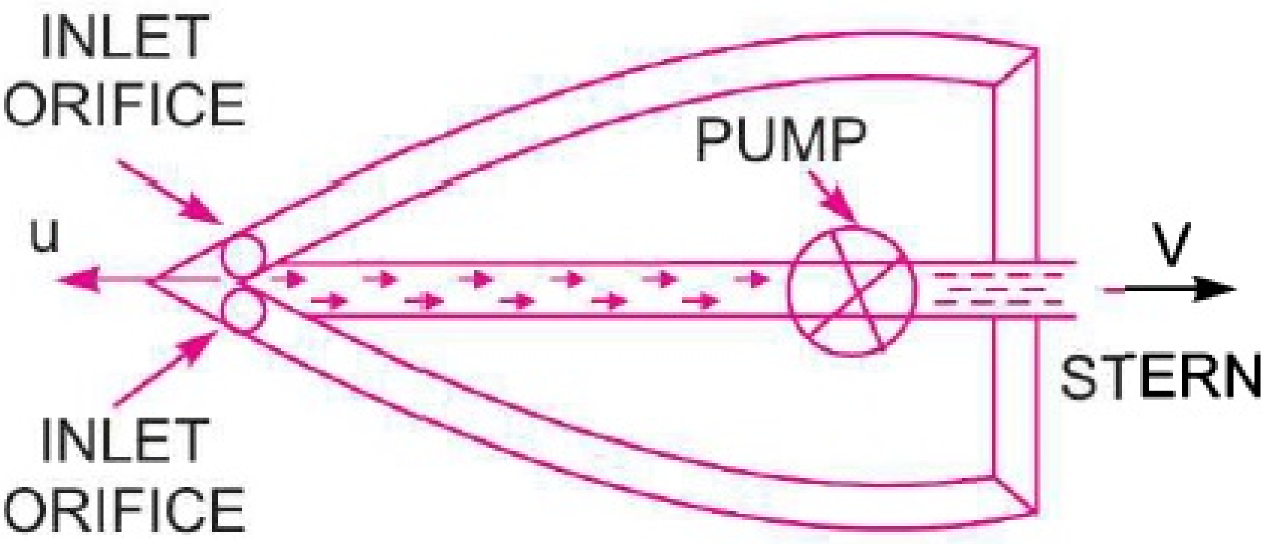
The Jet Propulsion Principle (Newton's Third Law of Motion)

- The water from the surrounding sea by the centrifugal pump is taken by two ways.

PRINCIPLE OF JET PROPULSION

1. Inlet orifices which are at right angle to the direction of motion of ship. (**AMID Ship**)

2. The inlet orifices which are facing the direction of motion of ship.



AMID SHIP

$$F = \rho a V(V + u)$$

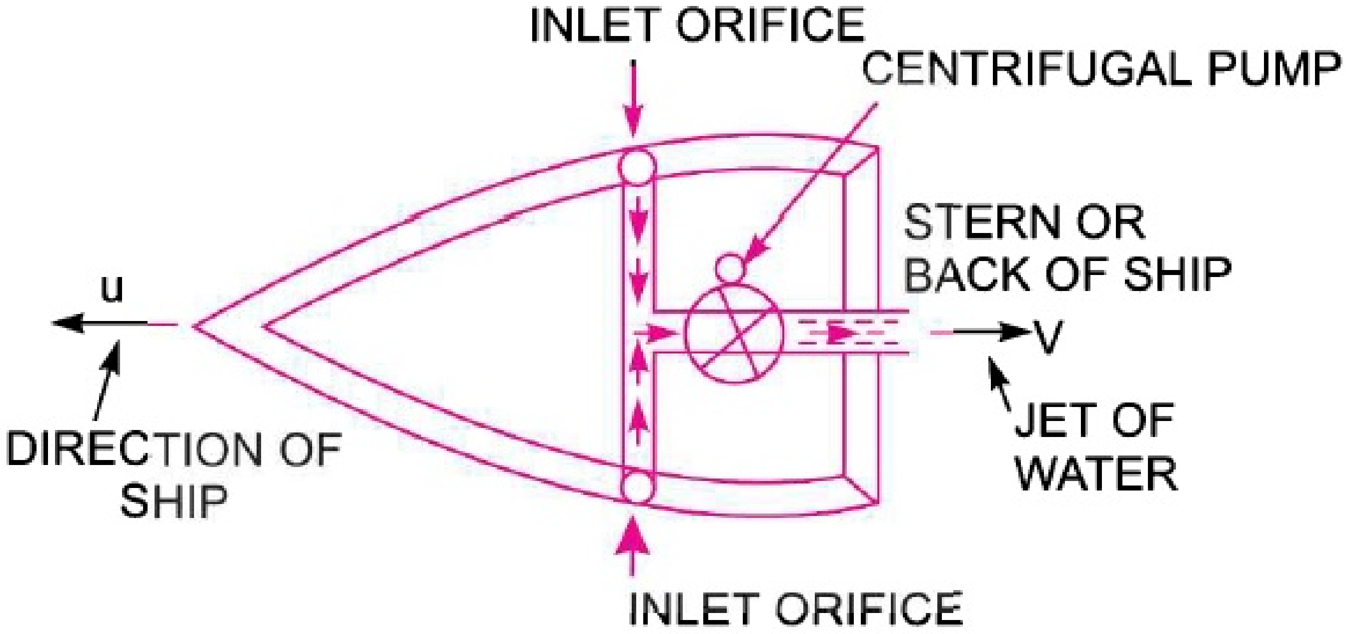
$$W = F \times u = \rho a V u(V + u)$$

$$F = \bar{m}\,(V_1 - V_2)$$

$$Kinetic\,Energy\,of\,jet = \frac{1}{2}\rho a(V + u)^3$$

$$(\bar{m} = \rho a(V + u))$$

$$\eta = \frac{2Vu}{(V + u)^2}$$



NON AMID SHIP

$$F = \rho a V(V+u)$$

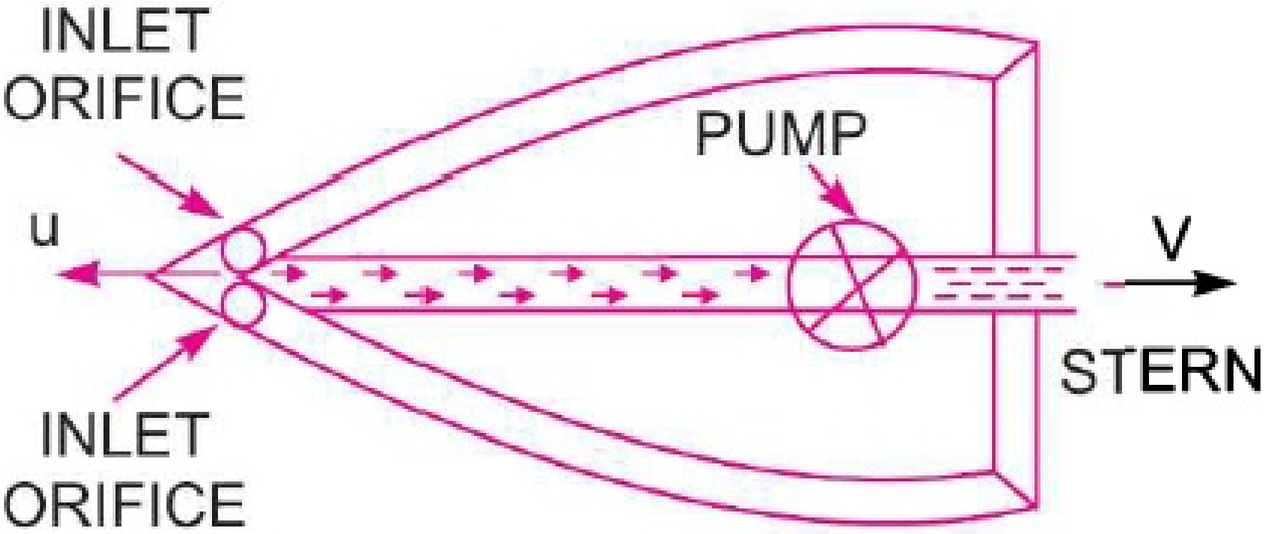
$$W = F \times u = \rho a V u(V+u)$$

$$F = \bar{m}\,(V_1 - V_2)$$

$$Kinetic\ Energy\ of\ jet = \frac{1}{2}\rho a(V+u)[(V+u)^2 - u^2]$$

$$(\bar{m} = \rho a(V+u))$$

$$\eta = \frac{2u}{(V+2u)}$$



Problems:

Problem 17.30 *The water in a jet propelled boat is drawn amid-ship and discharged at the back with an absolute velocity of 20 m/s. The cross-sectional area of the jet at the back is 0.02 m^2 and the boat is moving in sea water with a speed of 30 km/hour. Determine :*

(i) Propelling force on the boat, *(ii) Power required to drive the pump, and*

(iii) Efficiency of the jet propulsion.

Problem 17.31 *A small ship is fitted with jets of total area 0.65 m^2. The velocity through the jet is 9 m/s and speed of the ship is 18 km p.h. in sea-water. The efficiencies of the engine and pump are 85% and 65% respectively. If the water is taken amid-ships, determine the propelling force and the overall efficiency, assuming the pipe losses to be 10% of the kinetic energy of the jets.*

Problem 17.33 *The water in a jet propelled boat is drawn through inlet openings facing the direction of motion of the ship. The boat is moving in sea-water with a speed of 30 km/hour. The absolute velocity of the jet of the water discharged at the back is 20 m/s and the area of the jet of water is 0.03 m^2. Find the propelling force and efficiency of propulsion.*

Problems:

1. A jet of water of diameter 75 mm strikes a curved plate at its centre with a velocity of 25 m/s. The curved plate is moving with a velocity of 10 m/s along the direction of jet. If the jet gets deflected through 165^0 in the smooth vane, compute.

a) Force exerted by the jet.

b) Power of jet.

c) Efficiency of jet.

2. A jet of water impinges a curved plate with a velocity of 20 m/s making an angle of 20^0 with the direction of motion of vane at inlet and leaves at 130^0 to the direction of motion at outlet. The vane is moving with a velocity of 10 m/s. Compute.

i) Vane angles, so that water enters and leaves without shock.

ii) Work done per unit mass flow rate

Problems:

Problem 17.26 *A jet of water having a velocity of 30 m/s strikes a series of radial curved vanes mounted on a wheel which is rotating at 200 r.p.m. The jet makes an angle of 20° with the tangent to the wheel at inlet and leaves the wheel with a velocity of 5 m/s at an angle of 130° to the tangent to the wheel at outlet. Water is flowing from outward in a radial direction. The outer and inner radii of the wheel are 0.5 m and 0.25 m respectively. Determine :*

(i) Vane angles at inlet and outlet, *(ii) Work done per unit weight of water, and*
(iii) Efficiency of the wheel.

Problems:

1. A jet of water 50 mm diameter strikes a flat plate held normal to the direction of jet. Estimate the force exerted by the jet if

a. The plate is stationary

b. The plate is moving with a velocity of 1 m/s away from the jet along the line of jet. The discharge through the nozzle is 76 liter per sec.

2. A 75 mm diameter jet having a velocity of 12 m/s impinges a smooth flat plate, the normal of which is inclined at 60^0 to the axis of jet. Find the impact of jet on the plate at right angles to the plate when the plate is stationery.

a. What will be the impact if the plate moves with a velocity of 6 m/s in the direction of jet and away from it.

b. What will be the force if the plate moves towards the Jet.

Problems:

1. A jet of water of diameter 20mm strikes a 200mm X 200mm square plate of uniform thickness with a velocity of 10 m/s at the centre of the plate which is suspended Vertically by a hinge on its top horizontal edge. The weight of the plate is 98N. The jet strikes normal to the plate.

(i) What force must be applied at the lower edge of the plate so that plate is kept vertical?

(ii) If the plate is allowed to deflect freely, what will be the inclination of the plate with vertical due to the force exerted by jet water.

Problem 17.18 *A jet of water having a velocity of 20 m/s strikes a curved vane, which is moving with a velocity of 10 m/s. The jet makes an angle of 20° with the direction of motion of vane at inlet and leaves at an angle of 130° to the direction of motion of vane an outlet. Calculate :*

(i) Vane angles, so that the water enters and leaves the vane without shock.

(ii) Work done per second per unit weight of water striking (or work done per unit weight of water striking) the vane per second.

Problems:

1. A jet of water having a velocity of 35 m/s strikes a series of radial curved vanes mounted on a wheel. The wheel has 200 rpm. The jet makes 20^0 with the tangent to wheel at inlet and leaves the wheel with a velocity of 5 m/s at 130^0 to tangent to the wheel at outlet. The diameters of wheel are 1 m and 0.5 m. Find

i) Vane angles at inlet and outlet for radially outward flow turbine.

ii) Work done

iii) Efficiency of the system

Thanks:

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Any Questions

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