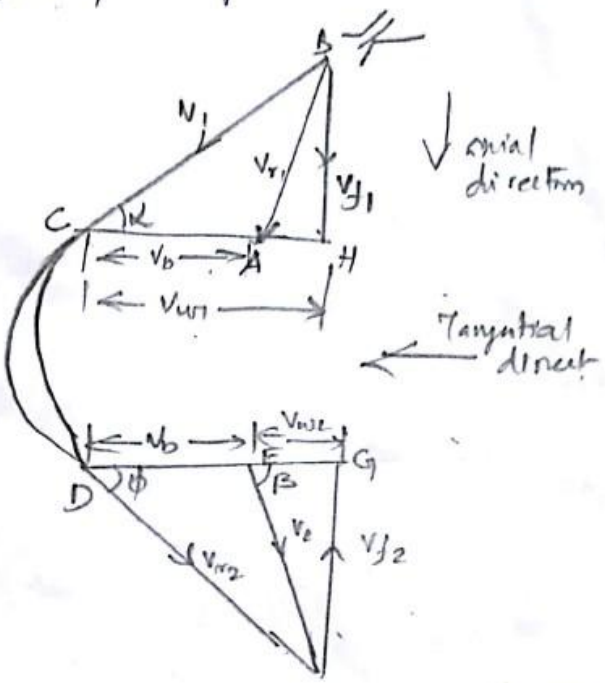
Velocity Diagram for Impulse Turbine



Velocity Diagram

V_1 = Absolute velocity of steam entering the ~~Blade~~ or moving Blade (AC)

V_b = Blade velocity or linear velocity of moving blade

(AC - inlet velocity triangle, DE in outlet velocity triangle)

V_{r1} = Relative velocity of steam jet to the moving blade (BA)

V_{f1} = Velocity of flow at the entrance of the moving blade

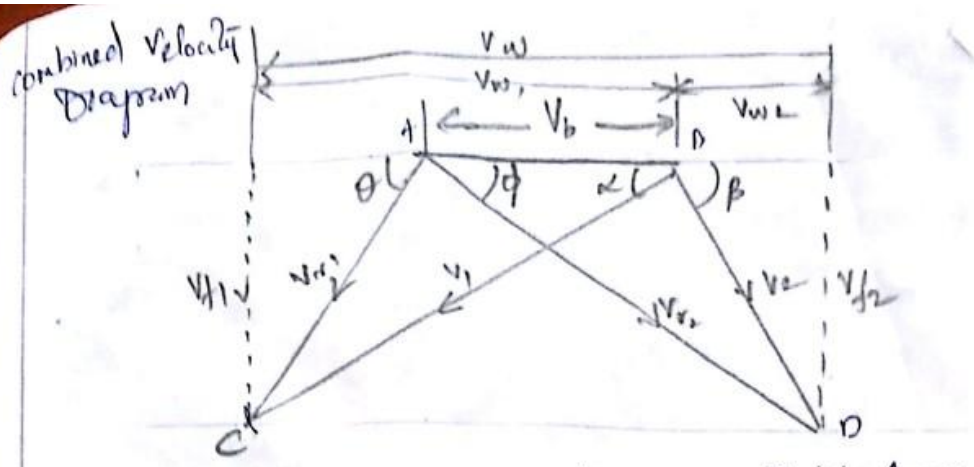
V_{w1} = Velocity of the whirl at the entrance

α = Nozzle angle (or) angle of absolute velocity V_1 and V_b

θ = Blade angle at inlet

β = angle of V_2 with direction of motion of blade

Combined Velocity Diagram



1) Draw a line AB equal to V_b (blade velocity) to some scale.
2) At B, Draw a line BC of length equal to V_1 and angle equal to α with AB.
3) Join AC which is equal to V_{r1}. It is angle θ
4) At A, draw an inclined line at an angle ϕ with AB Keeping A as Centre, AC as radius draw an Arc to cut this inclined line and get D. $AC = AD = V_{r2}$
5) Join BD which is equal to V_2. The angle of V_2 with the direction of blade velocity is β
6) If we resolve the velocity V_1, we get V_{f1} (Velocity of flow at inlet) and V_{w1} (Velocity of whirl at inlet)
7) If we resolve the velocity V_2, we get V_{f2} and V_{w2}

Blade efficiency

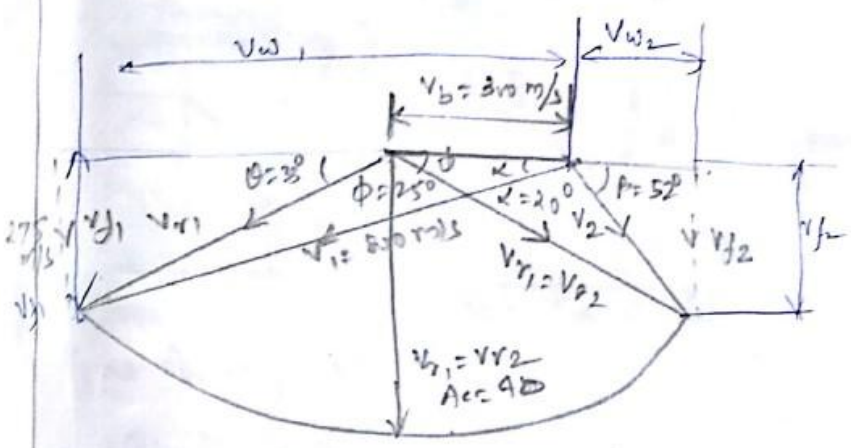
The Ratio of power developed by the turbine to the energy given by the blade per second.

$$\eta_{blade} = \frac{2(V_{w1} + V_{w2}) V_b}{V_1^2}$$

Max. blade efficiency = $\eta_{blade} = \cos^2\alpha$

(1) The following data refers to a single stage impulse turbine. Steam velocity = 800 m/s. Blade speed = 300 m/s. Nozzle angle = 20°, Blade outlet angle = 25°. Neglecting effect of friction, calculate the power developed by the turbine for the steam flow rate of 25 kg/s. Also calculate the axial thrust on the bearings.

Absolute velocity of steam entering the blades $V_1 = 800$ m/s, Blade speed $V_b = 300$ m/s, Nozzle angle $\alpha = 20°$, Blade outlet angle $\phi = 25°$, Steam flow rate $m = 25$ kg/s. Power developed = ?, Axial thrust on the bearing = ?



Power developed.

$$\text{power} = m(V_{w_1} + V_{w_2})V_b$$
$$= 25 \times 930 \times 300$$
$$= 6975 \times 10^3 \text{ watts}$$
$$= 6975 \text{ kW}$$

Axial thrust on Bearing

$$\text{Axial thrust} = m(V_{f_1} - V_{f_2})$$
$$= 25(275 - 220)$$
$$= 1375 \text{ N}.$$