$$\rho_{in} v_{m,in} S_{in} = \rho_{OUT} v_{m,OUT} S_{OUT} \quad \rightarrow \text{Mass Balance}$$

$$\dot{m}\left[\Delta h + \frac{\Delta v^2}{2} + g\Delta z\right] = \dot{L} + \dot{Q} \quad \rightarrow \text{Total Energy Balance}$$

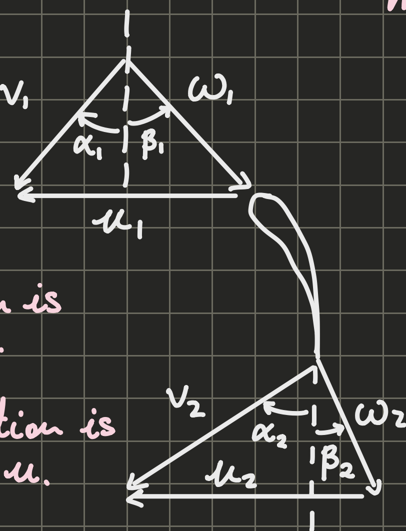
$$T_i = \frac{p_i}{\rho} + \frac{v_i^2}{2} + g z_i \quad \rightarrow \text{Bernoulli Trinomial} \qquad (\dot{L} = l \cdot \dot{m})$$

$$l - l_w = \Delta T \quad \longrightarrow \text{Mechanical Energy Balance} \qquad (l_w = T\Delta S_{IRR})$$

(BEM/MEB/BME)

$$q + l_w = \int T\,ds \quad \longrightarrow \text{Thermal Energy Balance}$$

$$\dot{m} = \rho v_m A_{cross} = \pi \rho v_m D_m b$$




(+) if direction is same as $u$.

(-) if direction is opposite of $u$.

$$\vec{v} = \vec{u} + \vec{\omega} \rightarrow l = u_2 v_{2t} - u_1 v_{1t} = \frac{\Delta v^2}{2} - \frac{\Delta \omega^2}{2} + \frac{\Delta u^2}{2}$$

$$\text{Rotor} = \vec{u} = \frac{2\pi}{60} n \cdot \frac{D}{2}$$

$$l - l_w - y = \Delta T \qquad y_{ci} = \xi_i \frac{v_i^2}{2} \qquad y_{DIS} = \frac{\lambda_i \cdot L_i}{D_i} \cdot \frac{v_i^2}{2}$$

$$y = \sum_i y_{ci} + y_{DISi}$$

$$p_{Ti} = \frac{p_i}{\rho} + \frac{v_i^2}{2} \qquad Q = \rho \cdot \dot{m} = \frac{\pi D_i^2 v_i}{4}$$

$$\Psi = \frac{gH}{n^2 D^2}, \qquad \varphi = \frac{Q}{nD^3} \qquad \eta = \frac{gH}{l}$$

Similarity, $\eta, \varphi, \Psi = \text{const}$

Perfect liquid $\Rightarrow q + l_{w} = c_L \,\Delta T$

$$gH_p = \Delta T_p = l - l_w$$

$$NPSH_R = \frac{P_1}{\rho g} + \frac{V_1^2}{2g} - \frac{P_{MIN}}{\rho g}$$ $\longrightarrow$ 1 is the entrance to the pump.

$$NPSH_A = \frac{P_1}{\rho} + \frac{V_1^2}{2g} - \frac{P_{SAT} + P_{DIS}}{\rho g}$$ $\longrightarrow$ ", found through BME $0 \to 1$

To avoid cavitation $NPSH_A > NPSH_R$

$$\chi = \frac{P_2 - P_1}{\rho g H} = 1 - \frac{V_{2t}}{2u_2}$$

$$H_p = A\left(\frac{\bar{D}}{D}\right)^4 Q^2 + B\left(\frac{n}{\bar{n}}\right)Q + C\left(\frac{n}{\bar{n}}\right)^2\left(\frac{D}{\bar{D}}\right)^2$$

$$\eta_p = E\left(\frac{\bar{n}}{n}\right)^2\left(\frac{\bar{D}}{D}\right)^6 Q^2 + F\left(\frac{\bar{n}}{n}\right)\left(\frac{\bar{D}}{D}\right)^3 Q + G$$

$\bar{n}, \bar{D} \rightarrow$ initial condition ; $n, D \rightarrow$ new condition

$$\dot{L} = \rho \frac{QH}{\eta} g$$

Series: $H_{eq} = H_1 + H_2$ Parallel: $H_{eq} = H_1 = H_2$

$Q_{eq} = Q_1$ $Q_{eq} = Q_1 + Q_2$

$$gH_m = T_0 - T_B = g(z_0 - z_B) - y_p$$

$$NPSH_{A,turb} = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} - \frac{P_{SAT} + P_{DIS}}{\rho g}$$ $\longrightarrow$ From BME $2 \to B$

$v_1 = \varphi v_1'$ , $v_1' = \sqrt{2 g H_m}$ , $\omega_2 = \psi \omega_1$ ; $k_p = \dfrac{u}{v_1'}$

$\eta = 0$ if $k_p = \varphi$ , $\eta_{BEP}$ at $k_p = \varphi/2$

$$C_{AX} = \frac{|\dot{L}|}{\omega}$$