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

$$T_i = \frac{P_i}{\rho} + \frac{v_i^2}{2} + gz_i \rightarrow \text{Bernoulli Trinomial}$$

$$\dot{L} = l \cdot \dot{m}$$

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

$$y = \sum y_{ci} + y_{DISi} = \sum \xi_i \frac{v_i^2}{2} + \frac{\lambda_i L_i}{D_i} \cdot \frac{v_i^2}{2}$$

$$P_{Ti} = \frac{P_i}{\rho} + \frac{v_i^2}{2} \rightarrow \Delta P_T = \rho \cdot l \cdot \eta$$

$$Q = \frac{\dot{m}}{\rho} = \frac{\pi D_i^2 v_i}{4}$$

$$\psi = \frac{gH}{n^2D^2} \ ; \ \varphi = \frac{Q}{nD^3} \ ; \ \eta = \frac{gH}{l}$$

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

$$NPSH_R = \frac{P_1}{\rho g} + \frac{v_1^2}{2g} - \frac{P_{min}}{\rho g}$$

$$NPSH_A = \frac{P_1}{\rho} + \frac{v_1^2}{2g} - \frac{P_{SAT} + P_{DIS}}{\rho g}$$

$$\text{Avoid Cavitation} \implies NPSH_A > NPSH_R$$

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

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

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

$$\overline{n}, \overline{D} \rightarrow \text{inital condition} \ ; \ n, D \rightarrow \text{New condition}$$

$$\text{Series: } H_{eq} = H_1 + H_2 \ ; \ Q_{eq} = Q_1 = Q_2$$

$$\text{Parallel: } H_{eq} = H_1 = H_2 \ ; \ Q_{eq} = Q_1 + Q_2$$

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

$$NPSH_{A,\text{turb}} = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} - \frac{P_{sat} + P_{dis}}{\rho g}$$

$$v_1 = \varphi v_1' \ ; \ v_1' = \sqrt{2gH_m} \ ; \ w_2 = \psi w_1 \ ; \ k_p = \frac{u}{v_1'}$$

$$D_s = D \cdot \frac{\sqrt[4]{gH}}{\sqrt{Q}} \ ; \ n_s = n \cdot \frac{\sqrt{Q}}{\sqrt[4]{gH}^3}$$

$$c_p = \frac{\gamma}{\gamma - 1}\mathcal{R}$$

$$l_s = c_p \cdot T_1 \cdot (\beta^{\frac{\gamma-1}{\gamma}} - 1)$$

$$\eta_s = \frac{l_s}{l}$$

$$\frac{T_T}{T} = 1 + \frac{\gamma - 1}{2}M^2$$

$$a = \sqrt{\gamma \rho T}$$

$$\chi = 0.5 \implies \alpha_1 = -\beta_2 \& \alpha_2 = -\beta_1$$

$$k_{p,t} = \sin(\alpha_1)/2$$

$$\eta_{TT,t} = \frac{l}{h_{T1} - h_{T2}} = \frac{l_r}{l_s}$$

$$\eta_{TS,t} = \frac{l}{h_{T1} - h_2} = \frac{l_r}{h_1 - h_2 + v_1^2/2}$$

$$\eta_{\text{cycle}} = \frac{\dot{L}_{\text{el}}}{\dot{m}_F \cdot LHV_F}$$

$$\alpha = \frac{LHV_F}{c_{p,g} \cdot (T_g - T_{ref}) - c_{p,a}(T_a - T_{ref})} - 1 = \frac{LHV_F}{\overline{c_p}(T_g - T_a)} - 1$$

$$\text{Turbine: } \beta_{TS} = \frac{P_{T0}}{P_1}$$

$$\text{Compressor: } \beta_{TS} = \frac{P_{T1}}{P_0}$$

$$M_u = \frac{u}{\sqrt{\gamma \cdot \mathcal{R} \cdot T_{T,0}}}$$

$$P_{out} = \frac{P_{\text{last}}}{\left(\frac{\gamma+1}{2}\right)^{\frac{\gamma-1}{\gamma}}}$$

$$T_{out} = \frac{T_{\text{last}}}{\left(\frac{\gamma+1}{2}\right)}$$

$$\frac{\rho_{\text{T}}}{\rho} = \left(\frac{T_T}{T}\right)^{\frac{1}{\gamma-1}}$$

$$\Delta s = c_p \cdot \ln(\frac{T_{T2}}{T_{T1}}) - R \cdot \ln(\frac{P_{T2}}{P_{T1}})$$