$\boxed{IV}$ $\chi = \frac{\square - \square_e}{\square_{VAP} - \square_e}$ $\eta_g = \frac{P_u}{(\dot{Q}_{gv} - \dot{Q}_u)} \cdot \eta_b = \frac{P_u}{(\dot{m}_b - \dot{m}_{f,ut}) H_i}$ $\frac{\dot{m}^* \sqrt{P_0^* v_0^*}}{P_0^* (1-\varepsilon^*)} = \frac{\dot{m}' \sqrt{P_0' v_0'}}{P_0' (1-\varepsilon')} = \Gamma$

$r_{cr} = \frac{P_{K,cr}^*}{P_a^*}$ usarlo per confronto in fPG $h_K = h_a - \eta_\theta (h_a - h_{KIS})$

$\boxed{\text{Ugello}}$ $r_{cr,aria} = \left(\frac{2}{K+1}\right)^{\frac{K}{K-1}} = 0{,}53$ se $\frac{P_2}{P_1} < 0{,}53$ $\frac{\dot{m}\sqrt{R T_1}}{A_g P_1} = cost = \Gamma$

$\Gamma = \sqrt{K \left(\frac{2}{K+1}\right)^{\frac{K+1}{K-1}}} \cong 0{,}685$ se critico $T_{out} = T_{in} \frac{2}{K+1}$ $\rho_{out} = \frac{P_{out}}{R T_{out}}$ $P_{out} \neq P_2$ $P_{out} = 0{,}53\, P_1$

(anche se $\frac{P_2}{P_1} < 0{,}53$ P_{out} é sempre pari al rapp critico!)

$\boxed{\text{Compr Volum}}$ $M = \lambda_v \rho_{IN} V_0 i$ $\dot{m} = M \cdot n$ $\ell_i = \frac{L_c}{M}$ $P_i = L_c \cdot n = \ell_i \cdot \dot{m}$ $T_2 \simeq T_1 + \frac{L_i}{c_p}$

n [giri/s]

$\boxed{\text{Stantuffo}}$ $\lambda_v = \eta_\varphi (1-\delta_1) \frac{\eta_{\tilde{}} V_A - V_D}{V_0} = \eta_\varphi (1-\delta_1) \left[(1+\mu) - \mu \beta_i^{1/m^{*\prime}}\right]$ $\beta_i = \beta \frac{1+\delta_2}{1-\delta_1}$

$L_c = V_A P_A \frac{m^*}{m^*-1} \left(\beta_i^{\frac{m^*-1}{m^*}} - 1\right) - V_c P_c \frac{m^{*\prime}}{m^{*\prime}-1} \left(1 - \frac{1}{\beta_i^{\frac{m^{*\prime}-1}{m^{*\prime}}}}\right)$ $\begin{cases} V_c = \mu V_0 \\ V_A = (1+\mu) V_0 \end{cases}$ $\eta_\varphi = \frac{M_{mand}}{M_{asp}}$

$\boxed{\text{Palette}}$ $r = \frac{V_0}{V_c}$ $P_c = P_{IN} r^{m^*}$ $\lambda_v \cong \eta_\varphi$ $L_c = \left[\frac{m^*}{m^*-1} P_{IN} V_0 \left(r^{m^*-1} - 1\right) + \frac{V_0}{r}(P_{out} - P_c)\right] i$

se adiabatico $m^* = K$!

se $V_{min} \neq 0$ $\lambda_v = \eta_\varphi \frac{V_0 - V_{min}}{V_0}$; $L_c = \left[\frac{m^*}{m^*-1} P_{IN} V_0 \left(r^{m^*-1} - 1\right) + \frac{V_0}{r}(P_{out} - P_c) - V_{min}(P_{out} - P_{in})\right] i$

$\boxed{\text{Turbocompressori}}$ $T_2 = T_1 \beta_c^{\frac{R}{c_p}\frac{1}{\eta_{y}}} = T_1 + \frac{T_{2IS} - T_1}{\eta_c}$ con $T_{2IS} = T_1 \beta_c^{\frac{R}{c_p}} = T_1 \beta_c^{\frac{k-1}{k}}$

$L_c = c_p T_1 \left(\beta_c^{\frac{R}{c_p}\frac{1}{\eta_{yc}}} - 1\right) = \frac{1}{\eta_c} c_p T_1 \left(\beta_c^{\frac{R}{c_p}} - 1\right)$ $P_{ass} = \frac{1}{\eta_0} L_c \dot{m}_a$ centrifugo con pale radiali $L_i = u_2^2$

$\boxed{\text{Turbogas}}$ $L_T = c_p' T_3 \left(1 - \frac{1}{\beta_T^{\frac{R'}{c_p'}\eta_{yT}}}\right) = \eta_T c_p' T_3 \left(1 - \frac{1}{\beta_T^{R'/c_p'}}\right)$

$P_u = \eta_m \dot{m}_a \left(\frac{1+\alpha}{\alpha} L_T - L_c\right)$ $\eta_b H_i = (1+\alpha)\, c_p' (T_3 - T_2)$ $\alpha = \frac{\eta_b H_i}{c_p'(T_3 - T_2)} - 1$

$\dot{m}_b (1+\alpha) = \dot{m}_g = \dot{m}_a + \dot{m}_b = \dot{m}_a \left(\frac{1+\alpha}{\alpha}\right)$ $R = \frac{T_5 - T_2}{T_4 - T_2}$ SE HO R $T_5 = T_2$ per il calcolo di α!

$T_4 = \frac{T_3}{\beta_T^{\frac{R'}{c_p'}\cdot \eta_{yT}}} = T_3 - \eta_T (T_3 - T_{4IS})$ con $T_{4IS} = T_3 / \beta_T^{R'/c_p'}$

$\alpha = \frac{\dot{m}_a}{\dot{m}_b}$ $\eta_g = \frac{\alpha P_u}{\dot{m}_a H_i}$ $\beta_c = K \sqrt{T_3} \frac{\dot{m}_a \sqrt{T_1}}{P_1}$ $\left| \frac{T}{P^{\frac{m-1}{m}}} = cost \quad P \cdot V^m = cost \quad T \cdot V^{m-1} = cost \right.$

$\boxed{\text{Bi - albero}}$ $\frac{T_3}{n_c^2} = \text{cost}$ $\frac{T_3}{T_4} = \text{cost}$ $\frac{L_{i,c}}{n_c^2} = \text{cost}$ (da usare se non riesco a fare più nulla con le altre)

$\boxed{\text{Roots}}$ $\mathcal{L}_c = i V_0 \Delta P$ $\frac{T_2}{T_1} = 1 + \frac{1}{\lambda_v} \frac{K-1}{K} (\beta - 1)$

Se motore $\dot{m} = \frac{1}{\lambda_v} \rho_{IN} V_0 i \cdot n$ $\longrightarrow$ Usare $P = \mathcal{L}_c \cdot n$ perché nel calcolo di $\mathcal{L}_i$ bisogna tenere conto che non tutta $\dot{m}$ fa lavoro quindi $\mathcal{L}_i$ andrebbe riferito solo alla M che "lavora"

Se misuratore $\lambda_v = 1$ $(\Delta P \cong 0)$

$\boxed{\text{Stadio}}$ $L_i = u_1 C_{1u} - u_2 C_{2u}$ (Motrici) $L_i = \frac{C_1^2 - C_2^2}{2} + \frac{W_2^2 - W_1^2}{2} + \frac{u_1^2 - u_2^2}{2}$

$L_i = u_2 C_{2u} - u_1 C_{1u}$ (operatrici) $L_i = \frac{C_2^2 - C_1^2}{2} + \frac{W_1^2 - W_2^2}{2} + \frac{u_2^2 - u_1^2}{2}$

Azione $C_1 = \varphi C_{1,is}$ $W_2 = \psi W_{2,is}$ $W_{2is} = W_1$ in quanto $\Delta P_{rot} = 0$

Reazione $C_1 = \varphi C_{1,is}$ $W_2 = \psi W_{2,is}'$ (che ottengo con isentropica da 1)

$\eta_\theta (TTS) = \frac{h_0^0 - h_2^0}{h_0^0 - h_{2is}}$ Da usare se E_c allo scarico è dissipata

$\eta_{\oplus} = \frac{h_0^0 - h_2^0}{h_0^0 - h_{2,is} - \frac{C_2^2}{2}}$ Se mi è utile E_c allo scarico ad esempio serie di stadi a reazione

Deflessione = angolo tra le velocità IN - OUT $\dot{m} = \rho \, \xi \, \pi d l \cdot C_{assiale}$

$\varepsilon = \alpha_0 - \alpha_1$ o $\beta_1 - \beta_2$

$\vec{R} = \dot{m} (\vec{C_2} - \vec{C_1}) = -P_1 A_1 \hat{n}_1 - P_2 A_2 \hat{n}_2 + \vec{F} + \int_{AL} P \cdot \hat{n} \, dA_L$ $\vec{F}_{sull'organo} = -\vec{F}$

$\boxed{\text{IDRAULICHE}}$ Dove non ho lavoro $\frac{P_A}{\rho g} + z_A + \frac{C_A^2}{2g} = \frac{P_B}{\rho g} + z_B + \frac{C_B^2}{2g} + Y_D$ $\eta_y = \frac{\mathcal{L}_i}{g H_u}$

Se ho scambio di lavoro $\mathcal{L}_i = \frac{P_1 - P_2}{\rho} + g(z_1 - z_2) + \frac{C_1^2 - C_2^2}{2} - E_{diss, gir}$ $g H_u = \mathcal{L}_i + \underbrace{E_{diss, turbina}}_{E_{d,distr} + E_{d,gir} + E_{d,diff}}$

$n_s = \frac{n D}{\sqrt{H_u}}$ $Q_s = \frac{Q}{D^2 \sqrt{H_u}}$ $n_c = \frac{n \sqrt{P_u}}{H_u^{5/4}}$ $\longrightarrow$ in cavalli $1 CV = 735 W$

$E_{d,distr} \rightarrow \frac{C_{1,is}^2 - C_1^2}{2}$ $E_{d,gir} \rightarrow \frac{W_{2,is}^2 - W_2^2}{2}$ $E_{d,diff} \rightarrow \eta_{DIFF}$

Vortice libero: $r_1' C_{1u}' = r_1 C_{1u}$

$P_u = \eta_0 \eta_y \eta_v \rho Q g H_u = \eta_0 \eta_v \rho Q \mathcal{L}_i$

$H_A^0 - H_B^0 = \underbrace{H_A^0 - H_0^0}_{Y_D} + \underbrace{H_0^0 - H_3^0}_{H_u} + \underbrace{H_3^0 - H_B^0}_{C_3^2/2g}$

$\eta_{DIFF} = \frac{\frac{C_2^2}{2} - \frac{C_3^2}{2} - E_{d,diff}}{\frac{C_2^2}{2} - \frac{C_3^2}{2}}$ Se recupera tutta la comp assiale $E_{d,diff} = \frac{C_{2u}^2}{2}$

C_2 assiale in pg.
Kaplan $C_{1m} = C_2$
Francis $C_{1m} \neq C_2$
Fuori progetto C_2 non sempre assiale ma $\Delta\beta$ è costante

$\varphi = \frac{C_1}{C_{1,is}}$ $\rightarrow$ $\frac{C_1^2}{2} \left(\frac{1}{\varphi^2} - 1 \right)$

$\psi = \frac{W_2}{W_{2,is}}$ $\rightarrow$ $\frac{W_2^2}{2} \left(\frac{1}{\psi^2} - 1 \right)$

Turbina: $P_u = \eta_0 P_i$ Compressore: $P_{ass} = P_i / \eta_0$ $P = C \cdot \frac{2\pi n}{60}$ $n = \frac{60 f}{p}$

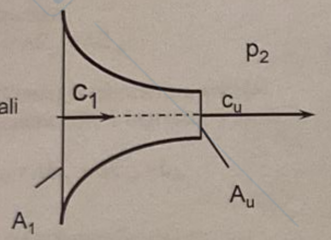
UGELLO SEMPLICEMENTE CONVERGENTE

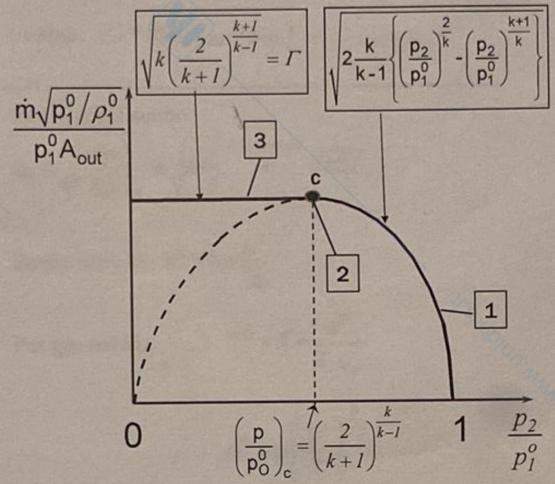
Condizioni di monte

p_1, ρ_1, T_1, c_1

Condizioni totali di monte

$p_1^o, \rho_1^o, T_1^o = p_0^o, \rho_0^o, T_0^o$





$$\dot m = A_u \frac{p_1^o}{\sqrt{p_1^o/\rho_1^o}}\sqrt{2\frac{k}{k-1}\left[\left(\frac{p}{p_1^o}\right)^{\frac{2}{k}} - \left(\frac{p}{p_1^o}\right)^{\frac{k+1}{k}}\right]} \quad (1, 2)$$

$$\dot m = A_u \frac{p_1^o}{\sqrt{p_1^o/\rho_1^o}}\sqrt{k\left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}} = \dot m_c \quad (3, 2)$$

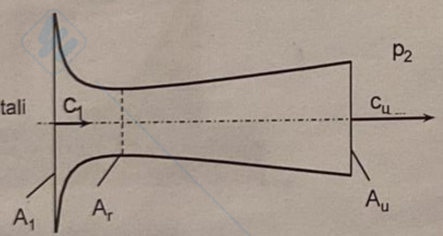
UGELLO CONVERGENTE DIVERGENTE (DE-LAVAL)

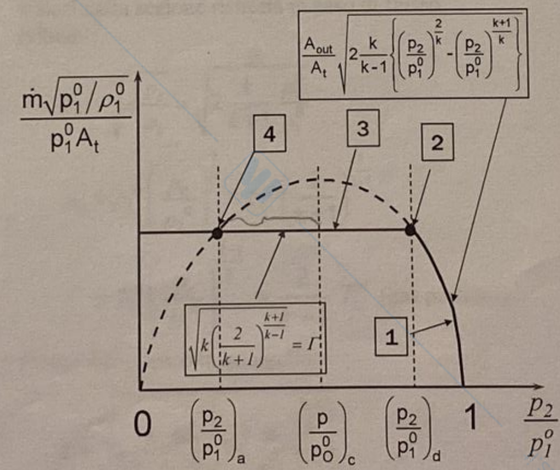
Condizioni di monte

p_1, ρ_1, T_1, c_1

Condizioni totali di monte

$p_1^o, \rho_1^o, T_1^o = p_0^o, \rho_0^o, T_0^o$





$$\dot m = A_u \frac{p_1^o}{\sqrt{p_1^o/\rho_1^o}}\sqrt{2\frac{k}{k-1}\left[\left(\frac{p}{p_1^o}\right)^{\frac{2}{k}} - \left(\frac{p}{p_1^o}\right)^{\frac{k+1}{k}}\right]} \quad (1, 2 \text{ e } 4)$$

$$\dot m = A_r \frac{p_1^o}{\sqrt{p_1^o/\rho_1^o}}\sqrt{k\left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}} = \dot m_c \quad (2, 3, 4)$$

$$\dot m = A_u \frac{p_1^o}{\sqrt{p_1^o/\rho_1^o}}\sqrt{2\frac{k}{k-1}\left[\left(\frac{p}{p_1^o}\right)_d^{\frac{2}{k}} - \left(\frac{p}{p_1^o}\right)_d^{\frac{k+1}{k}}\right]} = \dot m_c \quad (2)$$

$$\dot m = A_u \frac{p_1^o}{\sqrt{p_1^o/\rho_1^o}}\sqrt{2\frac{k}{k-1}\left[\left(\frac{p}{p_1^o}\right)_a^{\frac{2}{k}} - \left(\frac{p}{p_1^o}\right)_a^{\frac{k+1}{k}}\right]} = \dot m_c \quad (4)$$