Formuleo Turbomáquinas

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Ecuaciones 1 (Modelo gas ideal) *Gas Ideales:* $\tilde{R} = 8,314$*[J/mol/K]*$\| \tilde{R} = \bar{M}R$, $\bar{M}$*[kg/mol]*$\| pV = mRT \| pv = RT \| pV = N\tilde{R}T \| a = \sqrt{Z_a kRT} \| T_0 = T\left(1+\frac{k-1}{2}M^2\right) \| p_0 = p\left(1+\frac{k-1}{2}M^2\right)^{\frac{k}{k-1}} \| \rho_0 = \rho\left(1+\frac{k-1}{2}M^2\right)^{\frac{1}{k-1}} \| \frac{p_0}{p} = \left(\frac{T_0}{T}\right)^{\frac{k}{k-1}} = \left(1+\frac{k-1}{2}\mathrm{M}^2\right)^{\frac{k}{k-1}} \| \frac{\rho_0}{\rho} = \left(\frac{T_0}{T}\right)^{\frac{1}{k-1}} = \left(1+\frac{k-1}{2}\mathrm{M}^2\right)^{\frac{1}{k-1}} \| \frac{T_0}{T} = \left(\frac{p_2}{p_1}\right)^{\frac{k-1}{k}} = \left(\frac{v_1}{v_2}\right)^{(k-1)} = 1+\frac{1}{2}(k-1)\frac{c^2}{kRT} = 1+\frac{1}{2}(k-1)\mathrm{M}^2\|$

Proc. compres. iso. $p_0 = cte = p + \frac{1}{2}\rho c^2 \| h_0 = h + \frac{1}{2}c^2$

Gas perfecto: $h = c_p T$; $c_p = kR/(k-1) \rightarrow T_0 = T + \frac{1}{2}c^2/c_p \| s_x^0 = s_x - s_0 = \int_{T_0}^{T_x} \frac{c_p}{T}\mathrm{d}T \rightarrow s_2 - s_1 = c_p \ln\frac{T_2}{T_1} - R\ln\frac{p_2}{p_1}$

Ecuaciones 2 (Turbinas) *Rend. de la instalación:* $\frac{\textit{Potencia efectiva}}{\textit{Potencia entregada a la instalación}}$

Ecuaciones 3 (T. Hidráulicas) *Pelton: aprox Dixon* $w_2 \approx U \rightarrow c_2 \approx 2U\sin\frac{\beta_2}{2}$ *donde* $\beta_2 = \pi - \vartheta_2$

Ecuaciones 4 (T. de Vapor) *Trabajo:* $\mathrm{d}e = \frac{1}{\rho}\mathrm{d}p + \mathrm{d}\frac{1}{2}c^2 + \mathrm{d}q \|$ *Tobera:* $\eta_{\text{iso}}^{\text{tobera}} = \frac{c_1^2/2}{c_{1s}^2/2}$; $K_f = \frac{c_1}{c_{1s}} \|$ *Rotor:* $dp = 0:\ \eta_{\text{iso}}^{\text{rotor}} = \frac{\dot{W}/\dot{m}}{c_1^2/2}$ *con* $K_m = \frac{w_2}{w_1} \|$ *Eficiencia interna de etapa:* $\eta_i = \eta_{\text{iso}}^{\text{tobera}} \cdot \eta_{\text{iso}}^{\text{rotor}} \cdot \ldots = \frac{W/\dot{m}}{\Delta h_s} \|$ *Escalonamiento de reaccion:* $c_s = \sqrt{2\Delta h_s(1-\ ) + c_0^2} \|$ *Perdidas tobera:* $Y_{\text{tob.}} = \dot{m}(c_{1s}^2/2 - c_1^2/2)$ *Perdidas movil:* $Y_{\text{m}} = \dot{m}(w_1^2/2 - w_2^2/2)$ *Perdidas roz. entre fijo/movil:* $k_{\text{axial}} = 0,009$ *,*$k_{\text{radial}} = 0,027$ *:* $Y_{\text{roz.}} = k\rho n_{\text{Hz}}^3 D^5$ *[W]*$\|$ *Perdidas ventil.* ε *es grado adm.* l *es largo alabes en* cm *y* k *depende del nro. de ruedas* $k_1 = 3,8$*;* $k_2 = 4,5$*;* $k_3 = 6 \rightarrow Y_{\text{vent.}} = (1-\varepsilon)k\rho n^3 D^4 l$ *[W].*

Ecuaciones 5 (T.Gas) *Regeneración:* $\sigma = \frac{T_A - T_2}{T_4 - T_2}$*,*$\varsigma = \frac{T_2}{T_1}$*,*$\vartheta = \frac{T_3}{T_1}$*,*$\eta_{\text{regen}} = \frac{\varsigma - 1}{\varsigma}\frac{\vartheta - \varsigma}{\vartheta - \varsigma - \sigma\frac{\vartheta - \varsigma^2}{\varsigma}} \|$ *Potencia eff donde* $w = \Delta h$

$\dot{W}_e = (\dot{m}_{\text{air}} + \dot{m}_{\text{comb.}}) \cdot w_{\text{turb.}} - \dot{m}_{\text{air}} \cdot w_{\text{comp.}} \| \mathbf{C}_e = \frac{\dot{m}_{\text{comb.}}}{P_e}$

Ecuaciones 6 (Ciclo combinado) *Rankine:* $\eta = \frac{\dot{W}_{\text{t}}/\dot{m} - \dot{W}_{\text{b}}/\dot{m}}{\dot{Q}_{\text{in}}/\dot{m}} = \frac{|\Delta h_{\text{turb.}}| - \Delta h_{\text{bomba}}}{\Delta h_{\text{cald}}} = 1 - \frac{|\Delta h_{\text{cond.}}|}{\Delta h_{\text{cald}}} \| \mathrm{BWR} = \frac{\dot{W}_{\text{b}}/\dot{m}}{\dot{W}_{\text{t}}/\dot{m}} = \frac{\Delta h_{\text{bomba}}}{|\Delta h_{\text{turb}}|}$

$\|$ *Turb/bomba (b al revés):* $\eta_{\text{t}} = \frac{\Delta h_{\textit{turb}}}{(\Delta h_{\textit{turb.}})_s}$