**I° PRINCIPIO DELLA TERMODINAMICA**

$$Q_{12} = L_{12} + u_2 - u_1 + g\,(z_2 - z_1) + \frac{w_2^2 - w_1^2}{2}$$

$$Q_{12} = L'_{12} + h_2 - h_1 + g\,(z_2 - z_1) + \frac{w_2^2 - w_1^2}{2}$$

**EQUAZIONE DI BERNOULLI**

$$g\,(z_2 - z_1) + \frac{w_2^2 - w_1^2}{2} + \int_1^2 v\,dp + L_{12} + R'_{12} = 0$$

**GAS IDEALE**

$p\,v = \overline{R}\,T$ $\qquad \overline{R} = \frac{R}{M}$ $\qquad k = \frac{c_p}{c_v}$ $\qquad \overline{R} = c_p - c_v$ $\qquad c_v = \frac{\overline{R}}{k-1}$

<u>ISOCORA</u>

Senza deflusso $l = p\,\mathrm{d}v = 0$

Con deflusso $l = -v\,\mathrm{d}p$

$\mathrm{d}Q = c_v\,\mathrm{d}T$

<u>ISOBARA</u>

Senza deflusso $l = p\,\mathrm{d}v$

Con deflusso $l = -v\,\mathrm{d}p = 0$

$\mathrm{d}Q = c_p\,\mathrm{d}T$

<u>ISOTERMA</u>

$l = R\,T\,\ln\frac{p_1}{p_2} = R\,T\,\ln\frac{v_2}{v_1}$

$\mathrm{d}Q = \mathrm{d}L$ se reversibile

<u>ADIABATICA</u>

$p\,v^k = \cos t$ $\qquad T\,v^{k-1} = \cos t$ $\qquad T\,p^{\frac{1-k}{k}} = \cos t$

Senza deflusso reversibile $l_{12} = -\frac{p_1\,v_1}{k-1}\left(\left(\frac{p_2}{p_1}\right)^{\frac{k-1}{k}} - 1\right)$

Per sistemi aperti (con deflusso) $l_{12} = k\,\frac{p_1\,v_1}{1-k}\left(\left(\frac{p_2}{p_1}\right)^{\frac{k-1}{k}} - 1\right)$

Con deflusso reversibile $L' = k\,L$

<u>POLITROPICA</u>

Per sistemi aperti $l = n\,\frac{p_1\,v_1}{1-n}\left(\left(\frac{p_2}{p_1}\right)^{\frac{n-1}{n}} - 1\right)$

Per sistemi chiusi $l = \frac{p_1\,v_1}{1-n}\left(\left(\frac{p_2}{p_1}\right)^{\frac{n-1}{n}} - 1\right)$

Calore specifico $c = c_v + \frac{R}{1-n} = c_v + \frac{c_p - c_v}{1-n} = c_v\left(\frac{k-n}{1-n}\right)$

**ENTROPIA**

$$s - s_0 = c_v \ln\left[\frac{T}{T_0}\left(\frac{v}{v_0}\right)^{k-1}\right] = c_v \ln\left[\frac{p}{p_0}\left(\frac{v}{v_0}\right)^{k}\right] = c_p \ln\left[\frac{T}{T_0}\left(\frac{p}{p_0}\right)^{\frac{1-k}{k}}\right]$$

**CICLO RANKINE**

$$\eta = \frac{L_{netto}}{Q_+} \qquad \eta_{\text{is.espansione}} = \frac{L_{\text{reale}}}{L_{\text{ideale}}} \qquad \eta_{\text{is.compressione}} = \frac{L_{\text{ideale}}}{L_{\text{reale}}}$$

**CICLI INVERSI**

$$\varepsilon = \frac{Q_0}{L_{netto}} = \frac{|Q_2|}{|Q_1 - Q_2|} = \frac{T_2}{T_1 - T_2}$$

**POMPA DI CALORE**

$$\varepsilon' = COP' = \frac{|Q_1|}{|L|} = \frac{|Q_1|}{|Q_1 - Q_2|} = \frac{T_1}{T_1 - T_2} \qquad \varepsilon' = \varepsilon + 1$$

**CONDUZIONE TERMICA**

$$q = \frac{\lambda\, A\, \Delta t}{s}$$

$$q = \frac{\Delta t}{\dfrac{1}{2\pi\, L\, \lambda} \ln \dfrac{r_e}{r_i}}$$

**CONVEZIONE TERMICA**

$$q = h\, A\, \Delta t$$

**SCAMBIO TERMICO GLOBALE**

$$K = \frac{1}{\dfrac{1}{h_i} + \dfrac{s}{\lambda} + \dfrac{1}{h_e}} \qquad K_i = \frac{1}{\dfrac{1}{h_i} + \dfrac{r_i}{\lambda} \ln \dfrac{r_e}{r_i} + \dfrac{1}{h_e}\dfrac{r_i}{r_e}} \qquad K_e = \frac{1}{\dfrac{1}{h_i}\dfrac{r_e}{r_i} + \dfrac{r_e}{\lambda} \ln \dfrac{r_e}{r_i} + \dfrac{1}{h_e}}$$

**SCAMBIATORI DI CALORE**

$$\Delta T_{ml} = \frac{\Delta_1 - \Delta_2}{\ln \dfrac{\Delta_1}{\Delta_2}} \qquad q = c_{\text{p}}\, \dot{m}\, \Delta t \qquad \varepsilon = \frac{\dot{C}'\Delta t'}{\dot{C}_{\min}\left(t_i' - t_i''\right)} = \frac{\dot{C}''\Delta t''}{\dot{C}_{\min}\left(t_i' - t_i''\right)}$$