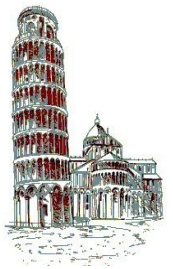
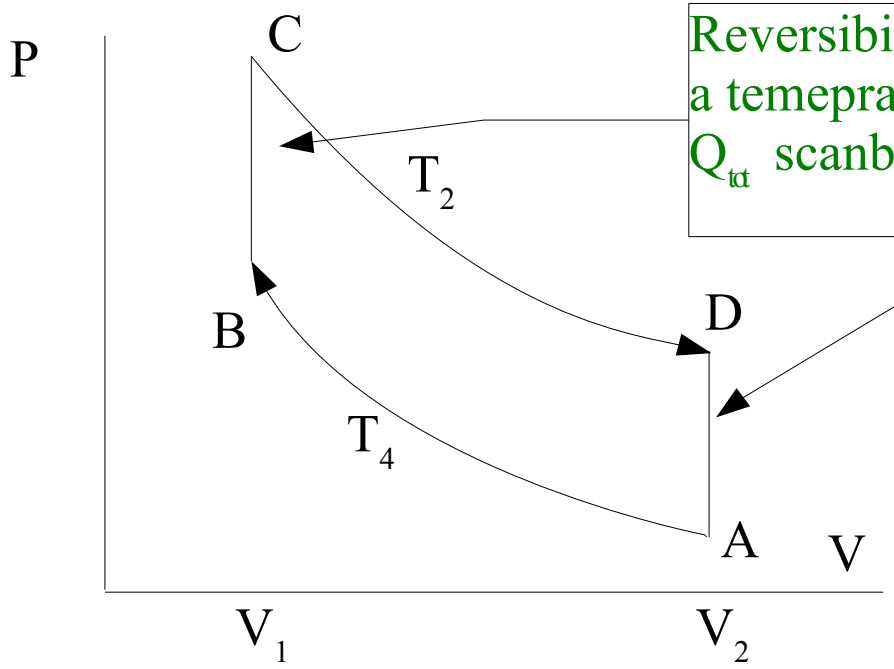
Termodinamica

Ciclo di Stirling



Isocora->isoterma -> isocora -> isoterma



Reversibile se c'e' una serie di sorgenti a temeprature scalate con continuita'e Q_{tot} scanbiato nullo

$$\Delta U_{BC} = n c_v (T_2 - T_4)$$

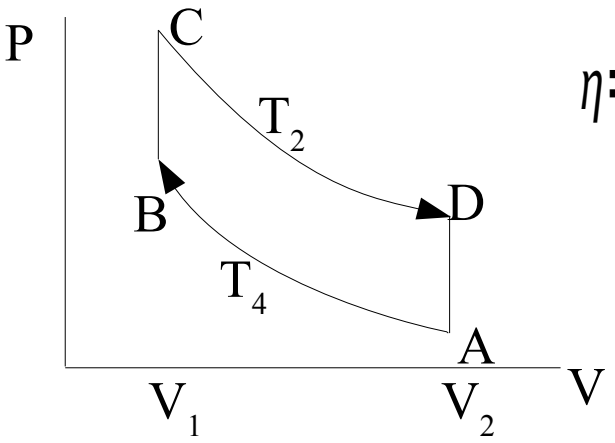
$$\Delta U_{DA} = -n c_v (T_2 - T_4)$$

$$Q_2 = L_2 = n R T_2 \ln\left(\frac{V_D}{V_C}\right) > 0$$

$$Q_4 = L_4 = n R T_4 \ln\left(\frac{V_B}{V_A}\right) < 0$$

Termodinamica

Ciclo di Stirling



$$\eta = \frac{Q_2 + Q_4}{Q_2} = 1 + \frac{n R_4 T_4 \log V_B / V_A}{n R_2 T_2 \log V_D / V_C} = 1 - \frac{T_4}{T_2}$$

Nel caso di sorgenti separate? T_2 e T_4 ..... le isocore sono **irreversibili**

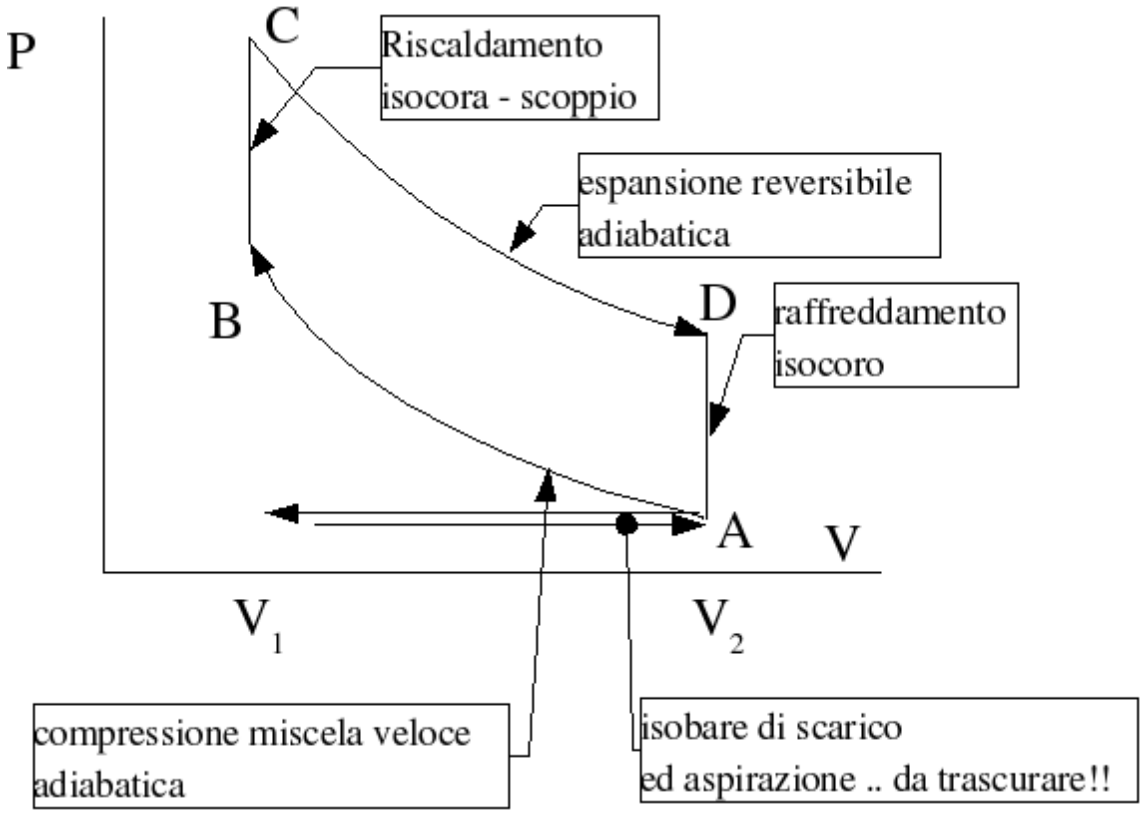
$$Q'_2 = n c_v (T_2 - T_4) = -Q'_4$$ da mettere nel bilancio

$$\eta' = \frac{Q_2 + Q_4 + Q'_2 + Q'_4}{Q_2 + Q'_2} = \frac{Q_2 + Q_4}{Q_2} \quad \frac{Q_2}{Q_2 + Q'_2} = \eta \frac{Q_2}{Q_2 + Q'_2} < \eta$$ cvd

Termodinamica

Ciclo di Otto. motore a 4 tempi a benzina

D: => adiabatica->isocora -> adiabatica -isocora



Riscaldamento a T_c

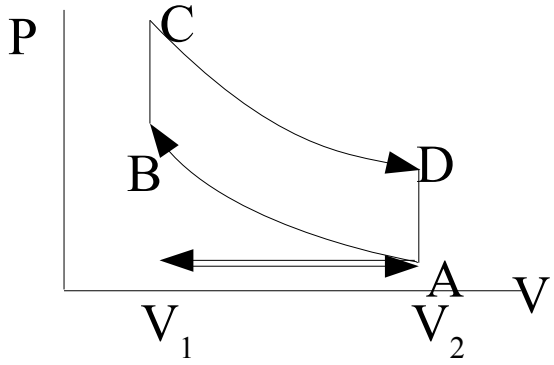
Raffreddamento a T_A

$$Q_2 = n\, c_v (T_C - T_B)$$

$$Q_4 = n\, c_v (T_A - T_D)$$

Termodinamica

Ciclo di Otto. motore a 4 tempi a benzina



$$\eta = 1 + \frac{Q_4}{Q_2} = 1 - \frac{T_D - T_A}{T_C - T_B}$$

$$T_A V_A^{\gamma-1} = T_B V_B^{\gamma-1}$$

$$T_D V_D^{\gamma-1} = T_C V_C^{\gamma-1}$$

$$\frac{T_D - T_A}{T_C - T_B} = \left(\frac{V_A}{V_B}\right)^{1-\gamma} = r^{1-\gamma}$$

rapporto di compressione

$\gamma = 1.4$ *per l'aria*

$$Q_2 = n\, c_V (T_C - T_B)$$

$$Q_4 = n\, c_V (T_A - T_D)$$

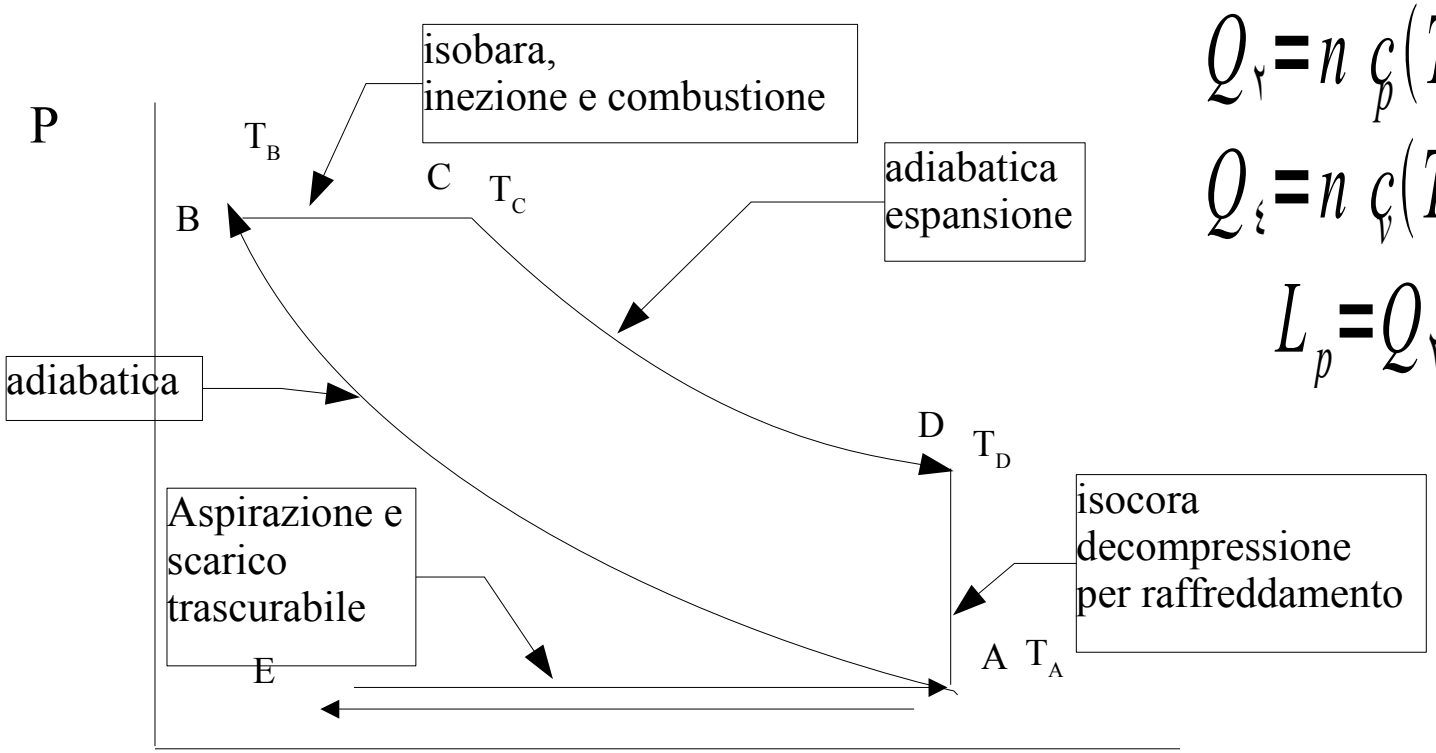
$$L_p = Q_2 + Q_4$$

$$\eta = 1 - r^{-0.4}$$

r=7 => η=54% > 30% reale

Termodinamica

Ciclo Diesel. motore a 4 tempi a gasolio



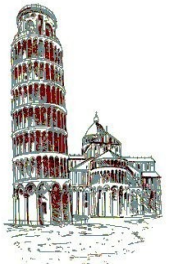
$$Q_2 = n\, c_p (T_C - T_B)$$

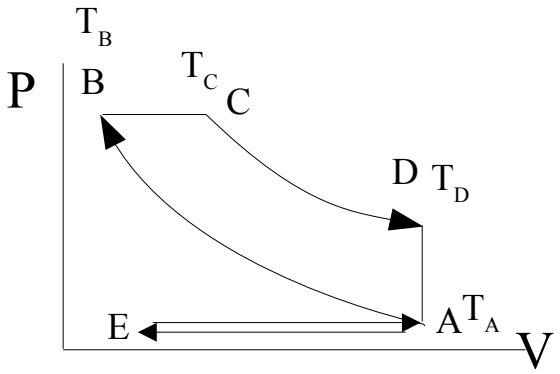
$$Q_4 = n\, c_v (T_A - T_D)$$

$$L_p = Q_2 + Q_4$$

Termodinamica

Ciclo Diesel. motore a 4 tempi a benzina





$$\eta = 1 + \frac{Q_4}{Q_2} = 1 + \frac{n c_v (T_A - T_D)}{n c_p (T_C - T_B)} = 1 - \frac{T_D - T_A}{\gamma (T_C - T_B)}$$

$$Q_2 = n c_p (T_C - T_B)$$

$$Q_4 = n c_v (T_A - T_D)$$

$$L_p = Q_2 + Q_4$$

$$T_D V_D^{\gamma-1} = T_C V_C^{\gamma-1} \qquad T_A V_A^{\gamma-1} = T_B V_B^{\gamma-1}$$

$$\frac{T_B}{T_C} = \frac{V_B}{V_c} \quad sull isobara$$

$$rapporti \quad r_c = \frac{V_A}{V_B} \approx 10 \qquad r_e = \frac{V_D}{V_C} \approx 5$$

$$\eta = 1 - \frac{1/r_e^{\gamma} - 1/r_c^{\gamma}}{\gamma (1/r_e - 1/r_c)} \qquad \eta = 54\%$$