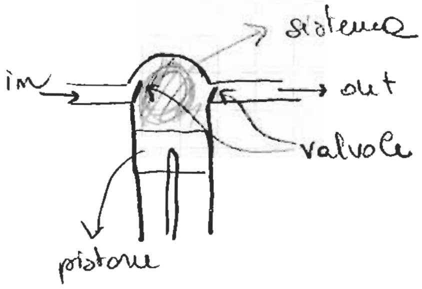
Esercizio sul motore diesel



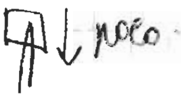
$0 \to A$

0) entra da "in" aria
P cost. e il pistone scende

$A \to B$

1) compressione adiabatica

$B \to C$

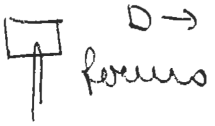


2) in B inietto il carburante
⇒ aria + carburante si espande
a pressione costante

$C \to D$

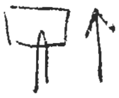
3) alta temp. della miscela
causa combustione ⇒ scoppio
e espansione adiabatica

$D \to A$

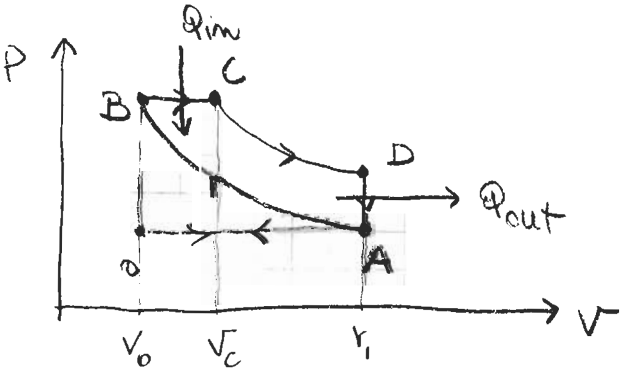


4) "out" aperta e energia espulsa
molto rapidamente

$A \to 0$



5) miscela espulsa con
pistone che sale



$$\Delta U = 0 \Rightarrow \Delta L = \Delta Q = Q_{BC} + Q_{DA}$$

$$Q_{BC} = n C_p (T_C - T_B)$$

$$\Rightarrow$$

$$Q_{DA} = n C_v (T_A - T_D)$$

$$\eta = \frac{\Delta L}{Q_{BC}} = \frac{Q_{BC} + Q_{DA}}{Q_{BC}} = 1 + \frac{c_v}{c_p}\frac{T_A - T_D}{T_C - T_B}$$

$$\eta = 1 - \frac{1}{\gamma}\frac{T_D - T_A}{T_C - T_B}$$

$A \to B$ $\quad T_A V_A^{\gamma-1} = T_B V_B^{\gamma-1}$ $\quad T_A = T_B \left(\frac{V_2}{V_1}\right)^{\gamma-1}$

$C \to D$ $\quad T_C V_C^{\gamma-1} = T_D V_D^{\gamma-1}$ $\quad T_D = T_C \left(\frac{V_C}{V_1}\right)^{\gamma-1}$

$$\eta = 1 - \frac{1}{\gamma}\frac{T_C\left(\frac{V_C}{V_1}\right)^{\gamma-1} - T_B\left(\frac{V_2}{V_1}\right)^{\gamma-1}}{T_C - T_B}.$$

Facciamo qualche conto: troviamo la potenza fornita da un motore diesel con 4 cilindri, 2 L di cilindrata, 3000 giri al minuto. $r = \frac{V_A}{V_B} = 22$ e $\frac{V_C}{V_B} = X = 2$ $\quad T_A = 300\ K$

$P_A = 10^5\ Pa$

V_A e V_B stesse formule dell'ab del motore a scoppio $\Rightarrow$

$$\begin{cases} V_A = \frac{r}{r-1}\Delta V = 0.523\ 10^{-3}\ m^3 \\ V_B = \frac{\Delta V}{r-1} = 0.238\ 10^{-4}\ m^3 \end{cases}$$

$$n = \frac{P_A V_A}{R T_A} = 0.02101 \approx 0.609\ g \text{ di aria}$$

$A \to B$ adiabatica

$$P_B = P_A r^\gamma = 7.57\ 10^6\ Pa$$

$$T_B = 1033\ K$$

$B \to C$ isobara $\quad P_C = P_B$

$$V_C = x V_B$$

$$\Rightarrow T_C = 2T_B = 2066\ K$$

$C \to D$ adiabatica $\quad V_D = V_A$

$$P_D V_A^\gamma = P_C V_C^\gamma$$

$$P_D = P_C \left(\frac{V_C}{V_A}\right)^\gamma = P_C \left(\frac{x}{r}\right)^\gamma = 2.64 \times 10^5\ Pa$$

$$\Rightarrow T_D = \frac{P_D V_A}{nR} = 790\ K$$

Rendimento

$$\eta = 1 - \frac{1}{\gamma} \frac{T_D - T_A}{T_C - T_B} = 0.66 \Rightarrow 66\ \%$$

$$P_{tot} = 4 \times \frac{2000}{60} \times \Delta L \quad \frac{1}{2}$$

$$\Delta L = n c_p (T_C - T_B) + n c_v (T_A - T_D) = 845\ J$$

$$\Rightarrow P_{tot} = 56.3\ kW.$$