Lesione 30 -

Diesel cycle has much higher β since the compress to ignite

η_{diesel} contains the volume ratio between the two points where it changes since it's not the same.

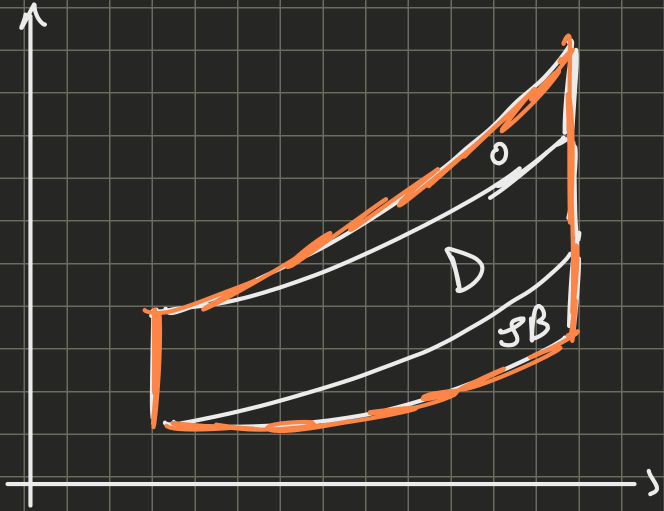
Because we have an r_c, the curve relative to the Otto cycle is lower.

The trend of the real efficiency is maintained like the ideal efficiency.
The is just simply a drop to correct the trend but the shape is the same.

Diesel vs. Otto

Advantages
- Higher overall efficiency
- Higher efficiency at part load
- Less valuable fuel

Disadvantages
- Heavier
- Lower power per unit displaced volume
- Generally noisier.



Humphrey cycle, is a cycle that attempts to optimize the cycle.

Impossible since ICE can't have isobaric cooling.

The idea is to take a gas-turbine, changing the burner to a combustion chamber where there can be an isocoric compression. This is not very practical. The new idea is to look at rotating combustion engines

Limit Cycle

Concept: Real Gas inside ideal machine

Two effects:

- Non-ideal gas $\Longrightarrow$ variation of c_p with T:

$$q_h = u_3 - u_2 = \int_{T_2}^{T_3} c_v \, dT \qquad \frac{dc_v}{dT} > 0$$

$$q_h = const \Longrightarrow T_3 \downarrow$$

c_v only nearly constant only at lower temperatures, and since we can reach $T = O(10^3)$ c_v is no longer constant

- Instability of Gases produced by combustion

Once our temperatures reach $T \sim 2500\,k$, the gases produce tends to be unstable and start to decompose it into other elements, these reactions are endothermic, causing the energy and temperature to drop, causing us to reduce produce energy.

For $T < 2000\,k$, the reactions are reversed.

These are exothermic, increasing T

$\longrightarrow$ Dissociation at high T requires energy $T_3 \downarrow$ } $l_{lim} \downarrow$

Recombination at low T releases energy } q_h -

$\Rightarrow \eta \downarrow \Rightarrow \eta_{lim} = \frac{l_{lim}}{l_{id}}$

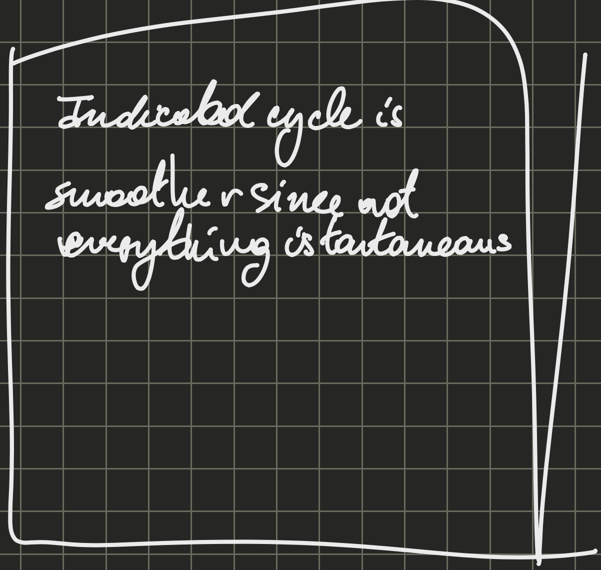
↳ Limit Cycle efficiency, is the difference between the ideal and real works, it is not a thermodynamic efficiency.

Real Cycles

Spark Ignition : Model

Four most relevant effects:

- Fluid-dynamic losses in ducts and across the intake and exhaust valves
- Heat transfer through duct walls and cylinder walls
- Non-instantaneous (not isocoric) combustion
- Phase displacements in the opening/closing of valves.



Losses reduce s because we need to keep cooling the walls so they don't fail on us.

<u>Power of the Engine:</u>

$$\eta = \frac{|\dot{L}|}{\dot{Q}_H} = \frac{\dot{m}_{FG}|l|}{\dot{m}_F \, LHV_F} = \frac{|l|}{\frac{\dot{m}_F}{\dot{m}_{FG}} LHV_F} = \frac{(\alpha+1)|l|}{LHV_F}$$

$$\dot{m}_{FG} = \dot{m}_F + \dot{m}_{ox} \longrightarrow \alpha = \frac{\dot{m}_{ox}}{\dot{m}_F}$$

$$|l| = \frac{\eta \, LHV_F}{\alpha+1}$$

organic loss

$$\eta = \frac{|\dot{L}|}{\dot{Q}_H} = \frac{\cancel{\dot{m}_{FG}}|l|}{\cancel{\dot{m}_{FG}}\, q_H} = \frac{|l|}{q_H} = \overbrace{\frac{|l|}{|l_{ind}|}}^{\eta_{org}} \cdot \frac{|l_{ind}|}{q_H}$$

indicated efficiency

indicated work from before

limit efficiency

normal cycle efficiency.

$$= \frac{|l|}{|l_{ind}|} \cdot \overbrace{\frac{|l_{ind}|}{|l_{lim}|}}^{\eta_{ind}} \cdot \overbrace{\frac{|l_{lim}|}{|l_{id}|}}^{\eta_{LIM}} \cdot \overbrace{\frac{|l_{id}|}{q_H}}^{\eta_{id}}$$

$$= \eta_{org} \cdot \eta_{IND} \cdot \eta_{LIM} \cdot \eta_{ID}$$

$$|\ell| = \eta_{org}\, \eta_{ind}\, \eta_{lim}\, \eta_{id}\, \frac{LHV_F}{\alpha+1}$$

$$|\dot{L}| = \dot{m}_{FG}\, |\ell| = \lambda \rho_0 V \frac{n}{60} \frac{1}{\varepsilon}\, \eta_{org}\, \eta_{ind}\, \eta_{lim}\, \eta_{id}\, \frac{LVH_F}{\alpha+1}$$

rps

$$\dot{m}_{FG} = \rho V \cdot \frac{n}{60} \cdot \frac{1}{\varepsilon} = \lambda \rho_0 V \frac{n}{60} \frac{1}{\varepsilon}$$

of gasses at intake

$< \rho_0$

↳ density of intaken fluid

↳ engine displacement

coefficient for 2 or 4 strokes

$\varepsilon = 1$ $\quad$ $\varepsilon = 2$

↳ number of revolutions to capture a new volume.

$$\lambda = \rho / \rho_0 \rightarrow \rho = \rho_0 \lambda$$