SSA 3

MATLAB

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Goal

- Add efficiency and losses

Conclusion

- The efficiency is added.
- The losses can be done after the model is worked out more. Still to many calculations and elaborations are missing.

Problems

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Follow up Steps

- Work out the model better using the NASA tables and formula's.
- combine the SecondExperiment.m and Simple_theoretical_script.m so the script can be elaborated since some sections of Simple_theoretical_script.m will be useful in SecondExperiment.m.

Work Division

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Time Division

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Overleaf Link

1 Efficiency

1.1 Otto efficiency

The Otto cycle is the name of the cycle used in spark-ignition internal combustion engines such as gasoline and hydrogen fuelled automobile engines. The Otto efficiency (ideal thermal efficiency) depends on the compression ratio r_c of the engine and the specific heat ratio γ of the gas in the combustion chamber. The Otto efficiency can be calculated using Equation 1.

$$\eta_{Otto} = 1 - (\frac{1}{r_c})^{\gamma - 1} \tag{1}$$

Thus, the thermal efficiency increases when the compression ratio increases. The compression ratio of Otto cycle engines is limited by the need to prevent uncontrolled combustion, known as knocking. The compression ratio of this engine is given by the engine data sheet, with a value of 8.5. The heat capacity ratio for gasoline at atmospheric pressure and ambient temperature is equal to 1.28[1], whereas that of ethanol is equal to 1.18[2]. In the ideal case, γ is assumed to be constant. Calculating the Otto efficiency using Equation 1, results in a value of 0.451 for gasoline, and 0.320 for ethanol. Therefore, adding more ethanol to the fuel mixture will reduce the thermal efficiency.

1.2 Thermal efficiency.

To compute the thermal efficiency of the engine under different circumstances due to the usage of different fuel blends, the formula for the Otto-cycle thermal efficiency γ is used.

$$\eta = \frac{\dot{W}}{Q_{in}} = \frac{\dot{W}}{Q_{LHV} \cdot \dot{m}_{fuel}} \tag{2}$$

In which $\dot{W}$ is the work performed by the cycle and is the area of the pV-diagram. The lower heating value (Q_{LHV}) is different for each fuel blend and therefore this value should be calculated using the NASA tables, the composition of the air-fuel mixtures and the enthalpy. $\dot{m}_{fuel}$ is the mass flow of the airfuel mixture in the cylinder that is calculated using the ideal gas law.

1.3 MATLAB implementation.

Equation 1 and Equation 2 are both added to SecondExperiment script, this can be seen in Figure 1.

```matlab

%% Efficiency
% Calculate the ideal thermal efficiency (Ott efficiency)
gamma = 1 %Since gamma (Cp/Cv) can be calculated using this matlab model I gave it a value of 1. SHOULD BE CHANGED
eta_O = 1-(1/compressionRatio)^(mean(gamma)-1);


% Calculate efficiency by dividing the work W by the input heat Q
% Work is equal to the area under the curve (trapz command)

p=1 %p isn't calculated yet.
eta = trapz(displacementVolume,p)/(QLHV*mdotfuel);

```

Figure 1: Equation 2 and Equation 1 in MATLAB.

As can be seen γ and p are not yet calculated in this MATLAB script because it's still to simple, this is also the reason why I wasn't been able to add the losses. There are still to many calculations that should be done first.

References

[1] http://large.stanford.edu/courses/2012/ph240/ramos1/#:~:text=For%20the%20engines%20in%20question,%CE%B7%20%E2%89%88%200.25%20at%20best.

[2] https://www.engineeringtoolbox.com/ethanol-ethyl-alcohol-properties-C2H6O-d_2027.html