SSA 1

Looking into experiments

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Goal

- The goal of this SSA is to create an RPC list for the project, research and document the main details of the experimental set-up such as the goal of the experiment, what should be measured and where is more information of the procedure. In addition, I also worked on finding Q_{LHV}.

Conclusion

- A list of RPC's have been created and the main details from the experiment phase has been documented. A beginning into calculating Q_{LHV} has been done.

Problems

- In the introduction presentation it was mentioned that by doing the experiments, the team will measure the fuel flow and in consequence will be able to calculate the heat added to the system (Q_i) (slide 39, PowerPoint presentation), which will allow us to find the efficiency. On the other hand, it is mentioned in the handbook that by doing the experiments the group van calculate the torque using a pulse sensor. I could not figure it out the connection between all the things mentioned above.
- I found it not as easy to read throw all the documentation on Canvas about the experiments and therefore it took me longer than expected.

Follow up Steps

- Find the exact connection between using the pulse sensor, calculating the torque and calculating the fuel flow and the heat added to the system.
- Find the function which computes the work from a graph in Matlab

Work Division

- I had shared the task with Vito. I have been working on documenting the experiment's highlights and beginning working on calculating Q_{LHV}

Time Division

- Creating the RPC list and documenting the experiment detail: 3.5hrs
- Working on the Q_{LHV}: 1hrs
- Making the SSA: 1 hr

Overleaf Link

1 RPC list

Requirements

- At the end the team has to come up with a well-funded advice for a bio-fuel composition that is suitable and efficient enough to be applied to a generator set
- The advice must be based on a detailed technological insight
- A model must be developed and implemented in a software tool (MATLAB) and validated/tuned as well

Preferences

- Efficiency of the engine should be as high as possible for the chosen bio-fuel
- The bio-fuel should be as green as possible

Constrains

- Major changes can not be done to the engine in order to improve the efficiency
- The team can only use as experimental set the Honda GX200 engine

2 Experiment 1

Goal of the experiment: is to perform certain input measurements on the fiddle engine (does not contain oil). Due to Corona measurements, in this year, the experiment will be as follow: a short video with the dissemble of the engine will be provided and the team can actually perform the measurements during the second experiment. [1]

What should be measured? (Figure 1)

- Bore [m]
- Stroke [m]
- Length of the connecting rod [m]
- Dead volume/ compression ratio [-]
- Timing of ignition [s]
- Valve timing [s]

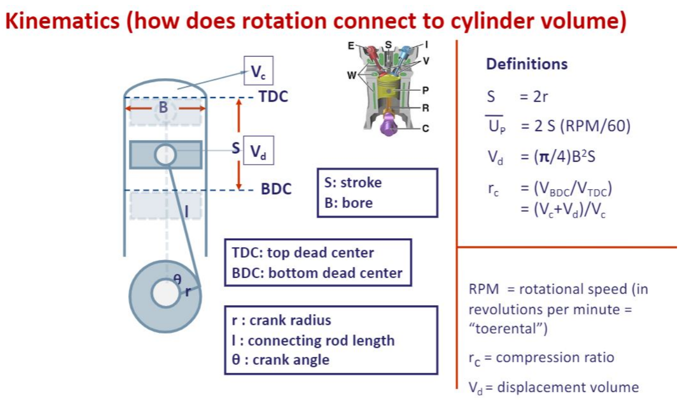

Figure 1: Visual picture of the components that the team will need to get the measurements

3 Experiment 2

Goal of the experiment: is to perform an engine test using the gasoline-ethanol mixture, which will be chosen by the group members.
From the set-up of experiment 2, the team can measure the torque and the pressure as a function of time. [1]

However, in the slide 39, from the introduction PowerPoint lecture, it is mentioned that the experiments will help the team get the cylinder pressure and fuel flow.

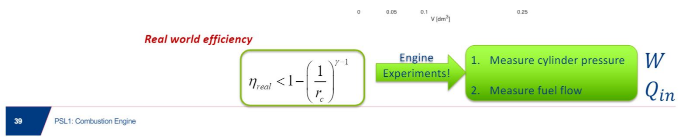

Figure 2: Slide 39, introduction lecture

The team will be using a pressure sensor and a pulse sensor, which will be equipped in the engine. The sensors are connected by a measurement board, which has a build in measurement card NI6211. Using a USB, the measurement board can be connected to a laptop.
Components of the set-up: Honda GX200 engine and a generator. [1]

Pressure sensor:

-measures the pressure in the cylinder. The data will be used on order to calculate the work done in the cylinder W (from Figure 5). By plotting a p-v graph in Matlab, the work can be computed as it is the area below the graph (it was also mentioned in the lecture that there is a function that can compute the work from a graph in Matlab, but I could not find it).

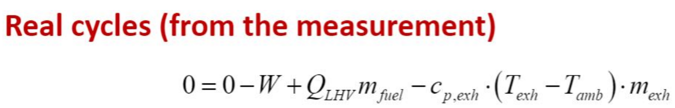

Figure 3: Central equation

-the 3 connections at the pressure sensor, yellow, brown and red, respectively output for mass, power supply are connected at the measurement board by a self-made 5-polar plug.

Pulse sensor:

-detector of the volume change

-helping in calculating the torque

-the sensor creates a voltage if a metal moves along it. The value of the voltage varies with the velocity and the amount of metal passes along the sensor.

Measuring the data:

-using he programs Ni-DAQmx9.02 and Meetpaneel 6.1 (find at the TU/e website with the so-called "
wtbfiler")

-the settings in Meetpaneel 6.1 with which the data have to be logged are: time/div: 50 ms and sample rate: 100 kHz

For further information about the exact guidelines of the experiment is Appendix 2 from Project Handbook on Canvas. (Link)

4 Experiment 3

It is mentioned in the Project Information document of Canvas (Link) and it is optional, with the purpose of taking extra measurements. It will be planned after the interim presentation.

5 MATLAB - Experiment 2

The calculation of $Q_L HV$ can be done by using the following formulas:

$$\boxed{} C_x H_y O_z + \boxed{\left(x + \frac{y}{4} - \frac{z}{2}\right)} O_2 \rightarrow \boxed{x} CO_2 + \boxed{\frac{y}{2}} H_2O$$

$$\widetilde{Q}_{LHV} = \sum_{i=1}^{N_{products}} \boxed{v_i} \widetilde{h}_i^0 - \sum_{i=1}^{N_{reactants}} \boxed{v_i} \widetilde{h}_i \qquad \left[\frac{J}{mole}\right]$$

$$Q_{LHV} = \sum_{i=1}^{N_{products}} s_i h_i^0 - \sum_{i=1}^{N_{reactants}} s_i h_i^0 \qquad \left[\frac{J}{kg}\right]$$

However, it is not explain exactly what s_i is. I looked at the introduction lecture and the teacher mentioned that s_i is the stoichiometric factors (x, y/2 etc) divided by the molar mass of each component.

However, it seems to be a problem with the units, as the molar mass has the unit of kg/mol and the stoichiometric factors do not have a unit. In this case s would have the unit of mol/kg, which multiplied with J/kg (unit of enthalpy), gives the final unit of the heat as $molJ/kg^2$

The first equation above would follow as:

$$\widetilde{Q}_{LHV} = x \widetilde{h}^o_{CO_2} + \frac{y}{2} \widetilde{h}^o_{H_2O} - \widetilde{h}^o_{C_xH_yO_z} - \left(x + \frac{y}{4} - \frac{z}{2}\right) \widetilde{h}^o_{O_2}$$

When it comes to the Matlab code, here is how the teacher used the Nasa database to compute the enthalpies for different components(PSL2 video lecture on Canvas):

```
T=[300:10:4000]; % Define T vector
iSp1=myfind({Sp.Name},{'O2'});  % Find index for O2
iSp2=myfind({Sp.Name},{'O'});   % Find index for O

hO2=HNasa(T,Sp(iSp1));          % Compute specific enthalpy for O2 as function of T vector
MO2=Sp(iSp1).Mass;              % Molar mass (kg/mol)
hO=HNasa(T,Sp(iSp2));           % Compute specific enthalpy for O as function of T vector
MO=Sp(iSp2).Mass;               % Molar mass (kg/mol)
```

References

[1] https://canvas.tue.nl/courses/14094/files/2986578?module_item_id=253237