Analysis of fuel produced from rapeseed oil

Aims of the experiment

- To analyse products from a synthesis
- To learn about viscosity as a physical quantity
- To learn about flash point as a physical quantity
- To compare the properties of biodiesel and diesel with each other

Principles

There is an ever-growing need for renewable energy sources. Biodiesel is also one of these, and is mostly produced from rapeseed oil. Biodiesel is similar to conventional fossil fuels in its properties. This includes its viscosity and ignition behaviour. However, the flash point and the density also characterise biodiesel as an adequate substitute for fossil fuels. Rapeseed oil itself is not suitable as a fuel as, due to its high viscosity, it is not readily transported to the engine and dispersed in the combustion chamber.

In order to avoid damage to the car and engine, exact analyses must be performed after the synthesis of the biodiesel. The intention of this is to ensure that the properties of the biodiesel correspond to those of diesel fuel.

On the one hand, the viscosity can be used for this. This is a measurement of the thickness of fluids. The greater the viscosity, the thicker the substance is. Rapeseed oil is significantly more viscous than biodiesel or conventional diesel fuel.

Another characteristic is the lower flashpoint of biodiesel compared with rapeseed oil. This lower flashpoint is necessary, as damage to the engine would otherwise result.

Another advantage of biodiesel, apart from its production from renewable raw materials, is its environmental friendliness. It is CO_2 neutral compared to fossil fuels.

In this experiment, various analyses of self-produced biodiesel are to be carried out.

In the first experiment, the flashpoints of biodiesel, diesel fuel and rapeseed oil will be compared.

In the second experiment, a simplified comparison of the viscosity of biodiesel, diesel fuel and rapeseed oil is to be carried out.

Fig. 1: Set-up of the experiment.

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Risk assessment

Do not allow heating oil to get on the skin and do not breathe its vapours in. Wear adequate protective clothing.

Heating oil (as a diesel replacement)

Signal word: Hazard

Hazard statements

H226 Flammable liquid and vapour.

H351 Suspected of causing cancer.

H304 May be fatal if swallowed and enters the airways.

H315 Causes skin irritation.

H332 Harmful if inhaled.

H373 Causes damage to organs through prolonged or repeated exposure.

H411 Toxic to aquatic life with long-lasting effects.

Precautionary statements

P102 Keep out of reach of children.

P301+P310 IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.

P331 Do NOT induce vomiting.

P261 Avoid breathing vapour.

P280 Wear protective gloves/protective clothing.

P308+P313 IF exposed or concerned: Get medical advice/attention.

P403+P233 Store in a well ventilated place. Keep container tightly closed.

P273 Avoid release to the environment.

Equipment and chemicals

1 Mobile CASSY 2 ..... 524 005
1 Temperature probe S, NTC 524 044
1 Magnetic stirrer with hotplate 607 5025
1 Stand rod 25cm, 12 mm diam. 300 41
1 Bosshead S 301 09
1 Universal clamp 666 666
3 Evaporating dish, porcelain, 24 ml, deep 608 310
1 Wooden sticks, 100 pcs. 672 2520
3 Graduated pipette 1 ml 665 994
1 Peleus ball 666 003
1 Hand-held stopwatch 313 07
1 Heating oil, 250 ml 672 1740
Also required:
1 Biodiesel from Experiment C 5.4.1.1
1 Rapeseed oil
1 Igniter

Set-up and preparation of the experiment

Set-up of the apparatus

1. No particular set-up is necessary for the determination of the viscosity.

2. The set-up for the determination of the flash point is as shown in Fig. 1.

3. Insert the temperature probe S via the Type K socket into the Mobile CASSY 2. This temperature probe S will be recognised and the instrument will display the temperature when switched on.

Note: If the Mobile CASSY 2 is not completely charged, a power supply should be kept ready in case it switches off.

Performance

Determination of the flashpoint

Into each of three evaporating dishes add heating oil, biodiesel and rapeseed oil, respectively, to a level that allows the temperature probe to be immersed.

Note: The heating oil serves as a diesel substitute. With heating oil and diesel we are dealing with almost identical mixtures of substances to which, however, various additives are added owing to their different uses. The fundamental properties are not changed, however, though this.

4. Start with the heating oil. Place this on the hotplate and immerse the temperature probe.

5. Now light a wooden shaving and hold it over the liquid.

6. Switch on the hotplate and now re-ignite the wooden shaving at intervals of 5 - 10 °C and hold it over the liquid.

7. Heat it further until the vapour over the liquid ignites or the liquid has reached a temperature of 250 °C.

8. When the liquid can be ignited, note the temperature of the flashpoint.

9. After the heating oil, repeat the procedure with the biodiesel and then with the rapeseed oil.

Note: The hotplate does not have to completely cool down between the measurements, as the flash points of biodiesel and rapeseed oil are significantly higher.

Comparison of viscosity

1. Insert one of the pipettes into the Peleus ball and firstly aspirate exactly 1 ml of heating oil.

2. Now measure the time that the 1 ml of heating oil needs to flow out of the pipette.

3. To do this, remove the Peleus ball and simultaneously start the time measurement with the stopwatch.

4. Stop the time when all the liquid has flowed out of the pipette.

5. Carry this out again for the biodiesel and the rapeseed oil.

Observation

Determination of the flashpoint

In this experiment, the three liquids are heated until the vapour ignites or a temperature of around 250 °C has been reached. An attempt is made to ignite the vapours with an ignited wooden shaving.

The heating oil is heated first. An attempt is then made to ignite the vapours at about every 5 - 10 °C. The heating oil starts to gently vaporise at 80 °C. If one attempts to ignite the heating oil now, a sound is heard. The vapours ignite briefly. When the temperature increases a little further, the vapour phase completely burns above the liquid.

The biodiesel follows next. Also with this, an attempt is made to ignite the vapours at about every 10 °C. The biodiesel starts to vaporise at a temperature of 180 - 190 °C. There is a distinct sound and a brief flare-up of the wooden shaving, which indicates that the vapours have ignited.

The rapeseed oil finally follows. Also with this, an attempt is made to ignite the vapours at about every 10 °C. This is repeated until a temperature of 250 °C is reached. After that, the experiment is terminated.

Comparison of viscosity

The outflow speed of heating oil, biodiesel and rapeseed oil from a 1 ml pipette is measured. The viscosity of the individual liquids can be judged according to the outflow speed. We start with heating oil. This flows out of the pipette the quickest. Then the biodiesel follows with an outflow speed similar to that of the heating oil. Finally the rapeseed oil is tested. This is more viscous than the other two substances and takes distinctly longer to flow out of the pipette.

Result

Determination of the flashpoint

In this experiment, the flash points of heating oil, biodiesel and rapeseed oil are determined in order to compare the substances with each other. The heating oil ignites at a temperature above 80 °C. This agrees well with the DIN standard, as the flash point must in all cases be above 55 °C. Biodiesel can normally be ignited at a temperature of 170 °C. The biodiesel used in this experiment ignites at a temperature of 180 - 190 °C. The somewhat higher flashpoint can be explained by the fact that it is self-produced and probably still contains contaminants of rapeseed oil, which raise the flashpoint.

The flashpoint of rapeseed oil is distinctly above 250 °C and it therefore does not ignite in this experiment.

Although the flash point of biodiesel is distinctly higher than that of heating oil, the lowering of the flashpoint compared to rapeseed oil is sufficient to enable biodiesel to be used in conventional engines.

Comparison of viscosity

In this experiment, the viscosity, i.e. the thickness, of heating oil, biodiesel and rapeseed oil are to be compared with each other. This is important for fuels, as they are otherwise not optimally transported to the engine and ignited.

The heating oil flowed out of the 1 ml pipette within 3.8 seconds. The biodiesel is somewhat slower, requiring 4.2 seconds, and the rapeseed oil is distinctly slower at 30 seconds.

Therefore, this clearly demonstrates that the synthesis of biodiesel was successful. Both the flashpoint and the viscosity have changed compared to rapeseed oil. However, the self-produced biodiesel should not be used in a normal car, as it still contains too many contaminants due to the limited purification.

Cleaning and disposal

The surplus rapeseed oil can be disposed of down the drain. The heating oil and biodiesel must be disposed of in the organic solvents waste.