

Should Vegetable Oils be used as a Fuel?

Teacher Notes

1. Vegetable oils

One property of vegetable oils is that they burn.

But vegetable oils, without modification, are not considered suitable as fuels for diesel engines.

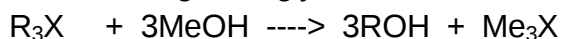
A suggestion is to break down the oil in some way to create smaller molecules that will be less viscous but still flammable. If these molecules are similar in size to the hydrocarbons used in diesel, then it will be possible to utilise them in standard diesel engines. *Explain this statement.*

2. Breaking Down Vegetable Oils

We are familiar with breaking down vegetable oils using an acid or an alkali.

But by reacting the oil with an aqueous substance, we have a problem of extracting the flammable part. How great a problem is this? Do you have a simple solution to extracting a flammable product (If the solution is not simple, the cost of extraction will stop the process from being viable)?

One cheap and simple method of breaking down vegetable oils is known as transesterification. This means making one ester from another. Vegetable oils are triglycerides (they are based on the alcohol, glycerol, which has three OH groups). It is possible by transesterification to base the ester on methanol or ethanol and thus create simpler molecules. Three simpler ester molecules are formed from the original triglyceride.



3. Factors affecting the best vegetable oil

The best vegetable oil can depend on many factors such as cost, appearance, calorific value, viscosity, stability, ease of burning, smell, or not being used for another purpose. Very often the weighting placed on the various factors is a societal choice and hence the best vegetable oil can vary from country to country. Best is thus very difficult to define. The manner in which best is interpreted is left for you to determine.

4. Viability of the vegetable oil

The use of vegetable oils is viable if vegetable oils are easily obtained, are cheap and are usable in a diesel engine directly, or with simple or cheap modifications - modifications to the diesel engine itself, or the conversion of vegetable oils to products usable in diesel engines directly).

5. Main use of vegetable oils

Vegetable oils are a source of food for both humans and animals. To use vegetable oils for fuel, land needs to be set aside for this purpose. This land is thus not available for growing foodstuffs. If land is plentiful, setting aside some land is not a problem, but when the land needed to generate fuel is at a premium, it becomes a question of ethics.

Testing biodiesel for flammability

Pour a little biodiesel into the top of a beer bottle (or other suitable small container). Try to light the biodiesel using a burning taper, or wooden splint. Note the ease with which it burns.

Test the suitability of the flame

With the biodiesel burning, check the colour of the flame. The more the flame is blue rather than yellow, the better. The flame should not be sooty.

Testing the viscosity of biodiesel

Depending on the quantity of biodiesel available, pour the biodiesel into a narrow glass tube. Seal both ends of the tube but allow a small air bubble to remain inside. Take the time for the air bubble to go from one end of the tube to the other, when the tube is held vertical and then inverted. Compare with other liquids.

Testing the calorific value

Pour a small but known mass of biodiesel into a spirit burner making sure the wick is in the liquid. Place the burner under a small tin can holding a known quantity of water and with the temperature being indicated by means of a thermometer. Light the burner and determine the time taken and the mass of biodiesel used in heating the water a known temperature rise (1°C).

Student Handout

Follow the trans-esterification process described below and carefully collect the washed and dried product. This product can be called biodiesel. Then devise a procedure for comparing flammability, viscosity, suitability of flame and calorific value with that of diesel. Also suggest which vegetable oil gives the best biodiesel (don't forget to indicate the parameters chosen to determine the meaning you have attached to best).

Preparation of Biodiesel

100 cm³ Vegetable Oil

15 cm³ 95% Ethanol

1 cm³ 9 mol dm⁻³ aq. Potassium Hydroxide Solution

1. Pour the vegetable oil and ethanol into a 250 cm³ beaker.
2. Slowly add the potassium hydroxide solution from a 1 cm³ plastic syringe or a small dropping pipette, over about 1 minute.
3. Stir continuously for a further 2-3 minutes and then stir occasionally (5-10 seconds every 2-3 minutes) for 2-3 hours or until 2 layers are formed on settling. Do not stir too vigorously as this may lead to emulsification.
4. Pour into a separating funnel and allow to settle for 1 hour.
5. Run off the lower layer. This layer contains most of the glycerol which is released during the reaction. The lower layer is discarded.
6. Add 10 cm³ of distilled water to the crude product and mix well (shaking is not advisable since an emulsion can form which will take a long time to separate). Leave to stand for 1 hour.
7. Run off and discard the lower layer (This washing procedure can be repeated if the product is not clear).
8. Add 0.5g anhydrous sodium sulphate. Stir for about 15 minutes.
9. Allow the sodium sulphate to settle.
10. Decant the biodiesel into a sample bottle.

Devise your own procedure for the following.

Test the product for:

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|------------------------|--------------------------|
| a) flammability, | b) viscosity, |
| c) calorific value and | d) suitability of flame. |

Compare the biodiesels so as to determine which is considered the 'best' biodiesel. Compare if necessary with ordinary diesel.