

Part 1 Pre-16 – Making biodiesel

Teacher's notes

The preparation of biodiesel from rape seed oil – or other suitable vegetable oil

Curriculum links

Biodiesel, a mixture of methyl esters of fatty acids, can be made very easily from a cooking oil made from rape seed, though other cooking oils may be tried. Enough fuel can be produced in a double lesson to burn, though it would not be pure enough to burn in an engine. This experiment could start off any fuel, thermochemistry or environmental topic as a demonstration, in which case it is probably better to allow the mixture from Stage 1 to react overnight as “one you have prepared earlier”.

Level

Pre-16 chemistry/science students.

Timing

60 min.

Description

A cooking oil is mixed with methanol and a catalyst (potassium hydroxide). The resulting reaction (transesterification) produces biodiesel and glycerol (propane-1,2,3-triol) which separate into two layers. The biodiesel, in the top layer, is removed and then washed with water to remove potassium hydroxide.

Apparatus (per group)

- ▼ Access to a balance
- ▼ Access to a centrifuge
- ▼ One 250 cm³ conical flask
- ▼ Two 100 cm³ beakers
- ▼ One 10 cm³ measuring cylinder
- ▼ One 20 cm³ measuring cylinder
- ▼ Teat pipettes
- ▼ Centrifuge tubes
- ▼ Sample tube and label.

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Chemicals (per group)

- ▼ Deionised water;
- ▼ 100 g Rape seed oil or other vegetable oil – eg cooking oil
- ▼ 15 g Methanol
- ▼ 1 g 50% Potassium hydroxide solution.

Safety

- ▼ Wear eye protection
- ▼ Methanol is flammable and poisonous
- ▼ Potassium hydroxide is corrosive.

It is the responsibility of the teacher to carry out a risk assessment.

Biodiesel as a fuel

Curriculum links

This section can be used as part of the study of *Products from oil, the use of fuels and products of burning hydrocarbons*.

Comparing the fuels and using the data in the information booklet could provide a starting point for further *Experimental and investigative science* at pre-16 level. Viscosity, flash point and heat of combustion are possible areas of further investigation.

Level

Pre-16 chemistry/science students.

Timing

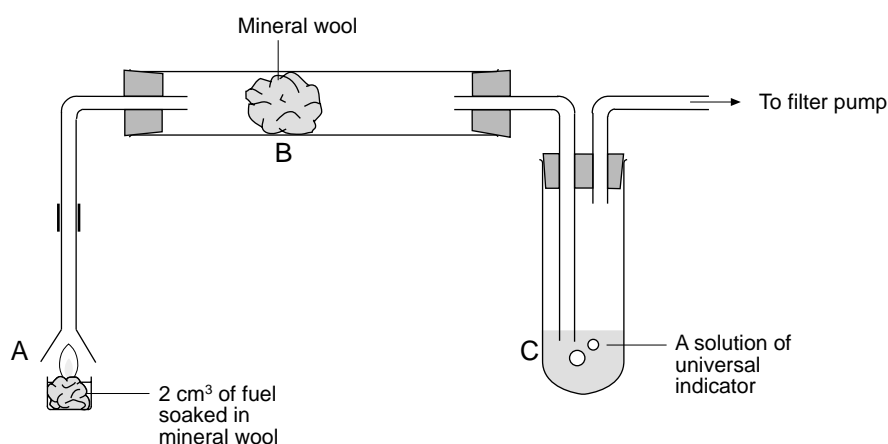
30 min.

Description

A sample of diesel and then a sample of biodiesel are burnt and the products of burning compared for sootiness and acidity.

Apparatus

- ▼ Glass tube with delivery tube, see below
- ▼ Filter pump
- ▼ Mineral wool and tweezers
- ▼ Glass filter funnel and rubber bung to fit
- ▼ Crucible
- ▼ Boiling tube with two tubes as shown below
- ▼ Pipette.



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Chemicals

- ▼ A few cm³ biodiesel (product from previous practical)
- ▼ A few cm³ paraffin (as used in commercial heaters) which is similar to diesel fuel
- ▼ A few cm³ universal indicator solution.

Safety

- ▼ Wear eye protection
- ▼ Paraffin is flammable
- ▼ It is the responsibility of the teacher to carry out a risk assessment.

Introducing biodiesel

Teacher's notes

The information sheet, *Introducing biodiesel*, is written in straightforward language and is suitable for a range of students. It can be used as background material for both pre-16 and post-16 chemistry students as part of a fuel investigation. It can also be used with the question sheet *Biodiesel and the environment* as homework, or would suit self-study work as a relevant application of science. The last section of the booklet includes the chemistry of esterification and, though this is referred to in many of the post-16 question sheets it may be omitted for pre-16 students.

Answers to questions on biodiesel and the environment

1. A biofuel is a renewable fuel produced from plants.
2. Biodiesel is a biofuel produced from oil-producing plants.
3. A feedstock is the starting material for making a product. For biodiesel this could be rape, sunflowers or corn.
4. Set-aside land is land for which farmers are paid not to grow particular crops. (The government pays a subsidy to a farmer for land on which crops are no longer grown for use as food. This is aimed at, for example, reducing the European Union (EU) grain mountain).
5. Biodiesel is used in many parts of Europe and in the US.
6. Any suitable answer – eg environmental (waterways, inner cities).
7.
 - a) It would take more land than is available to produce enough diesel to meet our present needs.
 - b) One hectare produces 1 200 litres of diesel, so the lorry could travel 9 600 km.
8. The excise tax or VAT might be reduced.
9.
 - a) After 7 days, 70% \pm 5% remains.
 - b) After 14 days, 40% \pm 5% remains.

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Team exercise: Biodiesel – will you produce it?

Teacher's notes

Curriculum links

This may be used as a data gathering, data analysis and presentation exercise for 11–14 year old students.

Level

Pre-16 and particularly 11–14 year old students.

Timing

60 min if the exercise starts with a demonstration, plus 60 min for presentation work.

Description

In this exercise groups of students collect fact cards about biodiesel to decide whether it is worth producing. They then make a presentation to the rest of the class. It could follow on from a quick demonstration of the production of biodiesel from rape seed oil, where each stage has been prepared in advance and could be linked to a discussion of possible solutions to the future fossil fuel shortage.

Teaching tips

Each group could collect 10–15 cards so that each presentation is based on a different selection of facts. This should encourage debate after the presentation.

The teacher will require:

- ▼ a starting sheet, a summary sheet and 20 fact cards (which can be photocopied from the enclosed masters) for each group of students; and
- ▼ a *Biodiesel – will you produce it?* – teacher's fact indicator.

The exercise is in two parts.

1. Collecting the facts

Every group is given the starting sheet *Biodiesel – will you produce it?* plus the summary sheet.

Each group is also given a different fact card to start them off.

The group looks at the card and writes down any facts it wishes to note in the matching place on the summary sheet. It then decides which further piece of information it wants by choosing one of the key words which are underlined on the fact card.

The group then asks for a new card from the teacher by reference to one of the key words on the fact card. The teacher refers to the fact indicator to supply the correct fact card. (It works most smoothly if there is a set of 20 fact cards for each group.)

This is continued until each group has obtained 10–15 fact cards and the worksheets are filled in. This takes about 30 minutes.

2. Presenting the facts

Each group of students now discusses the facts, decides whether or not to produce biodiesel and then gives a two minute presentation to the rest of the group. The presentation could include, posters, poems, songs, raps, etc. This can take at least another hour, including the final summing up by the teacher.

Biodiesel –Teacher 's fact indicator

Key words	Fact number
Biodiesel	1
Government influences	2
Rape	3
Chemical change	4
Uses	5
Chemical companies	6
Cost	7
Other European countries	8
Future	9
Fuel	10
Problems with biodiesel	11
Environment	12
Ordinary diesel	13
Scale	14
Cash crops	15
Renewable	16
More land	17
Alternatives	18
Diesel and water	19
Biodegradability	20