Biodiesel

Posted by Anonymous on Wed, 2019-04-17 15:09

Biodiesel: Do you have a method or advice that you can recommend for making biodiesel? I am concerned about the safety and waste disposal aspects.

Voting:

No votes yet

Year Level:
9
10
Senior Secondary
Laboratory Technicians:
Laboratory Technicians

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Biodiesel

Submitted by sat on 17 April 2019

Biodiesel is a renewable fuel and seen as an alternative to petroleum diesel.[1] Biodiesel is produced by reacting an alcohol, usually methanol, with a vegetable oil or animal fat in the presence of a catalyst. Commonly used catalysts include potassium hydroxide or sodium hydroxide. The chemical reaction is called *transesterification* and the products formed are methyl esters (the biodiesel) and glycerol. There are several possible methods for making biodiesel in the school science laboratory.

We recommend the method and scale available through the BBSRC[2] based upon the one published by CLEAPSS[3], for the following reasons:

- The activity is conducted on a small scale, only 10mL vegetable oil, which means lower risks and minimal chemical waste
- Potassium hydroxide is preferred over sodium hydroxide because it has a higher solubility in methanol.
- The preparation of the potassium hydroxide/methanol solution is conducted in a fume cupboard by the teacher or technician. The stock solution aliquots are delivered in small stoppered test tubes for student use. This method is very effective at reducing the risks of exposure to these hazardous chemicals.

We recommend that if an extension activity for burning the biodiesel is to be conducted, that one of the following methods are used in a fume cupboard.

- Use a spirit burner[4]
- Place a small wad of mineral wool soaked in 2mL of the biodiesel in a crucible[3,5]. Set alight with a long-nose gaslighter
- Place 2-5mL of the biodiesel in a tea light candle, which has had the paraffin wax removed[6]. Set alight with a long-nose gaslighter.

SAFETY NOTES:

- Methanol and potassium hydroxide have significant hazards.
    - Methanol is toxic and flammable.
    - Potassium hydroxide is highly corrosive.
- The preparation of the potassium hydroxide/methanol solution does take some time to dissolve, so it is best prepared in a fume cupboard by the teacher or technician:
    - using a magnetic stirrer,
    - allowing enough time, and
    - making up only the quantity required.
- It is essential that students are made aware of the significant hazards and mitigate the risk of exposure by following their teacher’s instructions, specifically:
    - Wearing safety glasses or goggles and nitrile gloves.
    - Inserting the stopper as soon as they have added the potassium hydroxide methanol solution.
    - Inverting the test tube carefully, rather than shaking the test tube. This will reduce the likelihood of the methanol squirting out. (Note: If the contents of the tube spill out and contaminate the gloves, then following normal good practice, the gloves should be removed and students should then wash their hands.)
- The combustion of any diesel fuel produces sooty smoke and toxic gases. Exposure to

these products should be avoided, especially by asthmatics or anyone who is allergic to petrochemicals or the smoke produced from their combustion.

Waste Disposal

The transesterification reaction, which is used to produce biodiesel, produces methyl esters of fatty acids (the biodiesel), with glycerol as the main by-product. The reaction mixture will form two layers. The top layer contains the biodiesel as well as some unreacted vegetable oil (triacylglycerols), some methanol, glycerol and other contaminants. The bottom layer contains glycerol, methanol, methoxide salt, soap (saponified fatty acids) and hydroxide. The ratio of biodiesel to glycerol in the product is about 10:1 by mass.

There are methods to treat both the biodiesel and the glycerol by-product for disposal, however these are generally time consuming and not practical for the school setting.[7]

Unused biodiesel must be kept for a licenced chemical waste disposal contractor because of the contaminants in it. It can be combined with other non-halogenated organic waste. Whether kept separate or combined, a label should be affixed on the side of the bottle stating the contents.

If the reaction is carried out on a small scale so that only very small amounts of glycerol are produced, then the glycerol layer can be washed down the sink. Glycerol is miscible with water and biodegradable, however it has a high oxygen demand (i.e. oxygen in the water body will be consumed as the glycerol degrades) and so, larger quantities should not be washed to waste. Larger quantities of glycerol should be stored for collection by a licenced waste disposal contractor.

References and further reading

[1]'What is biodiesel?', Biofuels Association of Australia website, http://biofuelsassociation.com.au/biofuels/biodiesel/ (Accessed April 2019)

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[3] CLEAPSS. 2007. *Making biodiesel*, CLEAPSS website, http://science.cleapss.org.uk/Resource/PS067j-Making-biodiesel.pdf (Login required)

[4] 'Experiment 2: The viscosity and heat content of biodiesel – teacher notes' Biodiesel Part 2 – Teacher Notes, Royal Australian Chemical Institute website, https://www.raci.org.au/document/item/3333 (Accessed April 2019)

[5] 'The preparation of biodiesel from rape seed oil – or other suitable vegetable oils worksheet',Learn Chemistry, RSC website, http://www.rsc.org/learn-chemistry/resource/res00002209/making-biodiesel (Accessed April 2019)

[6] 'Preparation & Combustion of Biodiesel', American Chemical Society website, http://highschoolenergy.acs.org/content/hsef/en/how-do-we-use-energy/biodiesel.html (Accessed April 2019)

[7] 'Biodiesel Safety and Best Management Practices for Small-Scale Noncommercial Use and Production',Sustainable Agriculture Research and Education (SARE) website, https://www.sare.org/Learning-Center/SARE-Project-Products/Northeast-SARE-Project-Products/Biodiesel-Safety-and-Best-Management-Practices-for-Small-Scale-Noncommercial-Use-and-Production (2008)

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'Waste Management in Biodiesel Production', eXtension website, https://articles.extension.org/pages/27660/waste-management-in-biodiesel-production (26 March 2012

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