**Investigating factors affecting the production of biodiesel**

*Background:*

Biodiesel is produced by reacting vegetable oils or fats with an alcohol in a reaction called transesterification. Glycerol also is produced in this reaction. The reaction requires a catalyst, commonly KOH.

This is depicted in Figure 1 below.



When synthesising biodiesel fuel, the amount of sodium hydroxide is critical. The sodium hydroxide acts as a catalyst in the synthesis. Increases in concentration will increase the rate of reaction; yet if the amount gets too large, soap will form rather than the desired ester.

Other conditions can have significant effect on the yield or rate of formation of the biodiesel fuel. Heating the reaction to a higher temperature will cause the reaction to proceed more rapidly; yet if the temperature gets too high it is possible to evaporate the alcohol, removing one of the reactants. In principle higher boiling alcohols can be used (ethanol, propanol etc) but this will result in a decrease of the solubility of the hydroxide.

An important property of biodiesel is viscosity. Viscosity is a fluid’s resistance to flow. A liquid such as honey has a very high viscosity; water has a relatively low viscosity and flows very easily. Viscosity is determined by both intermolecular forces and temperature. The fact that viscosity varies with temperature is an important consideration, because biodiesel can become a solid at low temperatures. The temperature at which the biodiesel turns solid, will depend heavily upon molecular composition, and thus is dependent on the original composition of the triglyceride. Another important property is the energy content of the biodiesel.

*Task:*

In this investigation you will choose and investigate a factor affecting the rate, yield or properties of biodiesel. The article below summarises many of the factors known to affect biodiesel production and is a good starting point for developing your research question.

Alemayehu Gashaw, Abile Teshita. Production of Biodiesel From Waste Cooking Oil and Factors Affecting Its Formation: A Review. *International Journal of Renewable and Sustainable Energy*. Vol. 3, No. 5, 2014, pp. 92-98. doi: 10.11648/j.ijrse.20140305.12

*Schedule:*

|  |  |  |
| --- | --- | --- |
| **Day** | **What happens?** | **% of marks** |
|  | Planning of the investigation. | 10 |
|  | Conducting of the investigation | - |
|  | Report on the investigation | 30 |
|  | Test questions related to experiment | 60 |

**Report:**

Based on your investigation, you will then need to compile a report, consisting of the following sections:

|  |  |  |
| --- | --- | --- |
| **Section** | **What needs to go in it** | **Marks** |
| Background | Background information about biodiesel, including its chemical structure, properties and uses, and overview of its manufacture (including a balanced chemical equation). Any information from external sources should be referenced using an appropriate format. Max 1/2 page. | 4 |
| Aim | 1-2 sentence overview of your aim | 1 |
| Method | Description of the method you performed. It should be written in paragraph format using past tense and passive voice (see <http://www.monash.edu.au/lls/llonline/writing/science/7.1.2.xml)>  Your method should include the actual amounts of substances used (masses or volumes) and actual conditions used (e.g. temperature, length of time heated).  Good responses may also use labelled diagrams and/or photographs when relevant. | 5 |
| Results | Graphs or figures should be labelled and captioned (<http://www.monash.edu.au/lls/llonline/writing/science/process/2.1.xml)> Any images from external sources need to be appropriately referenced.  Relevant calculations. Calculations should be formatted correctly and show logical and clear working. This is possible to do in Microsoft Word using Equation Editor. | 5 |
| Discussion and Evaluation | Paragraph-format answers which explore the following topics:   * A critical evaluation the success of your method for synthesis and isolation * Analysis of possible sources of error and evaluation of their impact on your results * Explanation of possible improvements to the experimental method and possible directions for future research   These topics are not intended to be answered as three individual and separate questions. There is an overlap between the three topics and they could be discussed together. | 10 |
| Conclusion | Summarise the main findings from your investigation | 2 |
| References | Information from other sources needs to be referenced *via* in-text references. The full citation should be included in a reference list after the conclusion.  For your report you can use any appropriate referencing system, e.g. Harvard, MLA, APA, Chicago, Vancouver. Information about different types of referencing systems is available online. | 3 |

Only one report needs to be handed in for each pair of students.

**Equipment booking: (4 marks)**

Complete on separate sheet provided.

**Variables: (6 marks)**

|  |  |  |
| --- | --- | --- |
| **Type of variable** | **Description** | **How it will be varied/measured/controlled** |
| Independent |  |  |
| Dependent |  |  |
| Controlled |  |  |
| Controlled |  |  |
| Controlled |  |  |
| Controlled |  |  |

|  |  |
| --- | --- |
| **Section** | **Marks awarded** |
| Booking of chemicals and equipment | \_\_\_\_ / 4 |
| Independent variable | \_\_\_\_ / 1 |
| Dependent variable | \_\_\_\_ / 1 |
| Controlled variables | \_\_\_\_ / 4 |