

BioFuel Production

SAMPLE



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Worksheet 1

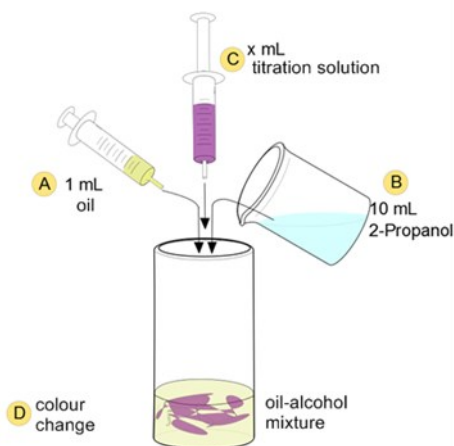
Production of Biodiesel (FAME) from fats & oils

Task

Find out the amount of KOH necessary for the production of FAME by titrating the oil with NaOH stock solution ($c = 1\text{g/l}$) and separate the oil into its two components glycerol and biodiesel (FAME).

Setup

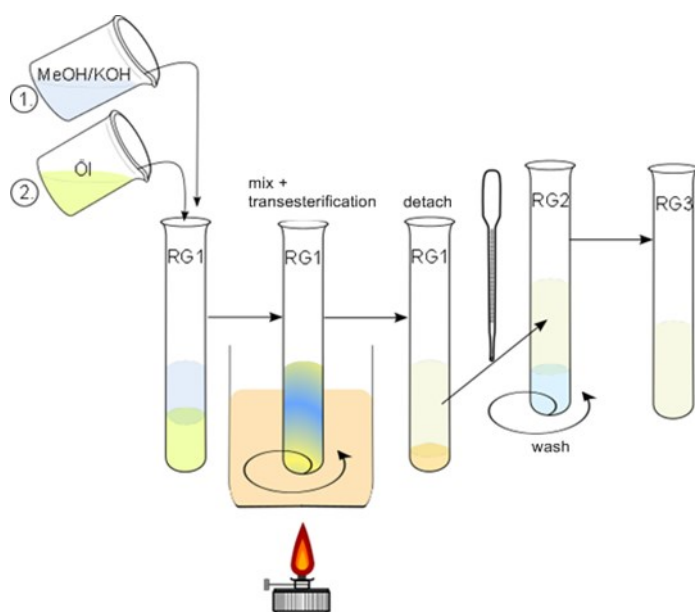
Titration



Required Equipment

- beaker
- test tubes
- 10 ml isopropyl alcohol 99 %
- at least 1 ml of oil (45 °C – for titration)
~10 ml for transesterification
- phenolphthalein solution (~0.3 %)
- water
- NaOH stock solution ($c = 1\text{ g/l}$)
- 2 x one-way syringes with 5 ml
- pipette
- KOH aqueous stock solution (1 g/l)
- bunsen burner/other heat source
- thermometer
- rubber septum / test tube stopper
- balance (only necessary for fresh preparation of the KOH solution)

FAME production



Worksheet 1

Production of Biodiesel (FAME) from fats & oils

Performing

Titration:

1. Measure exactly 1 ml of oil with the one-way syringe/pasteur pipette and add approximately 10 ml isopropyl alcohol to the oil into the beaker.
2. Shortly heat the mixture up to 40 °C. Don't bring it to the boil!
3. Add 3 drops of phenolphthalein to the mixture.
4. Now add the NaOH standard solution by a slight swirling until a permanent pink colour appears in the beaker (at least for 30 seconds). Note the amount used.

Used NaOH standard solution in ml: _____

Hint: At this point, all free fatty acids of the sodium hydroxide solution have been converted into its salts and the pH has increased to 8.5 due to the freely existing OH⁻ ions. The consumption in ml KOH stock solution now has to be converted to the needed amount KOH according to the table/formula. To ensure exact results, the titration may be conducted several times.

As a rule of thumb, the oil quality can be expressed according to its consumption as follows:

- 0 – 3 ml excellent quality; suitable for FAME production
- 3 – 6 ml medium quality; still suitable for FAME production
- > 6 ml low quality; unsuitable for FAME production

5. Using the table, now determine the additional necessary amount of KOH for 1 litre of FAME formation.

Determination of the additional necessary amount of NaOH for 1 litre FAME formation.

Consumption of stock solution during titration in ml	Additional necessary amount of KOH in g	Total amount of KOH 5 g + X in g	Acid value mg/g oil (density values for the different oils: cf. exp. 1.3 FAME <-> cooking oil, here: 0.92 kg/l)
1.0	1	6	6.5
2.0	2	7	7.6
4.5	4.5	9.5	10.3

6. Fill the necessary amount of methanol and the calculated amount of KOH into the first test tube (TT1) and dissolve it by repeated shaking. It is advisable to calculate the formation for approximately 16 ml of oil due to the typical size of a test tube of 20 ml. Then, enough FAME is produced for all following experiments. The calculation of the proportions is conducted according to the following table:

	Formation for 1000 ml of oil	Formation for 16 ml of oil
oil	1000 ml	16 ml
KOH	5 g + X g (e.g. X = 1 g)	0.1 g + X g
methanol	220 ml	3.5 ml

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7. Now fill the desired amount of oil for transesterification into test tube 1 (TT1).
8. Heat the mixture in a bain-marie to approx. 50 °C for approx. 20 minutes and shake the test tube from time to time using a stopper.
9. Let the mixture cool down and wait for phase separation (can take up to one hour).

Hint: The heavier brownish glycerol (density 1.2) settles on the ground, while the yellowish biodiesel (density 0.9) swims on top.

10. Wait for phase separation and pipette the swimming biodiesel carefully into a new test tube (TT2). Add water to the biodiesel in TT2 until the test tube is nearly full. Carefully turn the test tube several times by 180° head first to wash away excess methanol and catalyst rests. It is also possible to shake it carefully.

Hint: If the test tube is shaken too heavily, the separation of the two phases may take very long. To detach the solid parts, it can be helpful to additionally filter the FAME/water mixture if the biodiesel does not get clearer during washing.

Worksheet 1

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fats & oils



The full version of this curriculum is available upon
purchase of the kit.

Please see contents for a full list of experiments from the
full version.