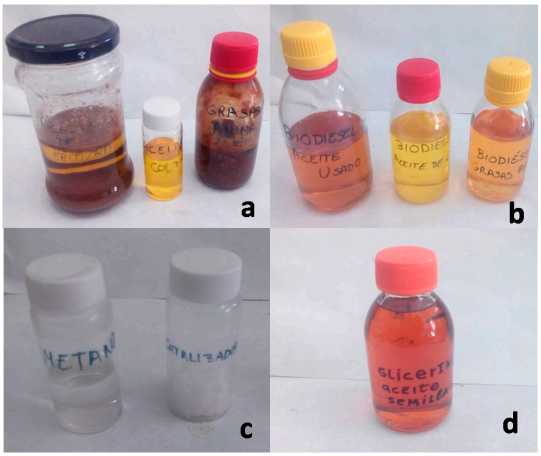
Guide for practices

Practice:

Biodiesel and biolubricant showcase.

Materials:

Samples of raw materials (a), biodiesel and biolubricants (b), reactives and catalysts (metanol and sodium hydroxide, c) and by-products (glycerol, d)



Procedure:

1.- Start a debate about possible raw materials to obtain biodiesel, explaining its main origin (vegetable oils) and finishing with others less evident (such as animal fats). Afterwards, you can pass the samples to the audience in order to be examined.

2.- Point out that many wastes, such as frying oil, might be useful for biodiesel production, avoiding its difficult management.

3.- Furthermore, point out the differences in viscosity or fluency of the samples, especially in the case of the animal fat, that is a semi-solid sample.

4.- Then, you can explain, depending on the academic level, the main chemical reaction to obtain biodiesel or biolubricants (that is, transesterification). You can show the main reagents and products and compare it with a recipe.

5.- Finally, by showing the biodiesel or biolubricant obtained, you can explain that transesterification is, mainly, for the unification of the viscosity of the raw materials, to show a good behaviour in diesel engines.

Objectives:

To introduce the concept of biodiesel and transesterification.

Practice:

Chemical reaction (transesterification).

Materials:

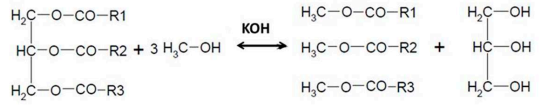
Seed oil, methanol, sodium hydroxide, a reactor coupled to a refrigerator and a heating plate.

Procedure:

1.- Start a debate about chemical reactions, to assess the real academic level of the audience (asking about reagents, products, catalysts, etc.).

2.- Show the chemical reaction that takes place during biodiesel production (transesterification), explaining the changes in the chemical structure of the triglyceride. For lower levels, compare it with a typical recipe (Spanish omelette, for instance).

Chemical reactions are, somehow, like a recipe

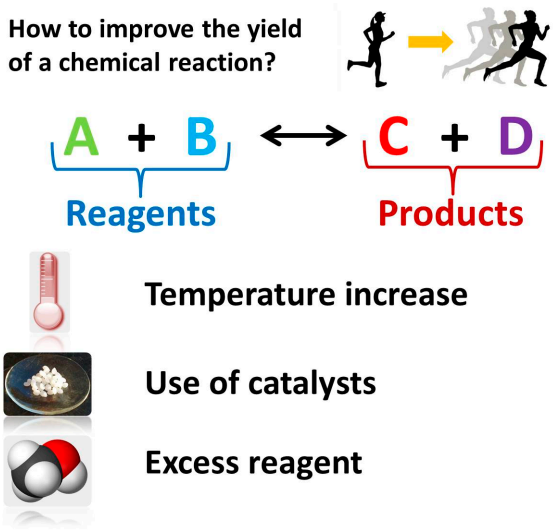


Triglyceride Methanol Biodiesel Glycerol

Eggs Potatoes Spanish omelette

3.- For higher academic levels, show the chemical reactor and explain the function of the heating plate (to heat the reaction and make it faster), refrigerator (to recover methanol, which evaporates at high temperatures) and the catalyst (to make the chemical reaction more effective.

4.- Finally, explain the main parameters to take into account to improve the kinetics and efficiency of a chemical reaction (by increasing temperature, the use of catalyst and excess reagents, etc.), pointing out that we should carry out this reaction in a sustainable way.



Objectives:

Further knowledge about chemical reactions.

Practice:

Density determination.

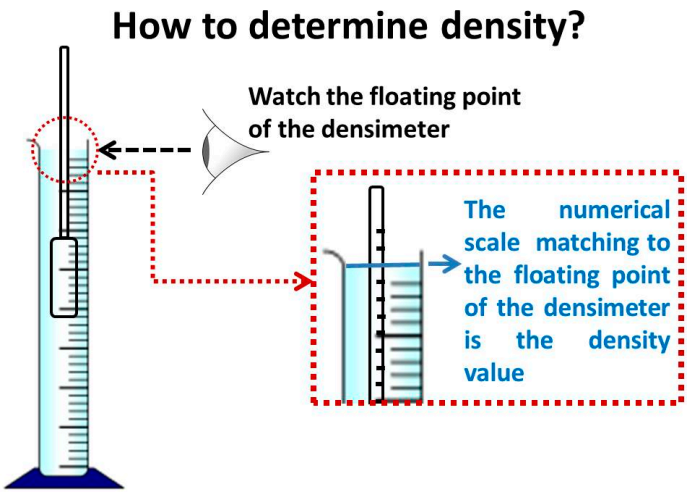
Materials:

Biodiesel sample, densimeter and a graduated cylinder (1 L of capacity).

Procedure:

1.- Start a debate about density, comparing dense and light products.

2.- Explain the density determination.



3.- Invite a student to determine the density of a sample by itself.

4.- Then, if the academic level is appropriate, compare the obtained value with the range of the standard.

Objectives:

To introduce the concept of density, its assessment and consider the compliance of this parameter with the standard.

Practice:

Viscosity race.

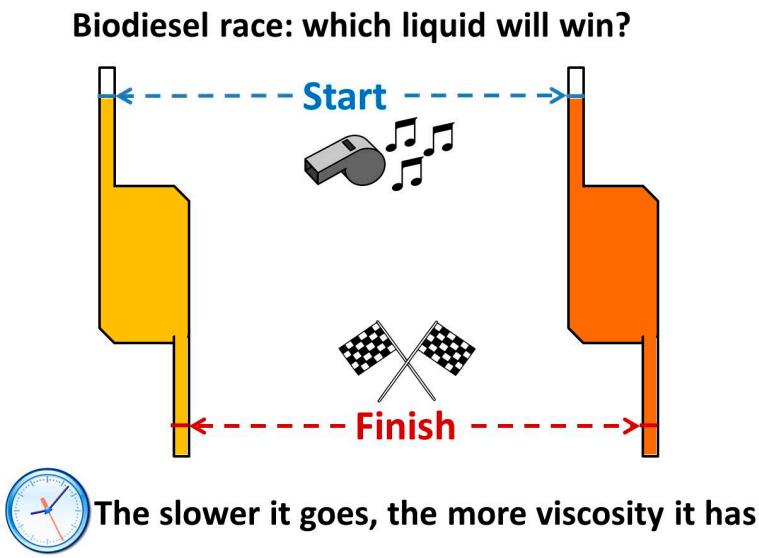
Materials:

Biodiesel and its corresponding oil, viscosimeter/s, 1-L beaker for each viscosimeter (containing silicone gel), heating plates and two sprayers (one with biodiesel and the other one with oil).

Procedure:

1.- Start a debate about viscosity and compare the viscosity of different materials (such as honey and wáter at different temperatures), to explain the viscosity determination with a viscosimeter.

2.- For lower academic levels, start a "liquid race". First, fill both viscosimeters (which should be covered in silicone gel at 40 °C) with biodiesel and oil by vacuuming, after the upper signal is covered. Then, put both liquids in this first limit by stopping vacuuming. At this moment, cover the upper pipe of the viscosimeter with a finger. Then, release your fingers and start timing the race. When each liquid crosses the final limit, the timing will be stopped. Then, assess which liquid was "faster" (in this case, biodiesel).



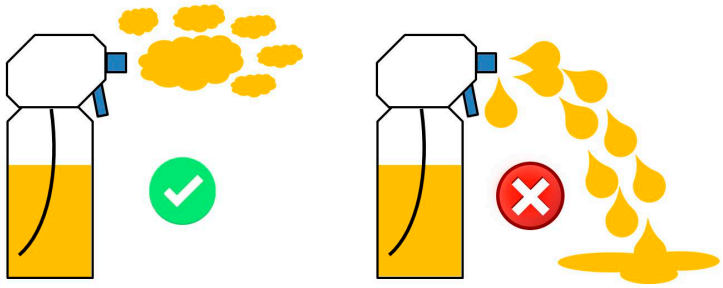
3.- For higher academic levels, do the same as in step 2 but with only biodiesel. Register the time and use the formula.

$$v = K \cdot t$$

Where v is viscosity (expressed in cSt or mm2·s-1), K is the constant of the viscosimeter (expressed in (mm2·s-1)·s-1) and t is the time that the liquid takes to flow in the viscosimeter (expressed in s). Ask a student to carry out the whole experiment and to calculate the viscosity value, assessing if it complies with the standard.

4.- For higher academic levels, invite a student to use two sprayers, one with biodiesel complying with the standard and another one with oil (which is more viscous, not complying with the standard. Check the difference, pointing out the generation of leaks (and therefore, of deposits in the engine which could be dangerous for the good performance of the diesel engine) for the case of the oil.

Importance of viscosity:
Difference between good and bad injection performance



Objectives:

Viscosity concept, its determination and the importance in biodiesel for a good performance in engines.

Practice:

Flash and combustion points

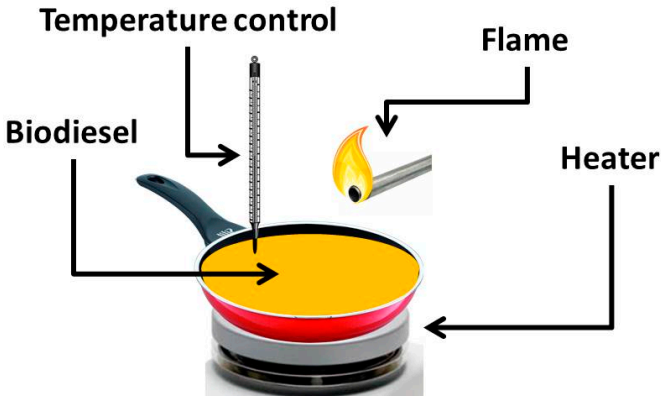
Materials:

Biodiesel and a Cleveland method equipment.

Procedure:

1.- Explain the concept of flash and combustion point, pointing out the importance of high values for biodiesel and biolubricants, in order to improve the safety during storage.

2.- Carry out a demonstration, without using a flame (for safety reasons). In normal and safe conditions, you should increase temperature slowly (by 10 °C per minute) and pass the flame near the sample.



Objectives:

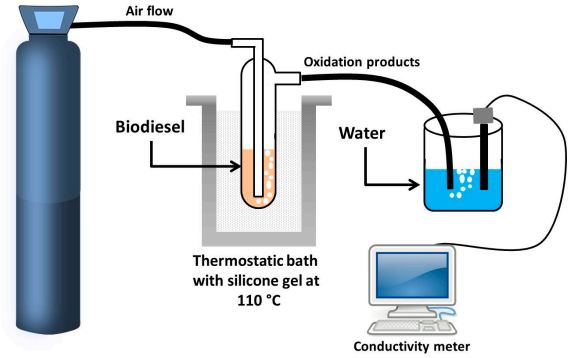
To introduce the concept of flash and combustion points.

Practice:

Oxidative stability determination

Materials:

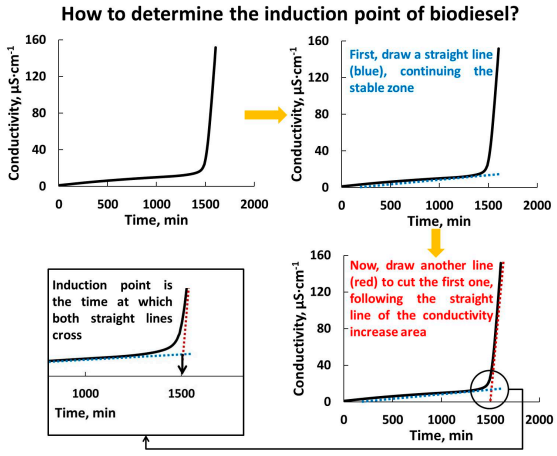
A Rancimat method equipment



Procedure:

1.- Explain the concept of oxidative stability, and why biodiesel and biolubricants are prone to oxidation compared to their equivalents from fossil fuels. Moreover, explain the importance of this concept for biofuel storage.

2.- Explain each component for oxidative stability determination, and the determination of the induction point (expressed in hours), which should be over 8 h to comply with the standard.



3.- Ask a student, according to your explanations, to determine graphically the induction point of a sample (previously measured to check the answer of your student).

Objectives:

To introduce the concept of oxidative stability.

Questionnaire about biorefineries (Primary school level)

1. - What is biodiesel?

a) A biofuel which is cleaner than fossil fuels

b) A biofuel which is more pollutant than fossil fuels

c) Frying oil that can be used directly in cars

2. – For a chemical reaction, what is true?

a) Some reagents react to produce their corresponding products

b) Temperature is not important

c) We never use catalysts

3. – Which product can you use to produce biodiesel and biolubricants?

a) Frying oil

b) Plastic

c) Soft drinks

4. – What can you do with frying oil at home?

a) Throw it down the drain

b) Deposit it in a clean point to produce biodiesel

c) Mix it with water to water your garden

5. – According to our experience, which liquid ran faster in the "liquid race"?

a) Biodiesel

b) Oil

c) They were the same

If the student got less than 3 answers right, the knowledge about biorefineries was not enough

If the student got between 3 and 4 answers right, the knowledge about biorefineries was enough

If the student got 5 answers right, the knowledge about biorefineries was excellent

Answers: 1a, 2a, 3a, 4b, 5a

Questionnaire about biorefineries (High-School level)

1. - What is biodiesel?

a) A biofuel which is cleaner than fossil fuels

b) A biofuel which is more pollutant than fossil fuels

c) Frying oil that can be used directly in cars

2. – You can use biodiesel in diesel cars?

a) No, because it is worse than diesel

b) Yes, as long as it complies with standards

c) Yes, you can use it in any case

3. – Which products can be obtained in a biorefinery based on vegetable oils?

a) Biodiesel

b) Biolubricant and glycerol

c) a and b are correct

4. – What can you do with frying oil at home?

a) Throw it down the drain

b) Deposit it in a clean point to produce biodiesel

c) Mix it with water to water your garden

5. – According to our experience, which liquid was more viscous?

a) Biodiesel

b) Oil

c) They were the same

If the student got less than 3 answers right, the knowledge about biorefineries was not enough

If the student got between 3 and 4 answers right, the knowledge about biorefineries was enough

If the student got 5 answers right, the knowledge about biorefineries was excellent

Answers: 1a, 2b, 3c, 4b, 5b

Questionnaire about biorefineries (University and professional level)

1. – You can use biodiesel in diesel cars?

a) No, because it is worse than diesel

b) Yes, as long as it complies with the EN 14214 standard

c) Yes, as long as it complies with the EN 14890 standard

2. – In a biorefinery, what happens with methanol?

a) It is removed as a by-product

b) It is added for biodiesel production and evolved in biolubricant production, and it can be re-used for the first stage

c) It is not necessary at all

3. – According to the experience, what was the density value of the sample in kg·m-3?

a) 884

b) 880

c) 840

4. – What are flash and combustion points?

a) A measurement related with the storage safety

b) The temperature at which the biodiesel sample starts sparkling and flaming, respectively

c) a and b are correct

5. – According to our experience, what was the oxidative stability of biodiesel (in h)? Did it comply with the standard?

a) 5.2, it did not comply with the standard

b) 8.4, it complied with the standard

c) 3.5, it complied with the standard

If the student got less than 3 answers right, the knowledge about biorefineries was not enough

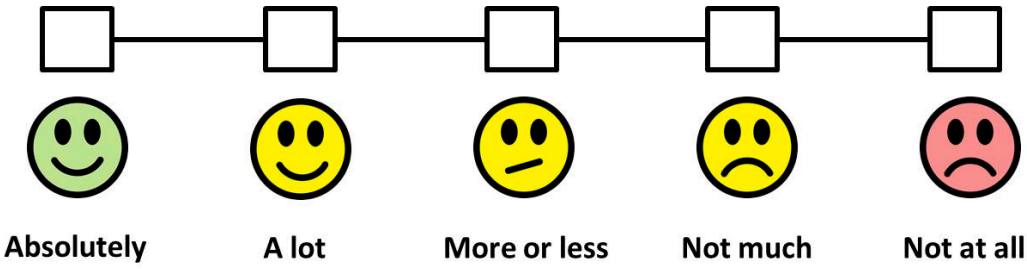
If the student got between 3 and 4 answers right, the knowledge about biorefineries was enough

If the student got 5 answers right, the knowledge about biorefineries was excellent

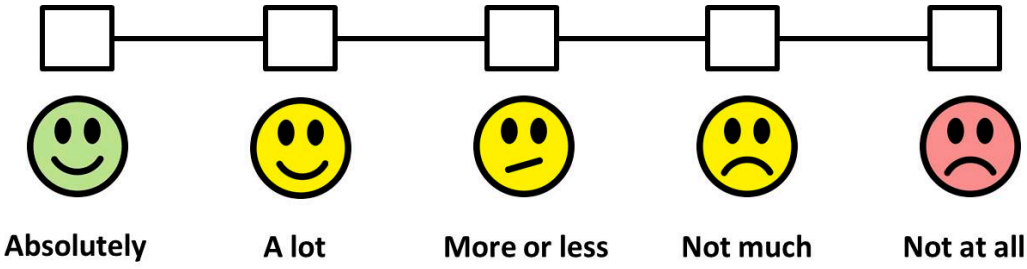
Answers: 1b, 2b, 3a, 4c, 5a

Satisfaction survey (all academic levels)

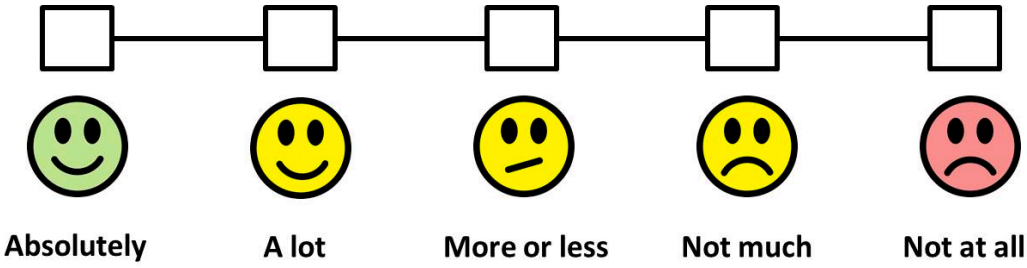
1. – Did you enjoy the presentation?



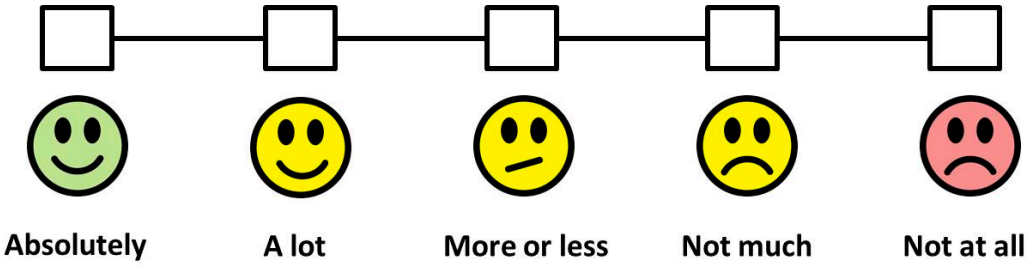
2. – Can you apply some concepts in your daily life?



3. – Were the experiences or experiments interesting?



4. – The speaker was explanatory enough?



Absolutely: 5 points; A lot: 4 points; More or less: 3 points; Not much: 2 points; Not at all: 1 point

*The presentation was (according to points): 4-8: **poor**; 9-12: **acceptable**; 13-16: **good**; 17-20: **excellent***