



From Your Kitchen to Your Car: Turning Cooking Oils into Biofuels



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Introduction

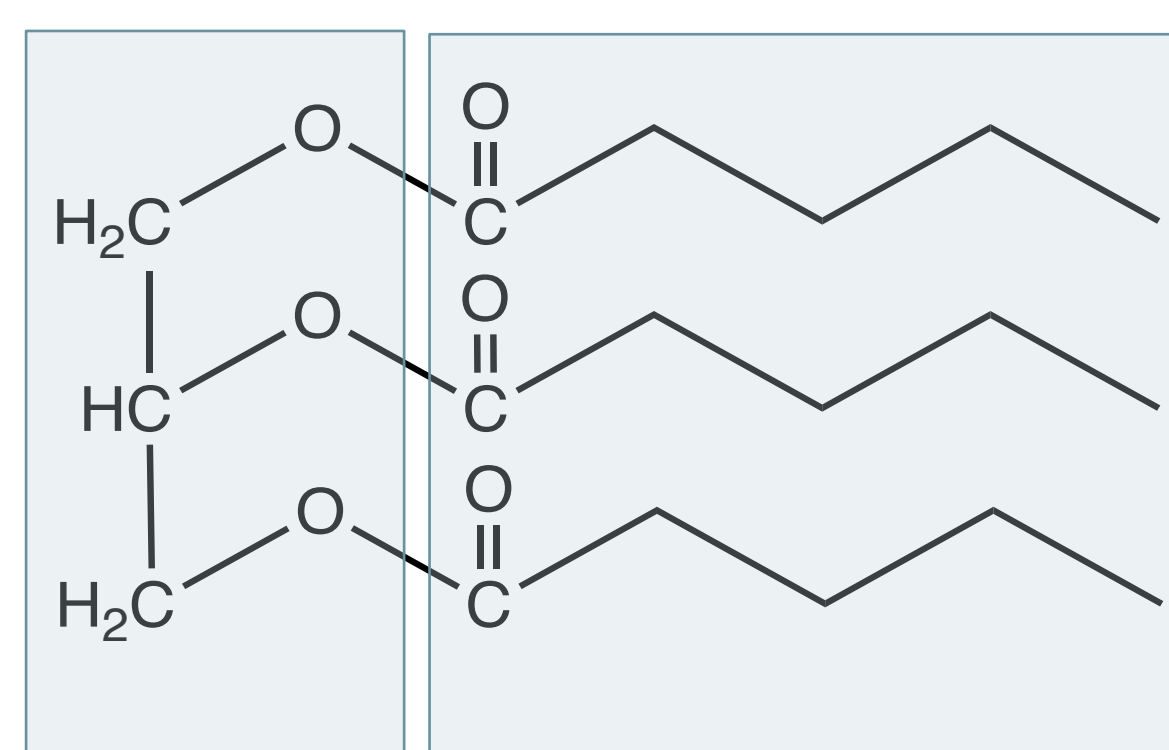
Cooking oil accounts for a significant amount of waste in the world. Just in the United States, **100 million gallons** of waste cooking oil are generated per day and each person generates around **9 pounds** of cooking oil per year.¹

Cooking oil, or any oil for that matter, isn't good for the environment. In water treatment plants, it can create residues that are hard to get rid of. In aquatic environments, oil can suffocate aquatic life and ruin habitats.

Biodiesel is an alternative fuel option that has similar functionality to fossil fuels, but is proven better for the environment when used. Biodiesel can be synthesized from cooking oil easily and in quantitative yields. Some of biodiesel's advantages are:

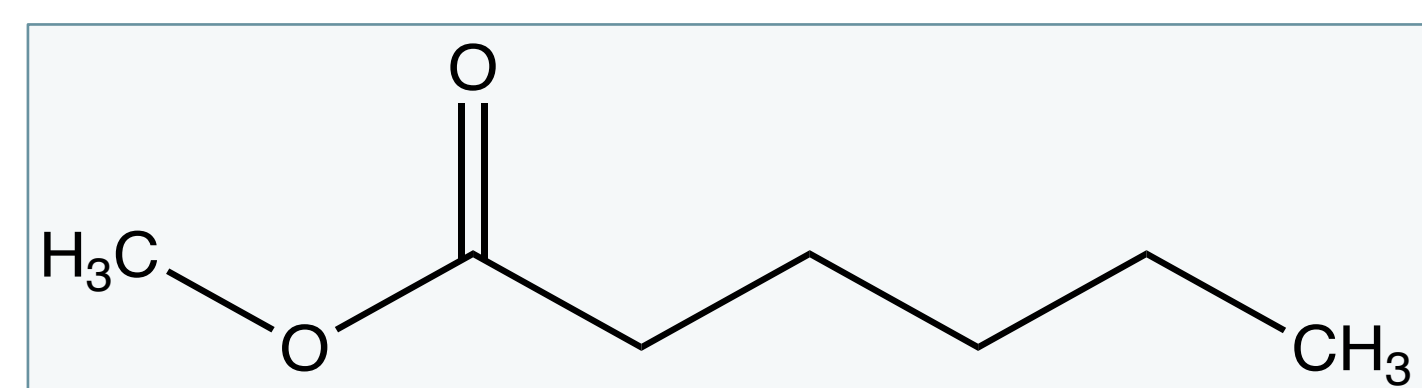
- Biodegradable
- Made from renewable resources
- Produces 78% less carbon emission than petroleum diesel²

Common oils used to make biodiesel are vegetable oils and animal fats. Biodiesel can be made right at home and used in any machinery that used petroleum diesel.



Glycerol Backbone Fatty Acid Chain

General Oil Composition: Triglyceride

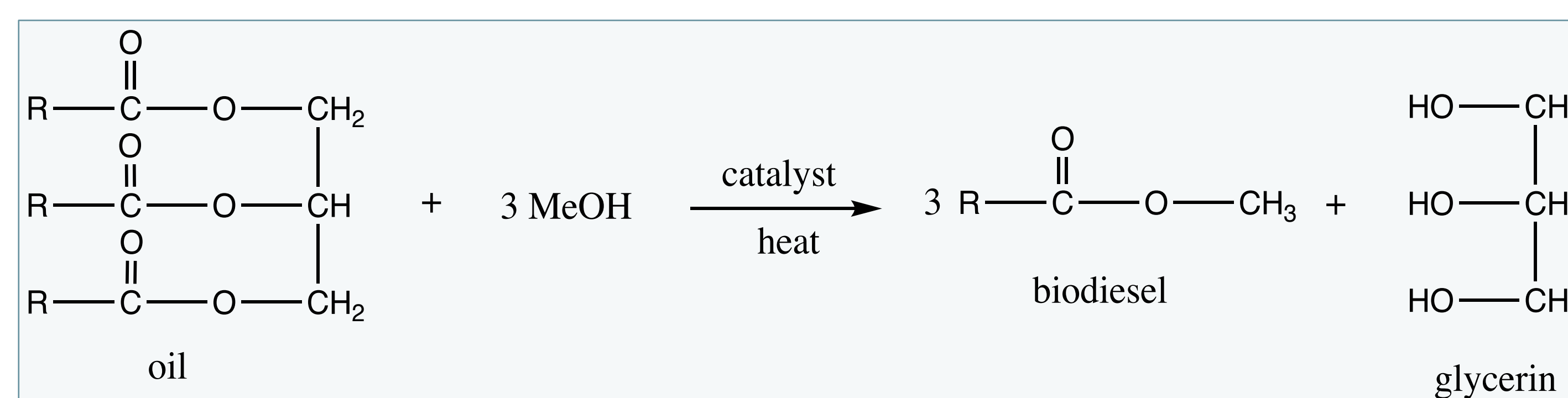


Fatty Acid Methyl Ester

General Biodiesel Composition

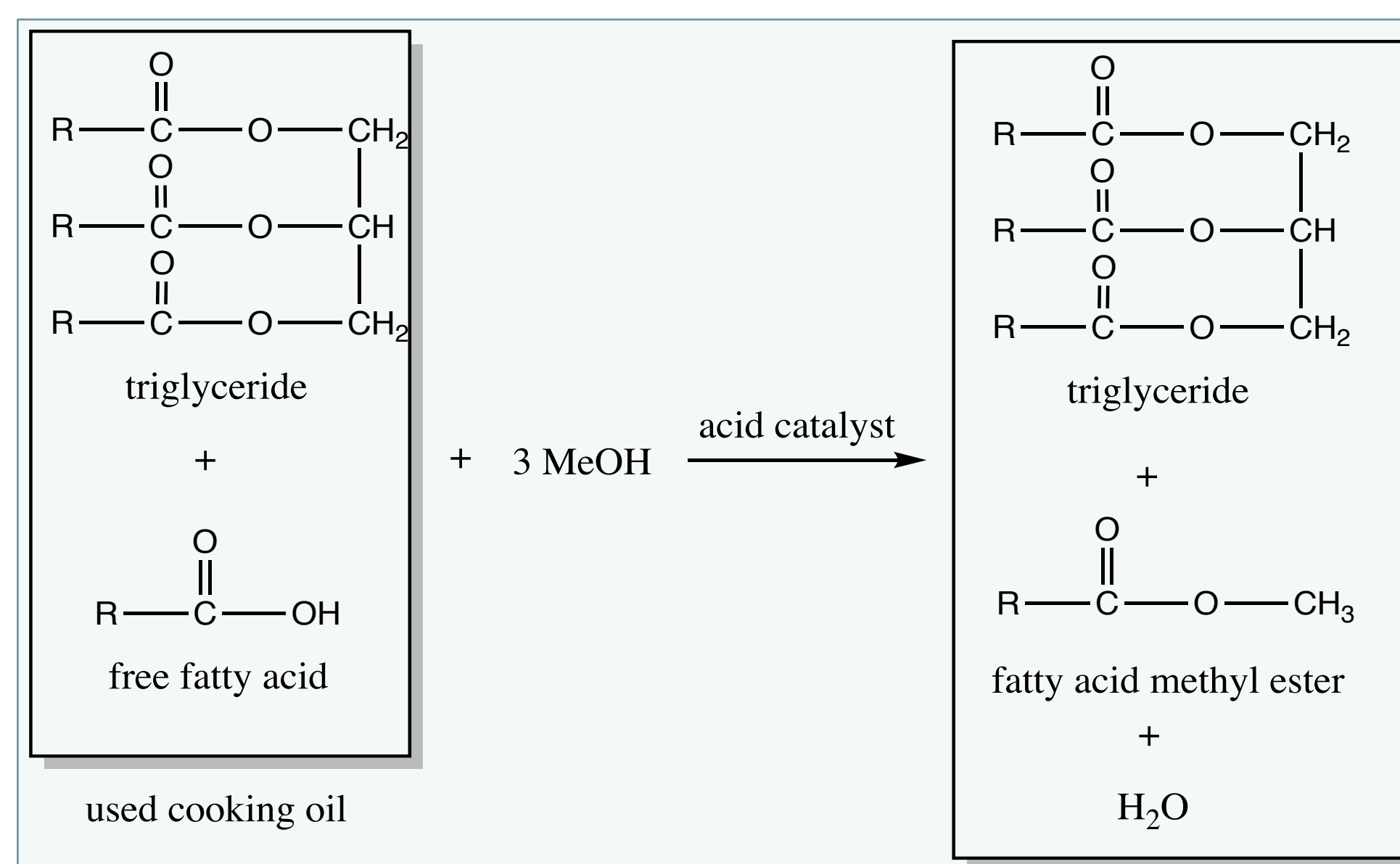
Theory

The triglycerides in the oil can be converted to fatty acid methyl esters through transesterification. This is done by reacting the oil with an alcohol and a base-catalyst.

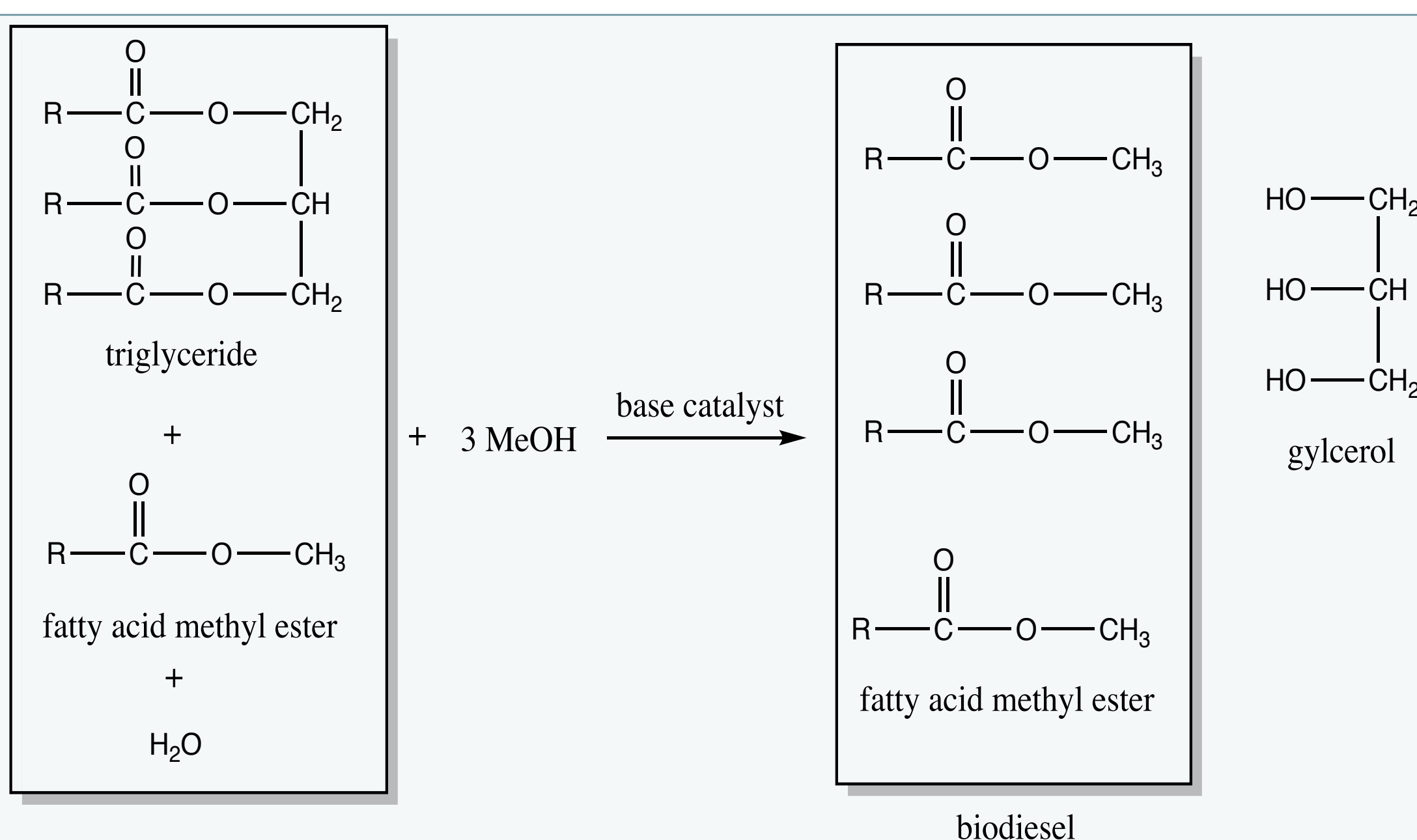


Scheme 1. General transesterification of cooking oil to yield biodiesel.

However, used cooking oil that's been exposed to heat has higher levels of free fatty acids. Free fatty acids in used cooking oil can react with the base catalyst directly and undergo saponification.



Scheme 2. General esterification of used cooking oil to convert free fatty acids to fatty acid methyl esters.



Scheme 2. Transesterification following esterification of used cooking oil to convert free fatty acids to fatty acid methyl esters.

Therefore, the used oil must be pretreated before the transesterification can be preformed. Pretreating consists of reacting the used cooking oil with an alcohol and an acid mineral catalyst. This will convert the FFAs into biodiesel.

Following the esterification preformed, transesterification can be utilized to convert the remaining triglycerides into biodiesel.

Results and Discussion

One way to monitor the progress of the reaction is with the eye. The reaction is complete when the product has two layers; a biodiesel and glycerin layer.



https://5.imimg.com/data5/KU/XY-2/used-cooking-oil-and-waste-vegetable-oil-250x250.jpg

Biodiesel can be made in quantitative yields. Iqbal, M, et al³ and Kawentar et al⁴ reported a fatty acid methyl ester yield of 94% and 92.76%, respectively.

References:

1. "Safety, Savings and Control." *Frontline International Cooking Oil Management*, Frontline International, www.frontlineii.com/sustainability-frontline
2. "Commonly Asked Questions." *Biodiesel*, Biodiesel.org, Apr. 2012, <https://www.biodiesel.org/docs/ffs-basics/commonly-asked-questions.pdf?sfvrsn=6>
3. Iqbal, M, et al. "Biodiesel Production from Waste Cooking Oil: An Efficient Technique to Convert Waste into Biodiesel." *Sustainable Cities and Society*, vol. 41, 2018, pp. 220-226
4. Kawentar, W. A.; Budiman, A. "Synthesis of Biodiesel from Second-Used Cooking Oil." *Energy Procedia*, vol. 23, 2013, pp. 190-199

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