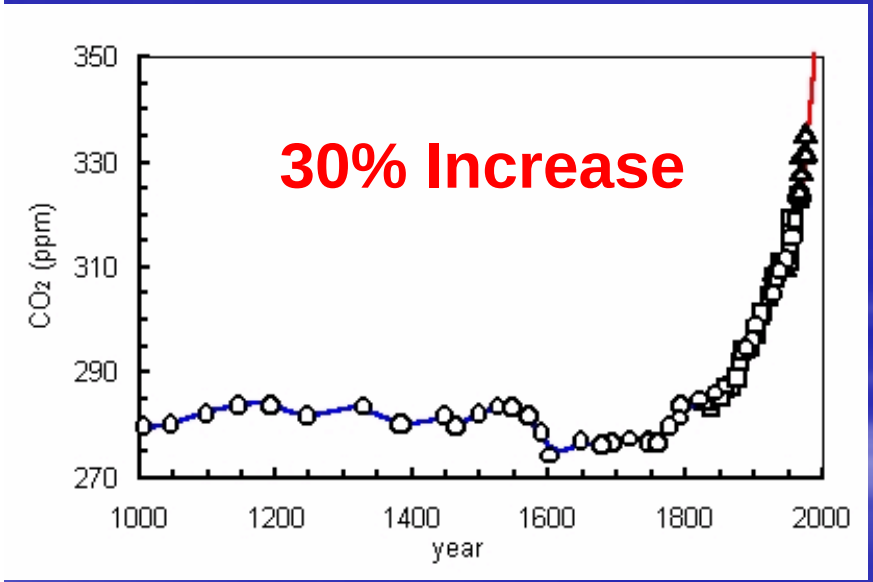
Biodiesel

An alternative to petroleum diesel

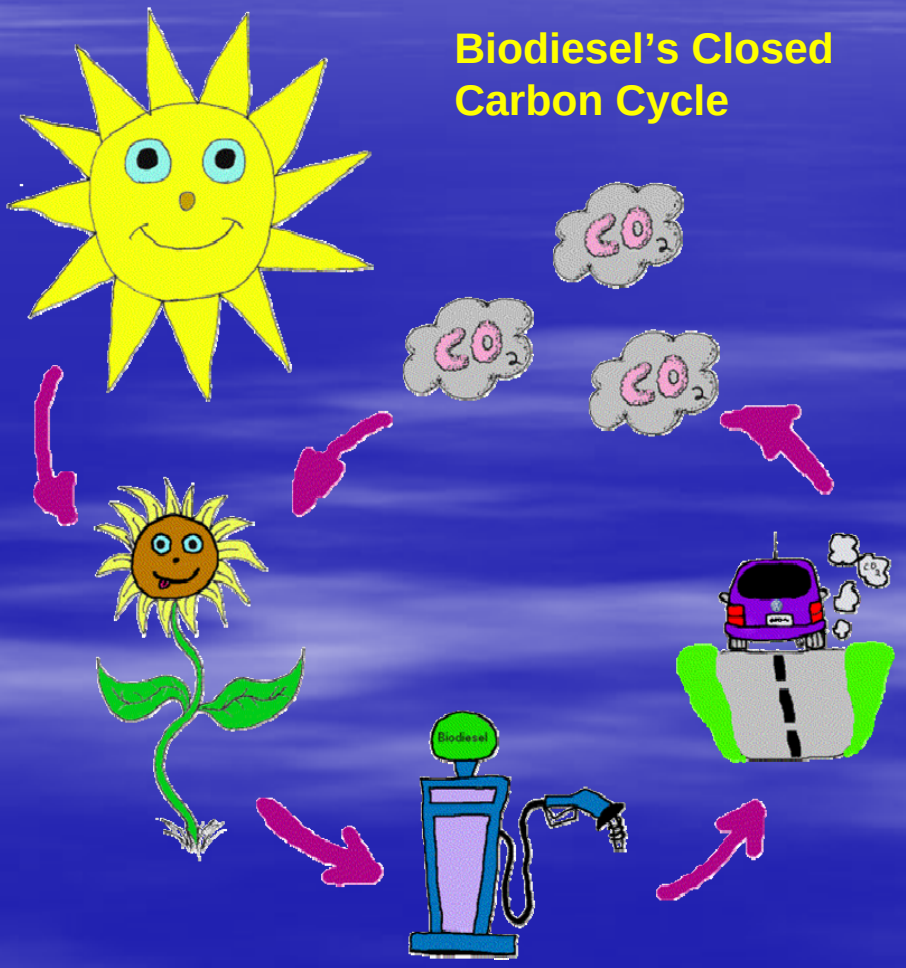
Environmental Issues

- Burning fossil fuels increases atmospheric levels of carbon dioxide
- Fossil fuels are a finite resource



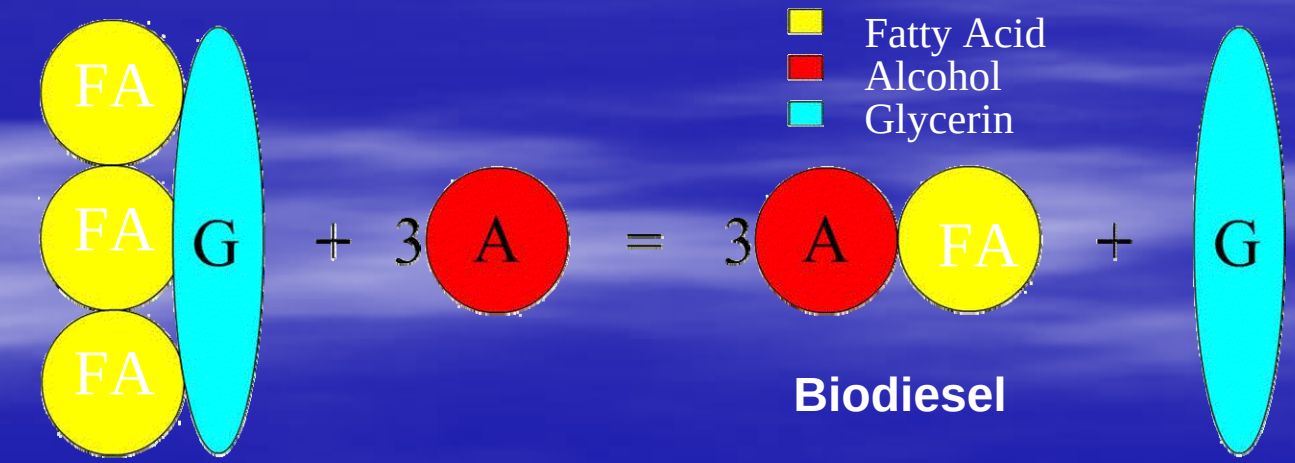
Graph taken from USF Oceanography webpage

Biodiesel's Closed Carbon Cycle



What is Biodiesel?

- Alternative fuel for diesel engines
- Made from vegetable oil or animal fat
- Meets health effect testing (CAA)
- Lower emissions, High flash point (>300F), Safer
- Biodegradable, Essentially non-toxic.
- Chemically, biodiesel molecules are mono-alkyl esters produced usually from triglyceride esters



Vegetable Oil

Biodiesel

Biodiesel can be used in existing Diesel Engines

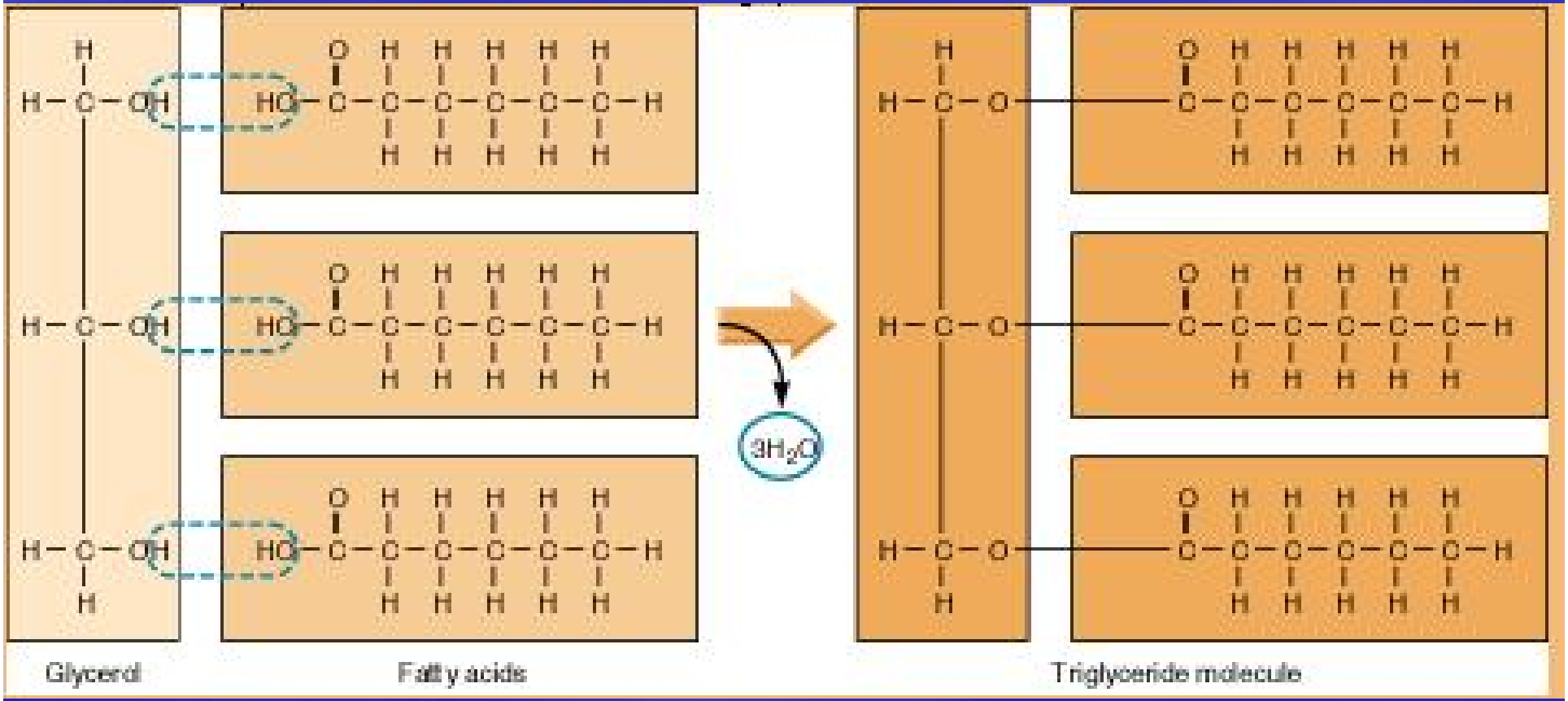
- Pure Biodiesel (B100) or blended with petroleum diesel (B20, BXX).
- Rudolf Diesel: peanut oil.
- Little or no engine modifications
- Use existing fuel distribution network.
- Available now

What is it made from?

- Rapeseed oil (Europe)
- Canola oil (Canada)
- Soybean oil (United States)
- Used Fryer oil
- Alcohol (methanol, ethanol)
- Catalyst, lye (Sodium Hydroxide, Potassium Hydroxide)
- Alcohol and lye are combined to make methoxide

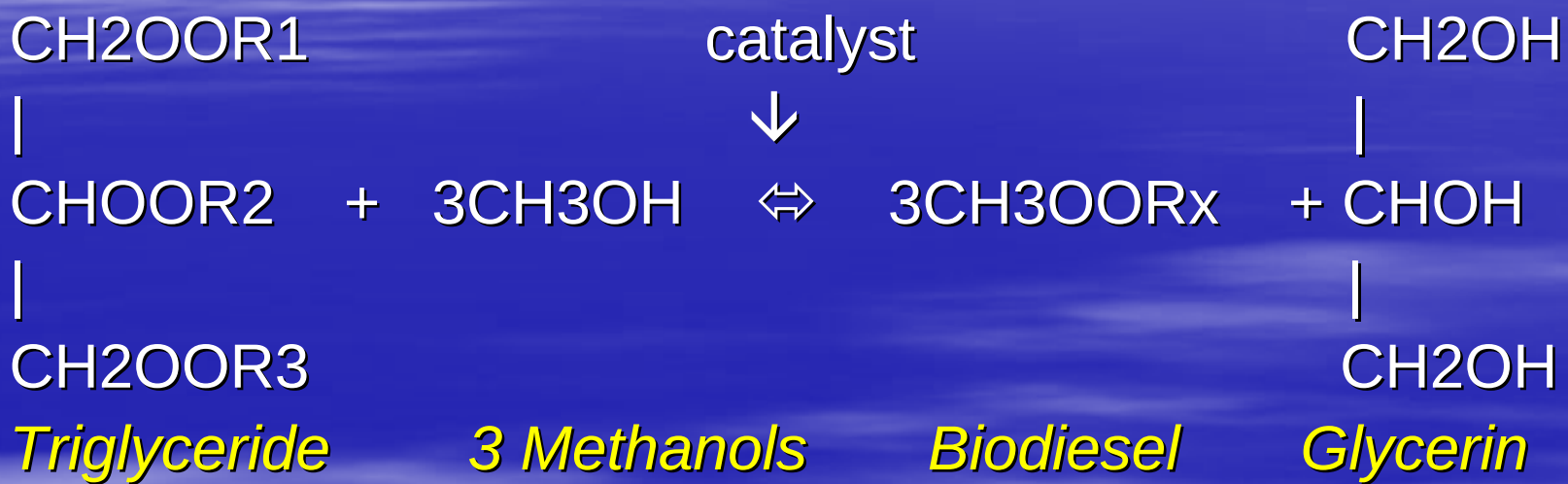
Chemistry of Triglycerides

- Biodiesel is made from the combination of a triglyceride with a monohydroxy alcohol (i.e. methanol, ethanol…).
- What is a triglyceride? Made from a combination of glycerol and three fatty acids:



Transesterification

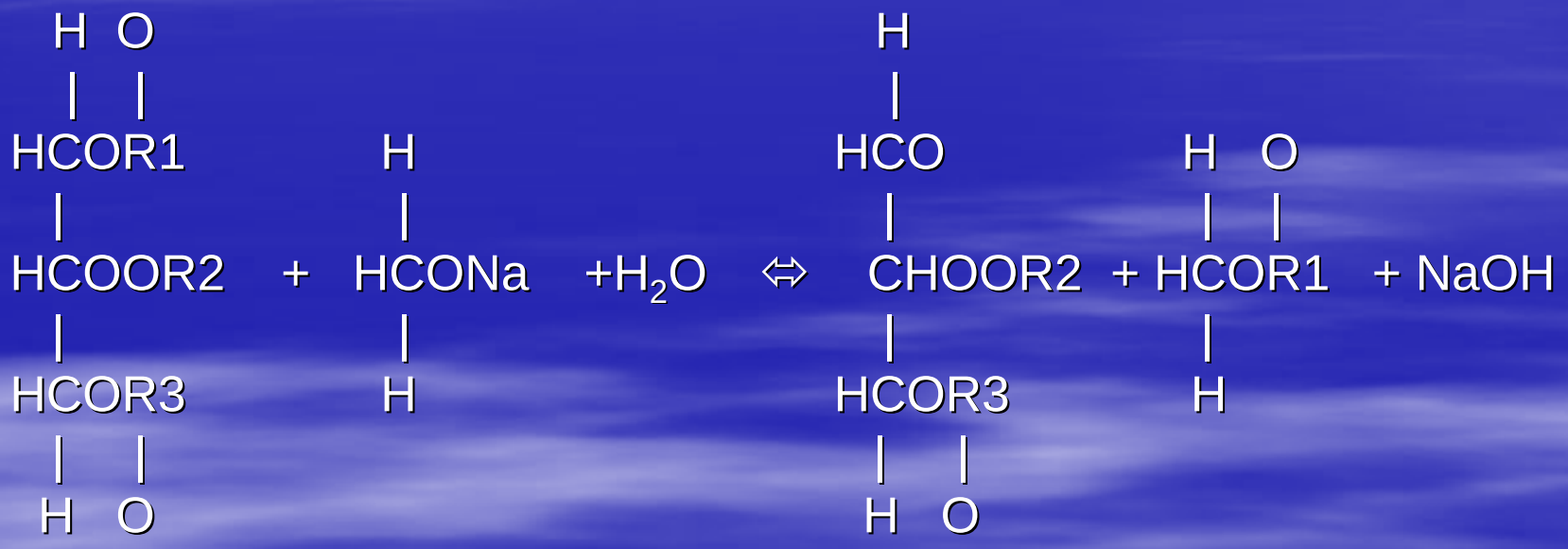
While actually a multi-step process, the overall reaction looks like this:



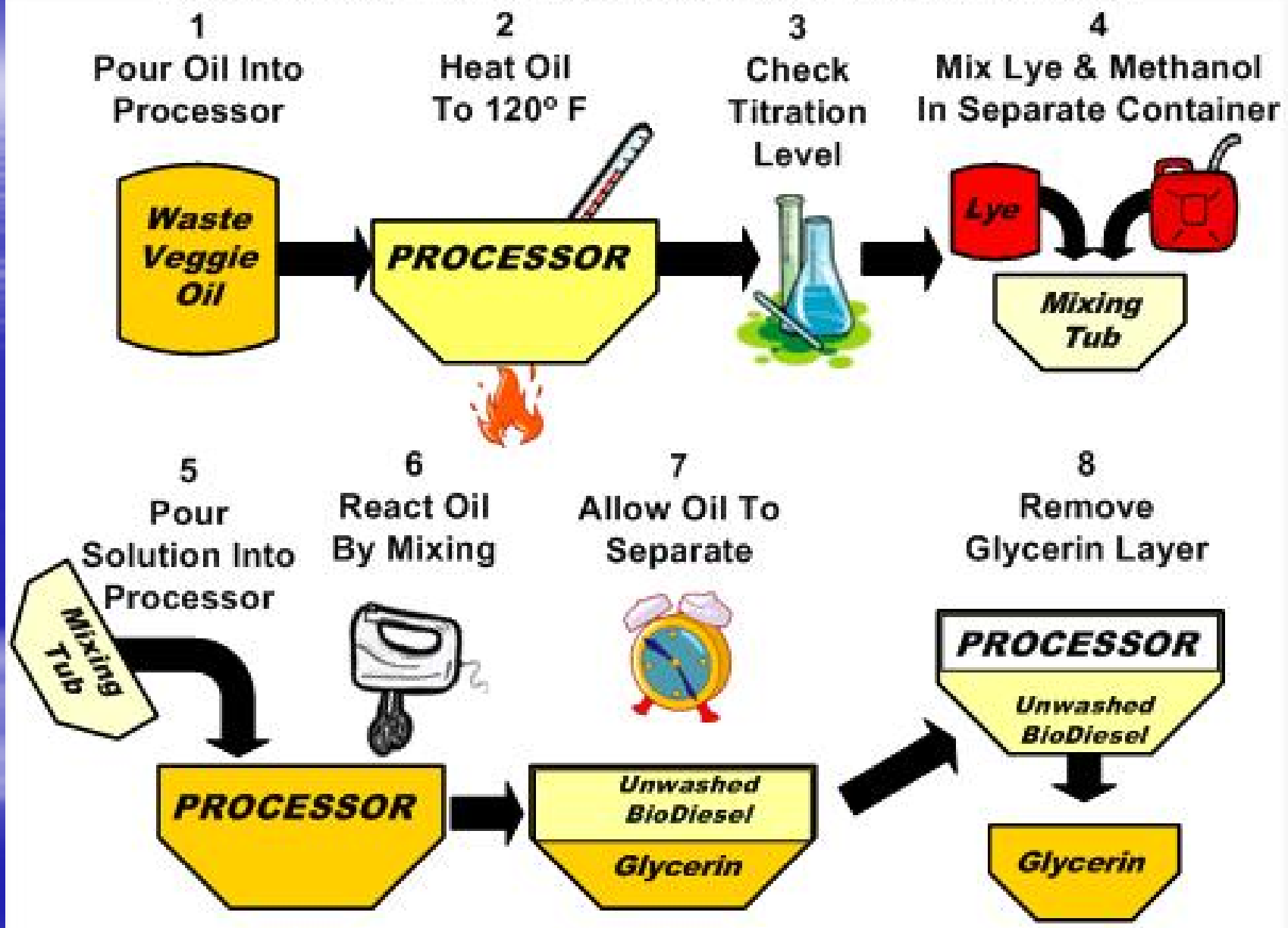
R1, R2, and R3 are fatty acid alkyl groups (could be different, or the same), and depend on the type of oil. The fatty acids involved determine the final properties of the biodiesel (cetane number, cold flow properties, etc.)

Individual step of Transesterification

First step, triglyceride turned into diglyceride, methoxide (minus Na) joins freed FA to make biodiesel, Na joins OH from water (from methoxide formation) to make NaOH. Other H joins the diglyceride.

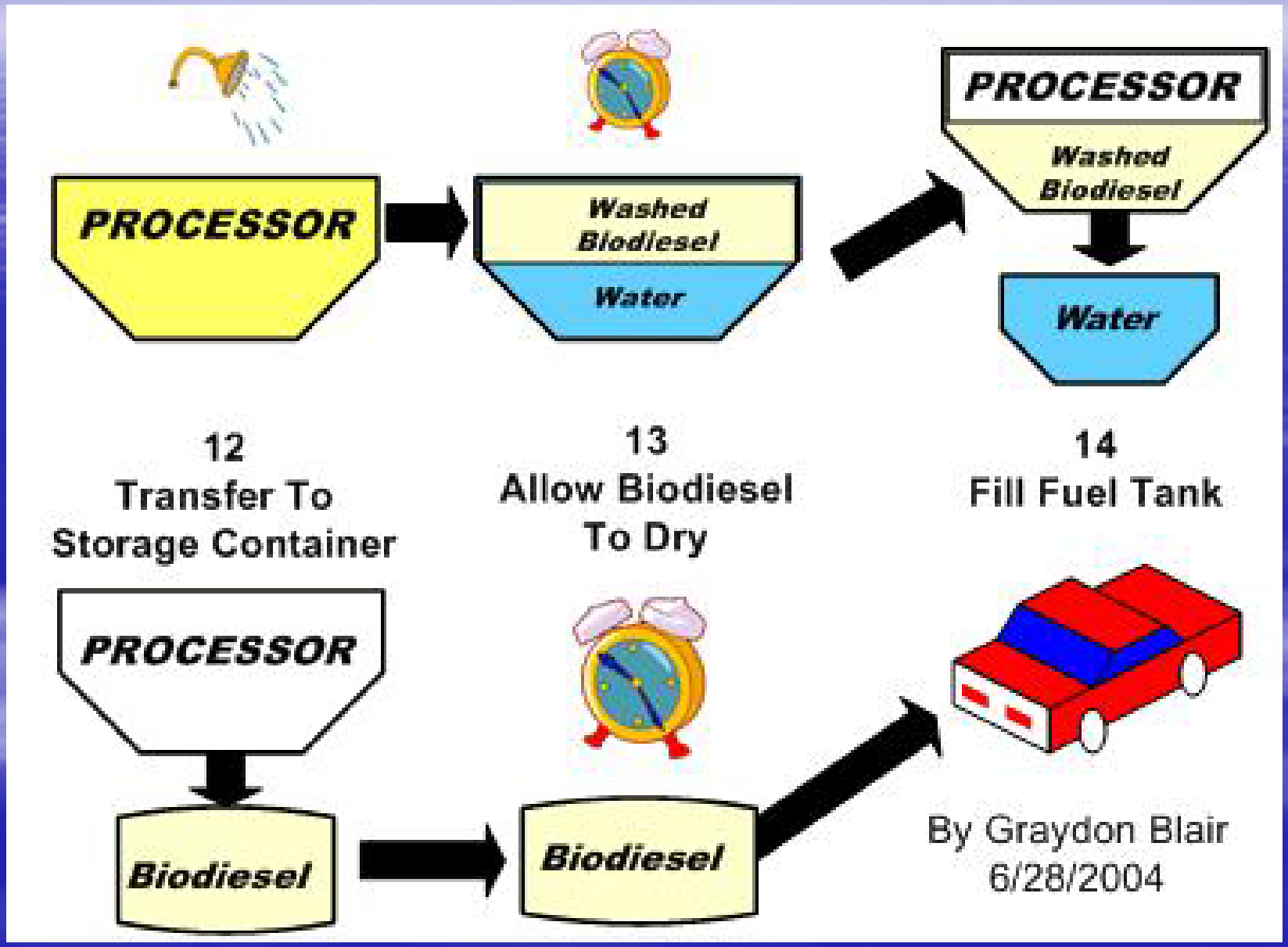


Triglyceride + Methoxide + H_2O ⇔ Diglyceride + Biodiesel + NaOH



http://www.utahbiodiesel.org/biodiesel_making.html

After Glycerin removal, biodiesel now just needs to be cleaned/purified before use:



"Appleseed" style biodiesel processor (design by Maria (Mark) Alovert). Uses old electric water heater as main unit

Biodiesel Challenges

- Cold Weather Operation (Cloud point and pour point is generally higher than petroleum diesel)
- Producing enough feedstock oil to replace a large portion of petroleum (33 billion gallons of diesel fuel is used in the United States)
- Engine and emissions optimization (Due to high cetane rating of biodiesel NOX emissions are higher than diesel fuel)