

USET, Inc.

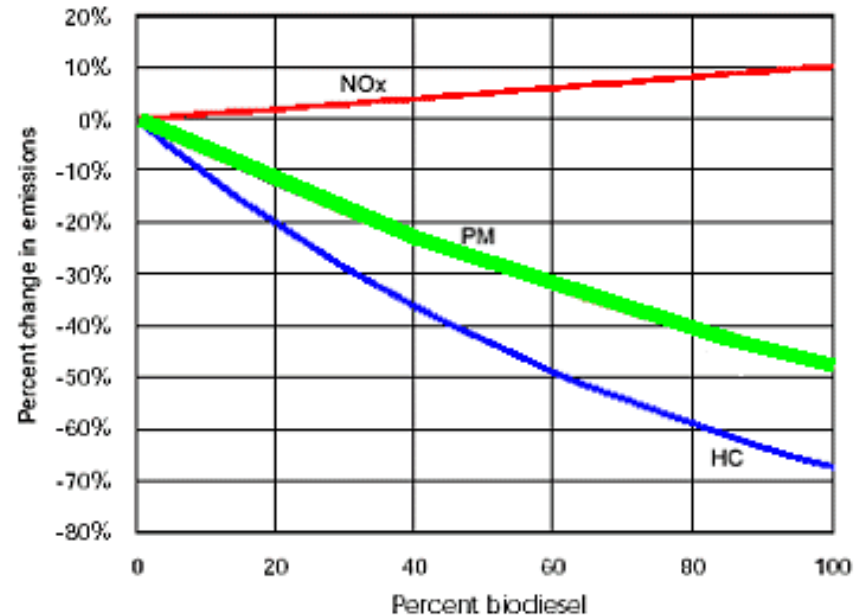
Biodiesel Chemistry

A Waste Conversion Demonstration Project

Biodiesel

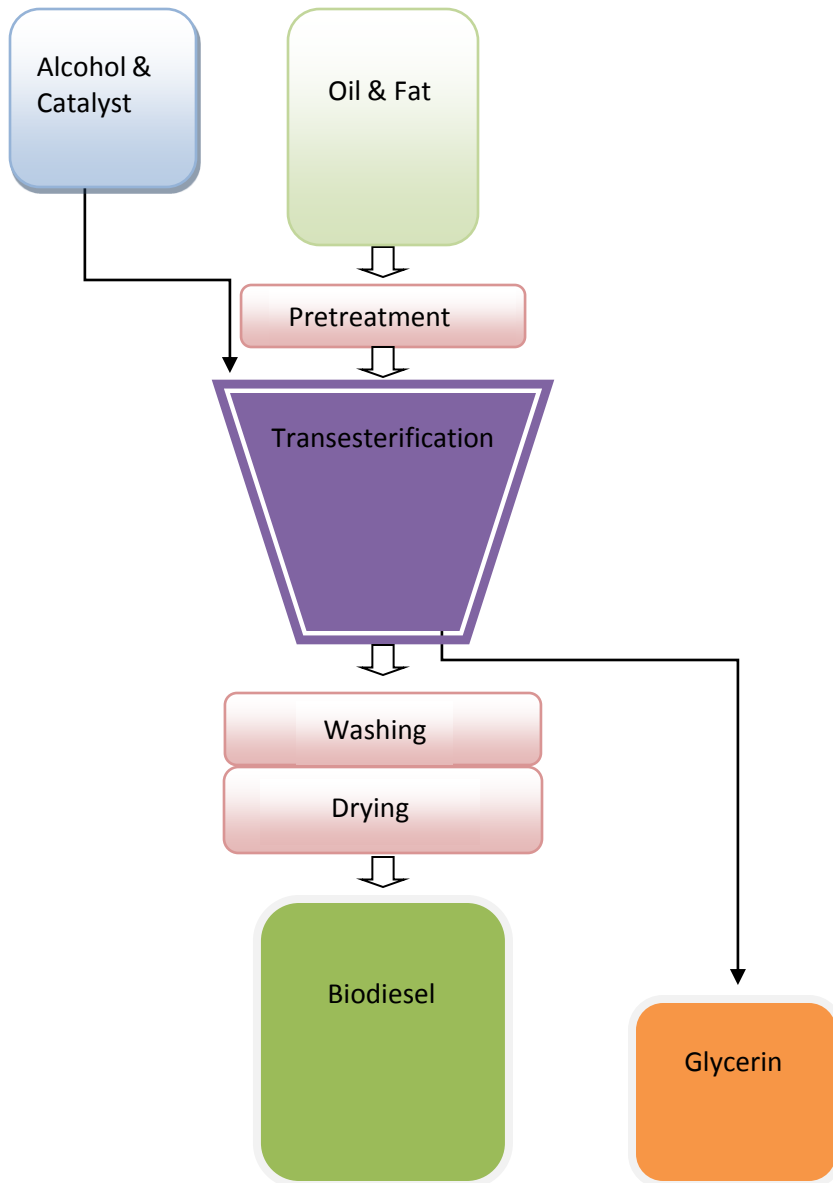
- ▶ EPA approved fuel when meeting ASTM standards
- ▶ Made from fats and oils
- ▶ Reduces emissions
- ▶ Non-toxic

Figure 1: Tailpipe Emissions of Biodiesel relative to Conventional Diesel[†]

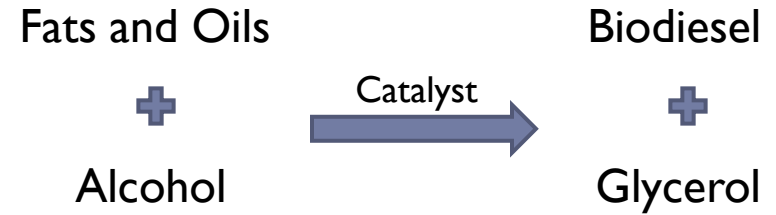


Source: U.S. EPA





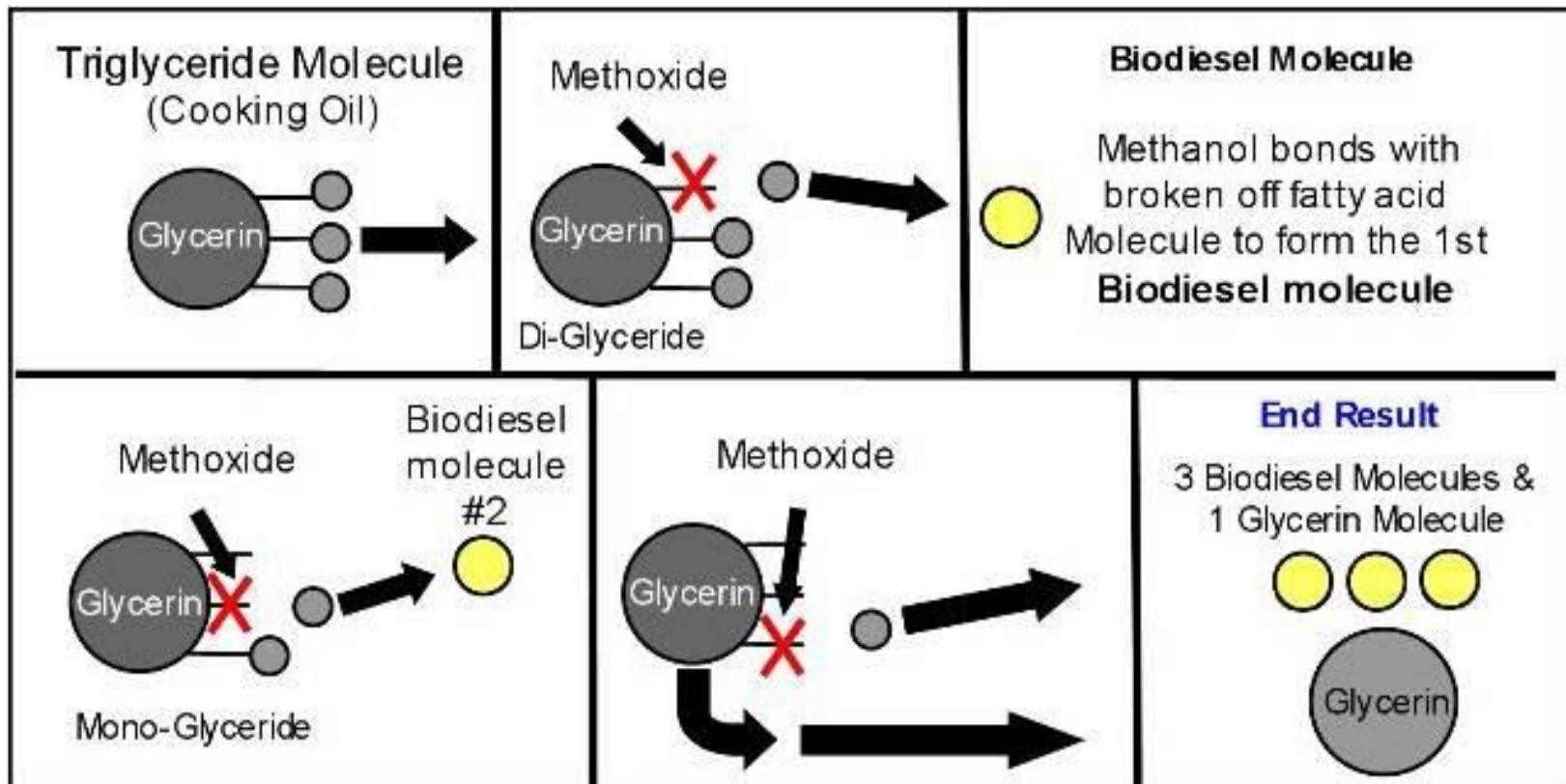
Basic Equation:



TRANSESTERIFICATION

- ▶ Processes of mixing oil with alcohol and catalyst to form biodiesel and glycerin

[VIDEO](#)



Fats and Oils

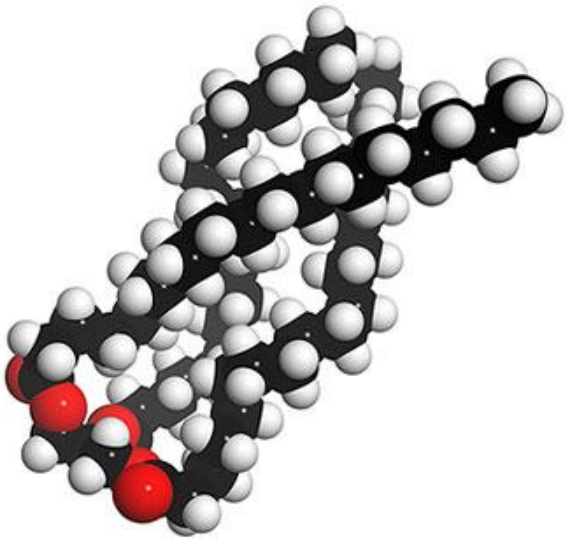
- ▶ Corn
- ▶ Hemp
- ▶ Soybean
- ▶ Camelina
- ▶ Sunflowers
- ▶ Peanuts
- ▶ Rapeseed (canola)
- ▶ Jatropha
- ▶ Palm oil
- ▶ Chinese tallow
- ▶ Algae
- ▶ *Used vegetable oil and animal fats (yellow grease)*

Crop	Oil Yield Gallons/acre
Corn	18
Cotton	35
Soybean	48
Mustard seed	61
Sunflower	102
Rapeseed/Canola	127
Jatropha	202
Oil palm	635
Algae (10 g/m ² /day at 15% TAG)	1,200
Algae (50 g/m ² /day at 50% TAG)	10,000

Fats and Oils

Water

- ▶ Saponification occurs due to excess water



Free Fatty Acids (FFAs)

- ▶ Break off the triglyceride molecule
- ▶ Amounts in vegetable oil increase with prolonged use
- ▶ Prevents oil from completely converting to biodiesel
- ▶ Forms soap

Alcohol

Ethanol

- ▶ Renewable
- ▶ More expensive
- ▶ May complicate reaction



Methanol

- ▶ Most commonly used
- ▶ Less expensive
- ▶ Lower viscosity fuel
- ▶ Flammable/toxic
- ▶ Generally from a non-renewable source

Catalyst

KOH – Potassium Hydroxide

- ▶ Reduces production time
- ▶ Fertilizer
- ▶ Slightly more expensive
- ▶ Thins glycerin

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www.tradeget.com

NaOH – Sodium Hydroxide

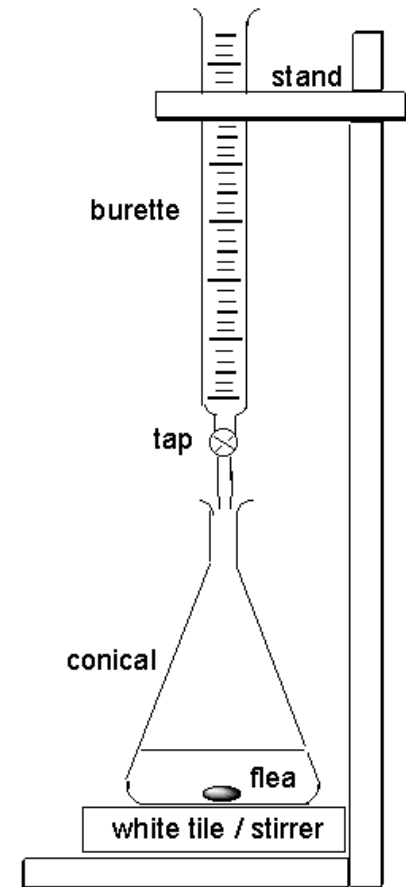
- ▶ Easier to purchase in small amounts
- ▶ Weed killer
- ▶ Less expensive
- ▶ Thickens glycerin

cnhengrunxin.en.made-in-china.com

TITRATION

- ▶ Measures acidity or FFA content of the oil
- ▶ Conduct 3 times to get an average
- ▶ Used to calculate amount of catalyst needed

[Video](#)



www.btinternet.com

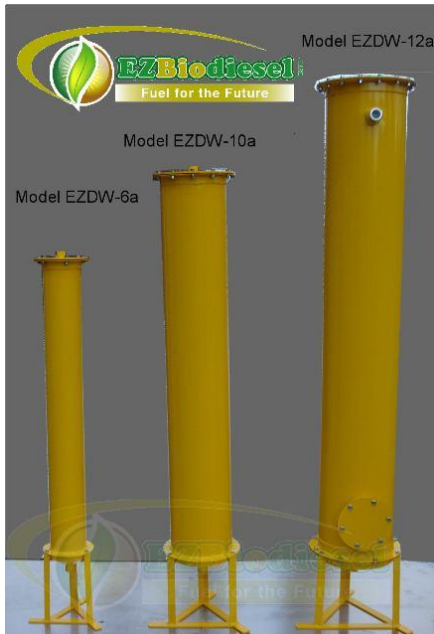
Washing the Biodiesel

▶ Water

- ▶ Danger of emulsification of fuel
- ▶ Time consuming
- ▶ Wastewater disposal
- ▶ Commonly used

▶ Dry wash

- ▶ Magnasol - powder
 - ▶ Biproduct can be used as fertilizer
- ▶ Puralite – plastic beads
 - ▶ Can be landfilled
- ▶ Cost of material



utahbiodieselsupply.com

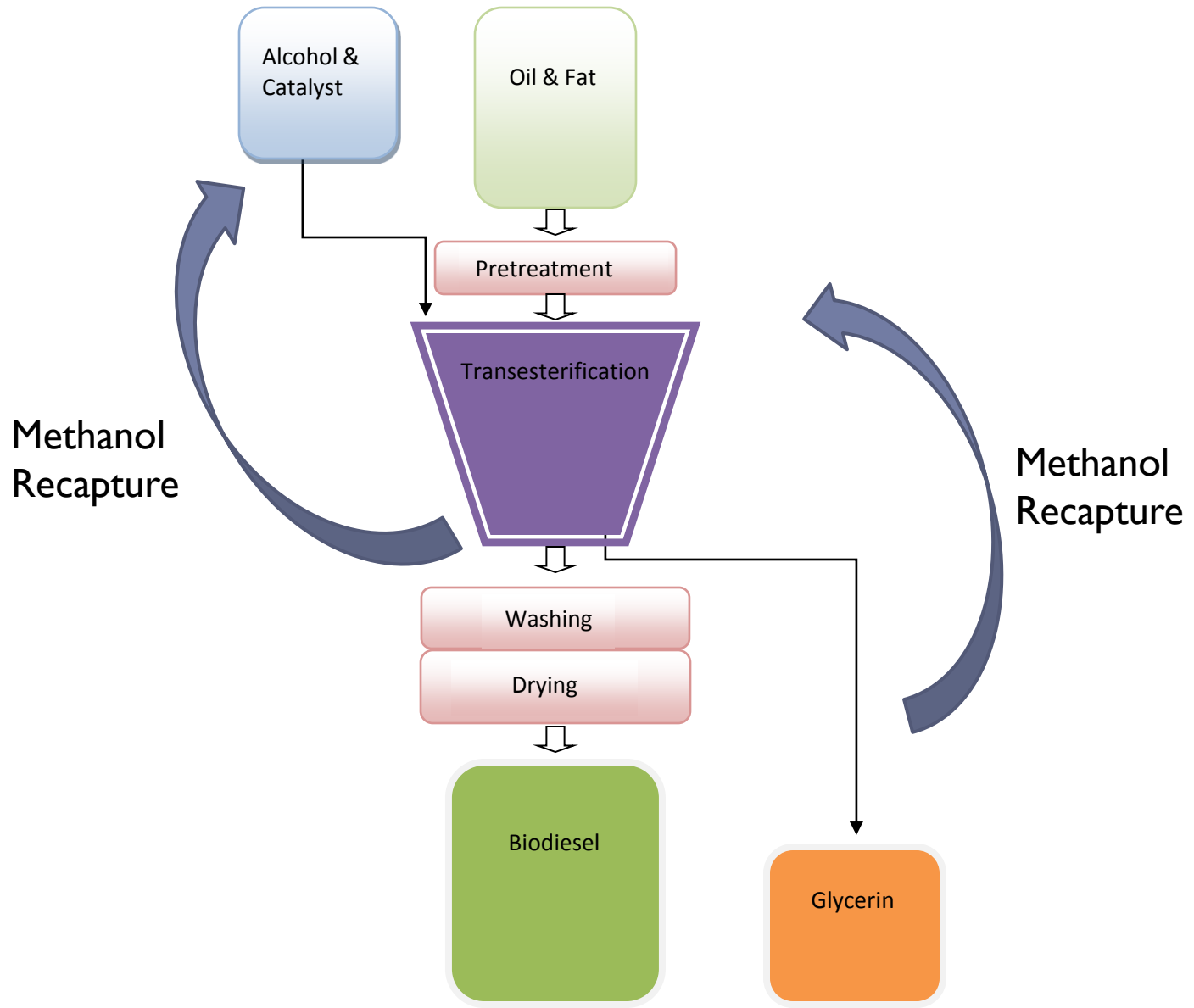


Vanderbilt Biodiesel Initiative

GLYCERIN

- ▶ Sinks and is drained off
- ▶ For every 100 gallons of biodiesel made, 10 gallons of glycerin will also be produced
- ▶ USES:
 - ▶ Compost
 - ▶ Fire logs
 - ▶ Soap
 - ▶ Refined further and sold
- ▶ Must have methanol removed and be neutralized before it is considered non-toxic





ASTM STANDARDS

- ▶ Complete reaction/removal of glycerin
- ▶ Removal of catalyst
- ▶ Removal of alcohol
- ▶ Absence of FFAs



<http://unitedbiofuelsofamerica.org/testing-standards/>

Questions?



Vanderbilt Biodiesel Initiative



BioPro 190 Processor