The Biodiesel Production Process

Types of Biodiesel Production

- **Batch Process**
  - Most common small-scale and home-brewing process
  - Slow reaction times 1-8 hrs.
- **In-line Shear Reactors**
  - **Continuous**
  - **Centrifugation speeds phase separation**
  - **Sensitive to feedstock quality**
- **Ultrasonic Reactors**
  - Experimental
  - Potential to dramatically reduce amount of catalyst used and reaction time requirement 15 min.

The Raw Materials

- **Biodiesel Feedstock** –

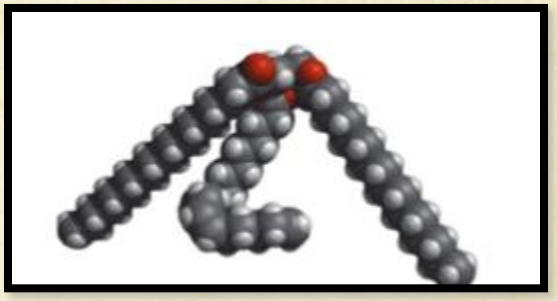
  the oil starting material that will be chemically converted into alkyl esters

- These can be oils from any biological source, botanical oils or animal fats.

Triglycerols

- Triglycerides are the most commonly converted oils.
- Phospholipids, waxes, and other polar lipids tend to emulsify and cause process issues
- This is what a triglyceride molecule ‘looks’ like:

$$\begin{array}{l} C\text{-}H_2OCOR' \\ C\text{-}H_2OCOR'' \\ C\text{-}H_2OCOR''' \end{array}$$



- A three carbon chain forms the glycerol backbone
- The R groups represent fatty acid chains

The Reaction Tank

- Location of the transesterification
- The reaction tank is a closed vessel
- The tank must be made of solvent resistant materials: polyethylene or stainless steel

The “Appleseed Reactor”

Heating the Oil

- Heat acts as a catalyst to drive the transesterification reaction
- The oil can either be heated in the reaction tank or heated prior to adding to the tank
- Oil in the reaction tank is at a temperature of 55°C
- Temperature is critical as methanol boils at 64.7°C

Transesterification of the Oil

- An alcohol, usually methanol, is combined with a strong base, potassium hydroxide (KOH) or sodium hydroxide (NaOH)
- This creates methoxide, which is then added to the reaction tank with the oil to initiate the transesterification reaction
- Methanol is added at 20% by volume of oil, only 10% needed in reaction.

Glycerol Settling

- During the transesterification reaction two products are created:
  - Alkyl esters and Glycerol
- Glycerol settles to the bottom of the reaction vessel and the Alkyl esters float on top
- The glycerol is drained from the bottom of the reaction vessel
- Glycerol typically constitutes 10% of total oil volume

Washing the Biodiesel

- The remaining alkyl esters contain small amounts of the base catalyst, free glycerol, and saponified fatty acids
- These are all water soluble and can be washed out of the biodiesel
- 1:1 ratio of water used per biodiesel made
- Wash water is drained off the bottom of a washing tank

Drying Biodiesel

- Water, however, is undesirable within a diesel engine
- All residual wash water must be removed from the washed biodiesel
- Either through intensive heating (100˚C), passive evaporation, or settling

Ready to use Fuel!

- Raw vegetable (or animal) oil has now been transesterified into alkyl esters
- These alkyl esters have been washed to increase the purity level
- And dried to remove all water
- The fuel is ready to run in any diesel engine

Producing 100 liters of biodiesel also:

- Consumes at least 350g base catalyst
- Consumes 20 liters methanol
- Produces 10 liters glycerol
- Produces 100 liters wash water