

TULSION®



BIODIESEL PRODUCTION: WET VS. DRY WHICH METHOD SHOULD YOU USE?

T-45 BD & T-45 BD Macro

Background:

Biodiesel fuel, a proven alternative to petroleum diesel, is commonly made via a trans-esterification reaction using a fat or oil in the presence of methanol and an alkali catalyst. A by-product of this reaction is the formation of glycerol / glycerin and soap, formed as the free fatty acids (FFA) react with the catalyst. Any water contained in the oil, catalyst or alcohol will cause an increase in the free fatty acid level by hydrolysis of the oil and therefore more soap will form.

While it is critical to eliminate the presence of water in the trans-esterification step, there are a number of options available to the biodiesel producer to purify the raw biodiesel but in simple terms, either a “Water-wash” or “Waterless wash” method may be employed.

Water Wash (WW) Process:

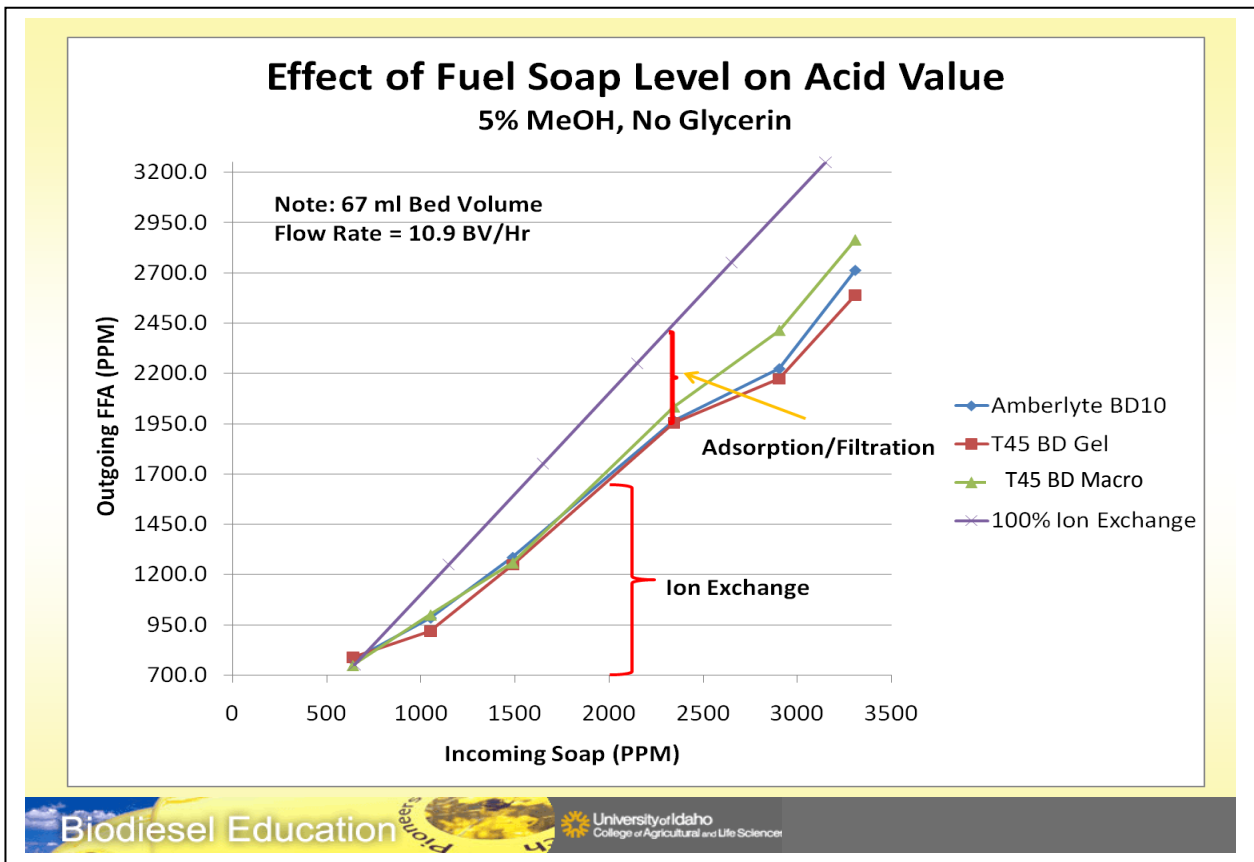
Traditionally, soap was removed from biodiesel using a water wash (WW) process. This requires the raw biodiesel to be intimately mixed with water and gently agitated. The mixture is then allowed to settle so the water phase separates from the methyl ester or biodiesel phase. In this method, soap is extracted into the water phase as are most of the metals and glycerin. However, the reactions are not complete and there are many downside issues producers need to be aware of should this method be used. They include:

- a) Water required for water washing must first be demineralized in order to remove metals and other contaminants that will get transferred to the biodiesel fuel causing the fuel to be out of specification. (Tom Bryan, Biodiesel Magazine, “Adsorbing it all”, March 2008)

- b) Water washing produces large amounts of waste water that must be treated prior to discharge or re-use.
- c) Multiple water washings are often required in order to reduce soap, metals and glycerin to acceptable levels.
- d) After the final water washing the fuel must be dried, significantly increasing the energy consumption and time required to produce a batch of B100 fuel.
- e) Water washing fuels with high soap levels can lead to emulsions that can cause yield loss and other operational problems.

Waterless or Dry Wash Methods:

Given the excessive volume of water required for the WW method, producers have turned to alternative Dry Wash Methods such as using ion exchange resins, cellulosics and inorganic compounds (e.g. magnesium silicate). When resin is used a combination of adsorption and ion exchange mechanisms are utilized, as shown in Graph 1.

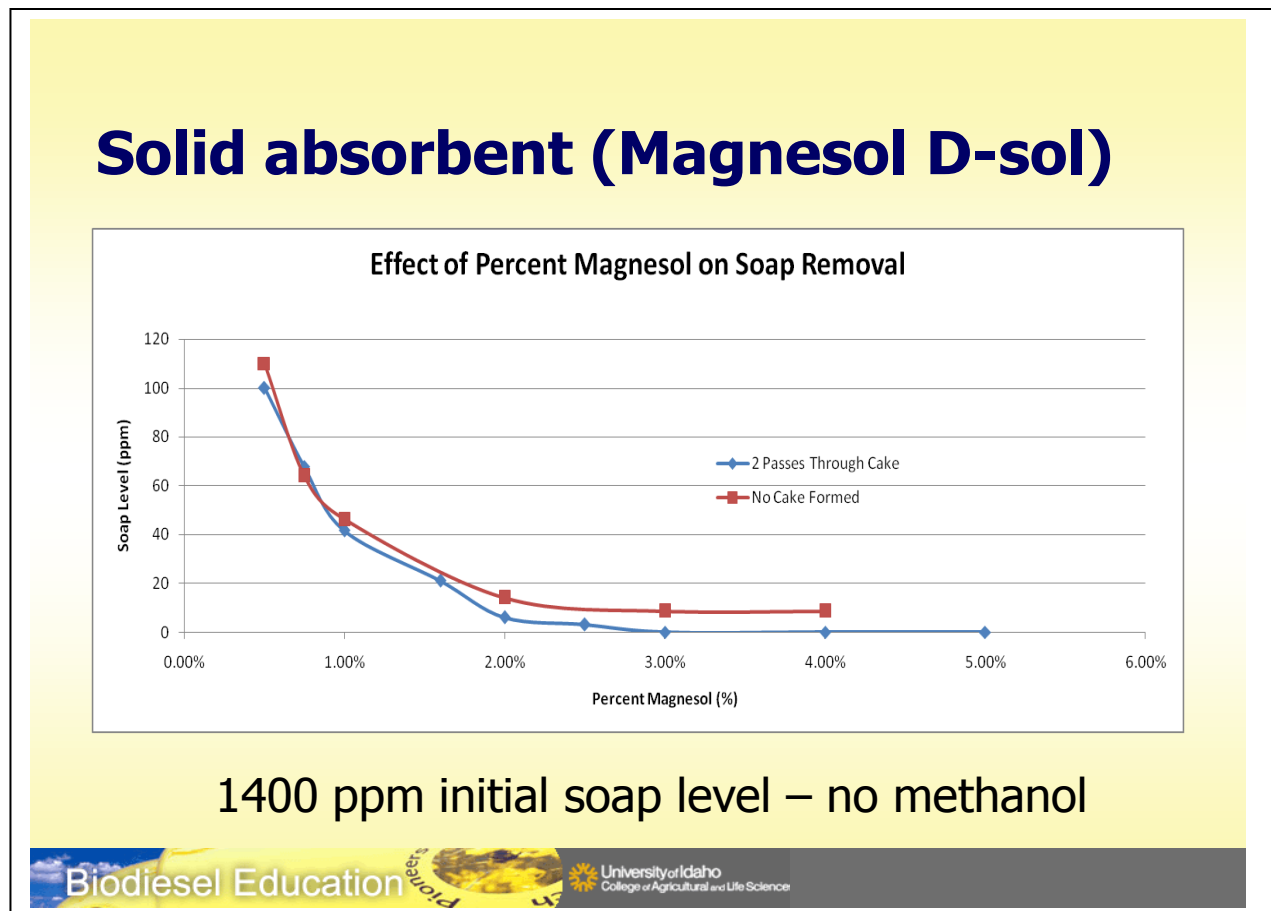


Graph 1* - Mechanisms employed when purifying raw biodiesel

* Data provided by Dr. Jon Van Gerpen at University of Idaho, Biological and Agricultural Engineering Department

Graph 1 clearly shows that both ion exchange and adsorption take place in the resin bed. Trace metals and polar contaminants like glycerin and monoglycerides are removed via ion exchange where a hydrogen ion replaces the contaminant; soap and glycerin are removed via adsorption.

When an adsorbent powder is used, such as magnesium silicate (or sawdust or cellulose), the polar contaminants are removed by multiple filtrations through a pre-coat filter or filter cake. Ionic contaminants such as alkali metals due to trace catalyst residue are not readily removed. Graph 2 shows that not only are multiple passes required to achieve the desired effluent soap concentration, the percent magnesium silicate must be greater than 3% in order to achieve thorough removal of the soap, contrary to the manufacturers recommendation of 1% by weight for every 1,000 ppm of soap to be removed.



Graph 2** – Magnesium Silicate required for thorough clean-up of raw biodiesel

** Data provided by Dr. Jon Van Gerpen at University of Idaho, Biological and Agricultural Engineering Department

Relative Economics of Ion Exchange vs. Magnesium Silicate:

To compare relative operating costs of these two methods a few assumptions were made:

1. The fuel to be treated used the same 1,000 ppm level of soap.
2. Resin and magnesium silicate consumed were based on actual field experience and not based on manufacture's literature.
3. Methanol is typically removed prior to treatment with magnesium silicate. It is required for optimum performance of ion exchange systems. The cost to remove methanol was not considered as it is required regardless of the purification method employed.

In a paper recently presented at the July 2008 conference of the American Society of Agricultural and Biological Engineers (ASABE) co-authored by Jacob Wall and Dr. Jon Van Gerpen, they report "a cost comparison of ion exchange resin to magnesium silicate was conducted and shown to be approximately 3 to 1 in favor of resin." On a more practical level, a Mid-West biodiesel producer reported consuming 1 lb of magnesium silicate for every 50 gallons of raw biodiesel fuel treated. For a producer generating five million gallons of B100 annually means the cost to purify the fuel using an inorganic media will be approximately \$500,000. In comparison, a South-East producer also generating five millions gallons of fuel per year reported using \$100,000 worth of ion exchange resins to purify the same volume. These examples confirm at least a 3:1 benefit when utilizing an ion exchange purification system versus magnesium silicate.

Beyond the economic advantage and return on investment ion exchange systems have to offer, the ease of handling the media should be considered in any evaluation process. For example ion exchange resins are poured from the bag into the service vessel. Raw biodiesel fuel is introduced into the vessel and the resin equilibrates with the methanol / biodiesel mixture causing the resin to expand to roughly twice its original volume thereby packing the ion exchange column for the first service cycle. No special handling or breathing apparatus are required when handling the 0.3 mm – 1.2 mm ion exchange beads.

Conversely, magnesium silicate media may be used on its own or as many users have reported, may be mixed with other media such as diatomaceous earth, sawdust or other cellulosics. Blending a small percentage of other media with the magnesium silicate produces a more uniform and consistent pre-coat that pack tighter and more evenly across the surface area of the drum filter. This improves the efficiency of each pass but does not eliminate the need to re-circulate the fuel multiple times. The use of masks and gloves are recommended when handling the finely powdered magnesium silicate and / or diatomaceous earth.



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