Biodiesel Purification: Finding the Right Fit

BY WILL SMITH

In 16 years of dealing with problematic feedstock, Pacific Biodiesel Technologies has evaluated dozens of biodiesel purification means. Finding the right process for a facility and feedstock is always challenging. The first step is to classify and quantify contaminants. Major contaminants come from reaction processes or feedstock adulterants. Process contaminants include free glycerin, residual glycerides, soaps, fatty acids and water. Feedstock contaminants include gums/phosphatides, sulfur-containing compounds, polymers, sterols, proteins and oil decomposition products.

Biodiesel plants utilizing degummed, refined vegetable oils or animal fats can employ various purification methods, provided process chemistry is controlled to reduce soap formation. Water wash is a time-tested, proven purification method used throughout the industry. A well-designed water wash system can be extremely effective in removing process contaminants like glycerin and soaps, but a major limitation is its low effectiveness in removing feedstock contaminants such as sterols and unsaponifiable matter, which can increase cold soak filtration time. This has led some facilities to retrofit with post-filtration systems, utilizing filter aid and chilling the biodiesel to coagulate and remove contaminants. Some water wash systems don't recycle wash water, resulting in a problematic waste stream. For smaller facilities processing refined vegetable oils or animal fats, a variety of disposable ion exchange resins are available for purification. Their performance is similar to water wash in removing soaps and free glycerin, but limited in removal of feedstock contaminants. The major advantages of ion exchange resins are low capital cost and elimination of emulsions and wastewater streams.

Both water wash and ion exchange resins are selective, efficient, proven purification methods. Problems arise, however, when they are applied to feedstock and contaminant levels for which they weren't designed. When processing oil with higher free fatty acids (FFA), without esterification or refining to remove FFA, soap levels increase dramatically and yields plummet. Most water wash operational problems stem from emulsions due to high soap levels. Similarly, ion exchange resins have a drastically reduced lifespan when exposed to high soap levels or phosphatides, require more frequent replacement, and increase the acid value and cold soak filtration of the fuel, driving up operating costs.

Low-quality feedstock such as used cooking oil, yellow grease, tallow, chicken fat and crude corn oil have high levels of contaminants, challenging traditional process chemistry and purification methods. The wide variability in feedstock quality depends on supplier, lot and seasonal variation. Aside from obvious challenges converting low-quality feedstock to crude ester, purification methods must be robust and adaptable to handle variation.

Silica purification is used at several PBT-built facilities and is a popular, versatile means for dealing with problem feedstock. Applicable in batch and continuous processes, silica adsorption uses synthetic or natural silicates to adsorb polar contaminants on the surface of silica particles, which are then filtered from the ester stream. Silica adsorption is very effective at removing free glycerin, soaps, trace metals and oil decomposition products, resulting in fuel with improved oxidative stability. The major downside, however, is handling the fine silica powder and spent filter cake. Additionally, silica is not effective at removing sulfur or polymers.

For heavily degraded feedstock, biodiesel distillation should be implemented for removing the most recalcitrant contaminants. High-vacuum distillation of crude ester results in a pure methyl ester absent of soaps, glycerides, polymers and sulfur-bearing compounds. High capital cost and yield loss are its primary drawbacks, but years of research by PBT on low-value feedstock such as brown grease or crude corn oil show that biodiesel distillation is the only viable solution to produce a consistent fuel from these problematic feedstocks.

Effective purification, regardless of method, starts with removing feedstock contaminants or using good process chemistry to prevent contaminant formation. Successful strategies may be as simple as working with a feedstock supplier to control contaminant levels, or optimizing catalyst loading. Changing feedstock or purification methods can be a significant investment. A decision of this magnitude should not be made by reviewing vendors' typical data, but after extensive lab/pilot plant work to determine true costs, yields and quality. Understanding the limits of biodiesel purification methods, and selecting appropriate combinations of feedstock and purification steps, will lead to a consistent quality of fuel at a cost both the producer and customer can afford.

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