BIOdiesel Tech NOTES

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MATERIAL COMPATIBILITY IN BIODIESEL PRODUCTION

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A common question in the biodiesel industry is whether a specific material is compatible with biodiesel or the ingredients that are used making it. The process to produce biodiesel involves the use of strong bases and/or acids and flammable chemicals. Some materials are more compatible with one or more ingredient chemicals used in a biodiesel plant. Unique chemical compatibility and safety challenges are presented in applications related to biodiesel production. This technote discusses some common metal and rubber materials used in the industry and their compatibility with biodiesel, methanol, and catalyst to consider for the producers, plant designers and users.

METALS

The ingredients of biodiesel and the neat fuel itself contacts metals in the storage tank, reaction vessel, piping, heat exchanger, and pump. Some metals, particularly copper and zinc or their alloys (such as brass or bronze), degrade over a period. Biodiesel with higher sulfur content tend to corrode copper faster. Copper and its alloys are commonly used in heat exchangers check valves, pressure relief valves, and other process systems mainly because of copper's excellent thermal conductivity. Extended use of copper/zinc metals causes component to tarnish (greenish discoloration) and corrode resulting in leaky vales, brittle plumbing, degraded fuel quality, and eventual failure. These metals are not chemically compatible with biodiesel and should be avoided.

The degraded metal usually ends up in the fuel itself. National Renewable Energy Laboratory reports that biodiesel will degrade and form high sediment levels if contacted for long periods by copper or copper-containing metals (brass, bronze) or with lead, tin, or zinc (galvanized surfaces) [1]. Incompatible metals may affect the biodiesel by accelerating its oxidation process and creating fuel insolubles. These insolubles causes high sediment levels and may clog filters.

ASTM D6751 specified Copper Strip Corrosion for biodiesel to be 3 or less. According to ASTM D130 [2] a copper stripe is placed in biodiesel at 50°C for three hours and degree of discoloration of copper is categorized between 1 and 4. A biodiesel meeting this standard in general should not corrode copper during short use, but prolonged contact can still degrade the fuel and cause sediment to form.

Aluminum is compatible with pure biodiesel; however, the compatibility has a D (severe defect) rating with caustic substance such as sodium or potassium hydroxide catalyst used to make biodiesel [2]. Additionally, aluminum heat exchangers commonly available in the market may have copper tubing or some parts made of copper. It is recommended to confirm with the vendor that the heat exchanger is free of copper, zinc or their alloy.

Stainless steel is the preferred metal to be used in biodiesel processing plants. The neat biodiesel can be stored and transferred in standard fuel tanks made of steel, aluminum and some plastics without a problem as long as the fuel is kept dry and the tanks are properly maintained.

RUBBER TYPE MATERIAL

Rubber is mainly used as gasket material or hoses. Fluorinated gasket materials in the class of FKM like Viton® are desirable for use in end use application of biodiesel fuel. They can be formatted in a variety of different durometer ratings. This allows gasket deformation under load to provide a good seal in low-pressure applications. Example applications are the seals in the fuel systems of cars and trucks.

In fuel production, however, FKM gaskets are not chemically compatible with the reagents and processing conditions to make fuel. At the University of Idaho in the short term, fuel production FKM gasket materials in methanol have swelled in excess of 5% volume resulting in seal failure. Commonly used gaskets materials like ethylene propylene diene monomer (EPDM), Nitrile/Buna-N, and Silicone are chemically not compatible with the reagents and processing conditions for Biodiesel fuel production. Nitrile is the most commonly used elastomeric material for molded and extruded products.

We tested the following four sealing materials used in methanol, three times, on 2-inch diameter gaskets.

1) Chemically Resistant Fluoroelastomer,
2) FKM(Viton®),
3) Buna Nitrile, and
4) Expanded Polytetrafluoroethylene (PTFE)

The gaskets were submerged in a beaker filled with methanol for 24 hours. The diameter before and after soaking was measured using an image taken from a high-resolution DSLR camera. The average increase in diameter was calculated (Table 1). We found that PTFE swelled the least in 24 hours in this experiment and FKM swelled the most in this experiment.

Table1: swelling of different sealing gaskets after 24 hours soaked in methanol.

Material	% Increase in Diameter
Chemically resistant fluoroelastomer	0.42
FKM	1.71
Buna-N, Nitrile	1.25
PTFE	0.07

Figure 1: The diameter before and after soaking in methanol was measured using a high-resolution image taken with a DSLR camera.

Buna-N, Nitrile, and chemically resistant fluoroelastomer have been used successfully for a few months in our biodiesel lab without developing a leak. They do tend to swell over time and are not recommended for long time use. There are also commercial gaskets available that use PTFE with barium sulfate. They would be an excellent choice if higher compressive forces needed to be applied to the gasket.

Reference

1. NREL. 2016. Biodiesel handling and use guide. National Renewable Energy Laboratory. Available at: www.afdc.energy.gov/uploads/publication/biodiesel_handling_use_guide.pdf
2. ASTM D130. Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test.
3. CP Lab. Available at: https://www.calpaclab.com/aluminum-chemical-compatibility-chart/