



Stability of Biodiesel Fuel and Bell Performance BIO DEE-ZOL Additive

Biodiesel is an expanding fuel market in the United States; in just one year, production rates increased from about 70 million gallons (2005) to over 200 million gallons (2006). Consumers gravitate toward biodiesel largely because it is a renewable fuel (to reduce national dependence on foreign oil sources) and it is environmentally-friendly (reduces emissions). Producers of biodiesel are increasing for these reasons and, in addition, because it is easy to manufacture.

Stability Issues

Despite its positive qualities, biodiesel has certain negative chemical characteristics when it is used as an alternative fuel. Chief among these properties are its instability problems. Alternative fuels derived from biological sources (including biodiesel) are inherently more unstable than traditional petroleum fuels like diesel and gasoline.

The degradation of biodiesel is caused by two main chemical processes – hydrolysis and oxidation, as well as from exposure to excess heat.

- **Instability from Hydrolysis** – When biodiesel is exposed to water, a hydrolysis reaction happens across the ester linkage of the biodiesel molecule, increasing the acidity of the fuel. An increase in the bio-material acidity in the fuel directly increases the rate of degradation and decomposition of the biodiesel blend. This is why the total acidity, or Acid Number, specification is important to know.
- **Instability from Oxidation** – As biodiesel is exposed to air, it reacts with the oxygen in the air to form peroxide compounds. These peroxides eventually produce gums and compounds which are harmful to engine components.
- **Instability from Heat** – Biodiesel is generally stable in the presence of heat for short periods of time if it is kept away from oxygen and water. But if it is stored at high temperatures for long periods of time (such as in a hot climate in Florida or Texas), other factors (microbes, hydrolysis and oxidation) will increase, resulting in fuel instability.

Factors Controlling Stability of Biodiesel

Bio-feed composition, environmental conditions and petroleum-feed composition are the three most important factors controlling the stability of biodiesel fuels.

Bio-feed Composition – This is the composition of the feedstock oil which was used to produce the bio-portion of the biodiesel blend (as opposed to the composition of the



diesel fuel portion of the blend). Different oils such as soybean, coconut, palm or animal fats, react differently to the chemical processes used to transform the oil into usable biodiesel stock. Oxidative instability is related to the amount of olefinic or unsaturated materials produced by these processes. Higher amounts of unsaturated molecules mean greater instability.

Environmental Conditions - Water content, microbial presence, exposure to sunlight, exposure to metals during transport and storage, exposure to oxygen and the presence of natural preservatives are key influences upon instability.

- **Water Content** – Exposure to water causes hydrolysis reactions that increase the acidity and instability of the fuel
- **Microbial Presence** – When water is present in the fuel, microbes are growing in the fuel as well. Microbes produce enzymes such as lipases during their life cycle which help to digest biodiesel, resulting in deleterious effects on the fuel and its stability.
- **Exposure to Sunlight** – Exposure to sunlight increases both the rate and the magnitude of oxidation. Light will cause peroxides to be formed, but by different mechanisms than conventional causes (exposure to air). This sunlight-enhanced oxidation cannot be eliminated by conventional antioxidants. Therefore, biodiesel fuel should not be in contact with sunlight if stored for a period of time.
- **Exposure to Metals** – Some metals, like copper and manganese, can act as oxidation catalysts, increasing the production and decomposition of peroxides.

Natural Preservatives - Vitamin E derivatives (called tocopherols) are naturally present in many plant oils such as soybean. These can extend the storage life of biodiesel blends. Unfortunately, biodiesel processors often remove these compounds in order to sell them as by-products to other industries.

Diesel Fuel Makeup

The recent EPA mandate to lower sulfur content down to 15 ppm requires refiners to hydrotreat the fuel. Hydrotreating will remove and change the structure of certain materials in the fuel that previously protected the fuel against oxidation and instability. Polymers and gums tend to form more quickly in ultra low sulfur diesel than in higher-sulfur diesel. This has a negative impact upon the oxidative stability of biodiesel blends made with ultra low sulfur diesel.



Additives and Fuel Stability: Bell Performance Bio Dee-Zol

To combat the problem, Bell Performance, Inc. of Longwood, Florida has introduced a multi-purpose biodiesel additive called **Bio Dee-Zol** to help stabilize biodiesel blends. **Bio Dee-Zol** improves the stability measurements for biodiesel blends exposed to different types of storage situations.

The Rancimat Rating for Fuel Stability

The D6751 specification for biodiesel utilizes the Rancimat rating to assign a stability measurement for biodiesel. The United States standard requires biodiesel to maintain three hours of stability under the Rancimat method. The European biodiesel standard requires six hours.

In surveys conducted on soy biodiesel evaluated for oxidative stability, it has been determined that most biodiesel samples will initially exceed the three hour minimum specification. However, the stability of in-spec biodiesel diminishes upon storage due to factors described earlier in this paper.

Bio Dee-Zol and Oxidized Fuel Stabilization

Traditional stabilizers are added to biodiesel to prevent the destabilization of biodiesel. In certain instances, these stabilizers can correct oxidative degradation which has already occurred. This benefit is in contrast to cold flow improvers, which can be used to prevent fuel gelling but cannot reverse gelling once it has occurred.

Testing performed with the active ingredients in **Bio Dee-Zol** showed that the Rancimat ratings of biodiesel fuels treated with the ingredients increased by 100-150% compared to untreated fuel. This shows that the active ingredient in **Bio Dee-Zol** was effective in correcting instability issues associated with aged and oxidized biodiesel fuel.

Bio Dee-Zol and Mingled Fuel Instability

Fresh biodiesel and aged biodiesel are often mixed together within storage tanks. Mixing old and new biodiesel together adversely impacts the stability of the entire blend. Research has shown that the Rancimat rating for such a blend decreases as the percentage of aged biodiesel increases. Adding just 10% aged biodiesel to fresh biodiesel reduces the Rancimat rating of the blend by almost 50%. Increasing the percentage to 25% cuts the Rancimat rating by over 70%. Adding as little as 15% of an unstable biodiesel can drag the stability of a high quality biodiesel fuel out of specification.



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Bio Dee-Zol helps minimize the Rancimat depression that occurs when adding old and new biodiesel together. When a blend of old and new fuel with an out-of-spec Rancimat rating of just 2.03 hours was treated with stabilizer, the stability rating improved by 160%, up to 5.32 hours, well above the standard specification. So **Bio Dee-Zol** helps minimize potential problems when old and new biodiesel fuels are mixed together.

Bio Dee-Zol and Instability Caused by Metallic Exposure

The presence of a transition metal like copper will cause up to a 50% loss in oxidative stability. When treated with the active stabilizer in **Bio Dee-Zol**, the reduction in Rancimat rating was reduced by 90%, such that the biodiesel samples remained above specification for stability.

Conclusion

Biodiesel fuels will better serve the customer if the disadvantages of the fuel can be minimized. Factors such as oil feedstock composition, exposure to oxygen, water, and sunlight, and metallic storage containers can all cause the fuel to degrade more quickly than usual. The use of a high quality stabilization product such as Bell Performance's **Bio Dee-Zol** can minimize fuel-related problems and associated potential equipment problems encountered by unstable biodiesel fuel.

For more information on **Bio Dee-Zol** and other high quality Bell Performance products for biodiesel, ethanol, gasoline and diesel, visit our web site at www.bellperformance.net or call 407-831-5021.

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