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PROPER MAINTENANCE PROGRAM ENSURES OPTIMAL DIESEL ENGINE PERFORMANCE

By Scott Irwin

Fuel system maintenance is critical for extending engine reliability and performance, whether on the road or on the water. A good fuel supplement should be considered as part of your diesel engine maintenance program.

Fossil Fuel vs. Biodiesel Fuel

Most diesel fuel used today comes from previously living organisms. These fossil fuels include crude oil, coal and natural gas. A small but growing source for diesel fuel is currently or recently living organisms, including animals, plants and algae; these are usually called biodiesel fuels.

The most common source for diesel fuel is petroleum crude oil. Crude oil is a complex mixture of many hydrocarbon compounds, including a slightly tighter mixture known as diesel fuel. When comparing gasoline to diesel, diesel fuel has a higher boiling point because the molecules that make it up are typically of a higher molecular weight. This higher weight means that it has a lower vapor pressure and a higher flash point, so it burns longer and provides more power per gallon burned. The downside is that diesel doesn't burn quite as cleanly, resulting in more fuel system deposits and particulate emissions (smoke) than gasoline.

While biodiesel can be used as a fuel the same as petroleum-based diesels, it differs chemically, which can provide some benefits and some disadvantages. It burns cleaner than petroleum diesel, but its cold flow properties are not as good. Another problem is that it degrades quicker than petroleum diesel.

Another difference between biodiesel and petroleum diesel is lubricity. Because biodiesel contains oxygen as part of its molecular make-up, it has some affinity to metal. As such, it provides some lubricating properties to the fuel system. Petroleum diesel fuels used to contain residual amounts of sulfur, but refiners have been required to refine sulfur out of diesel fuels. When biodiesel is blended with petroleum diesel, the blend will easily meet the requirements of ASTM D975 that sets the specifications for diesel fuels, including fuel lubricity.

Diesel Fuel Roles

In addition to providing the energy source, diesel fuel has three other roles in the diesel engine fuel system: Lubrication, cooling and cleaning.

Lubrication – Diesel fuel has lubricating properties and lubricates all the moving components in the engine fuel system, such as fuel pumps and injector pump assemblies. Lubrication in the fuel system is critical for reducing wear and ensuring reliability for long life.

Cooling – Fuel circulates through the fuel system and absorbs the heat generated by the engine. The heat in the fuel is then dissipated as it is recirculated back through the fuel service tank. Without proper cooling, oxidation of the fuel can occur, which can cause a higher viscosity that can further hinder the fuel's lubricating ability.

Cleaning – Diesel fuel picks up unwanted contamination in the fuel system as it circulates through the engine fuel system. These contaminants are removed by the filtration system. Having a quality filtration system is a must for the very strict tolerances of the engine fuel system components.

Diesel Fuel Challenges

Problems faced by diesel equipment operators, particularly in marine operations, include water, oxidation, weather and ultra-low sulfur diesel.

Water – Water can come from the fuel supplier, fuel storage tanks or through condensation that occurs when air enters through the tank vents and meets the warmer fuel in the service tank. Water can settle in the tank or become emulsified within the fuel and become difficult to remove.

When water accumulates in tanks and stays there for extended periods of time, certain anaerobic microbes find their way into the water phase and thrive there. They live in the water but eat the fuel. If their population gets large enough, they will then begin to live in and above the fuel. Microbes can form biomass in the fuel. This biomass can plug fuel filters and injectors, thus resulting in engine stalling or reduced performance. The only way to get rid of the microbes is to kill them, remove the water, and remove the biomass. This can be costly and tedious.

Water is also a catalyst for fuel degradation, which can result in the formation of sludge and varnish that accumulates in fuel tanks and lines and ultimately foul injectors. The result would be diminished engine performance. When large water droplets pass through fuel injectors and are exposed to the high temperatures in the combustion areas of an engine, they can immediately vaporize into high-pressure steam that will damage certain injector tips.

Oxidation – Whether it is petroleum diesel, biodiesel or a blend, diesel fuel has been subjected to high temperature processing. While all are likely hydro-treated for finishing and to remove sulfur, without additional protection, diesel fuels slowly degrade when stored for extended periods of time. This degradation process is called oxidation. As the name suggests, oxidation is the reaction of the fuel's hydrocarbon structure with oxygen; the result of which causes darkening of the fuel and the formation of varnish deposits in the storage tank and ultimately within the fuel system in the engine.

When varnish begins to form in the fuel, it passes through the injector and accumulates on the tips of the injectors.

When this occurs, the performance of the engine will begin to suffer.

Weather – Cold weather operations present additional challenges to a diesel engine's fuel system. Water that is present in fuel can form ice crystals, restricting fuel flow. In low temperature operations fuel gelling and wax formation is a factor to be aware of, as well as cold filter plugging; all of which can inhibit fuel flow through the engine. As winter arrives, it is not uncommon for owners of diesel-powered equipment to experience engine startup issues or maybe even shutdown issues.

Ultra-Low Sulfur Diesel – Diesel engines are undergoing radical design changes, and at the same time the fuel industry has been subject to new EPA mandates requiring sulfur to be removed. With so many simultaneous challenges occurring with both fuel systems and fuel, it's not surprising to find some unintended consequences.

ULSD is number 2 diesel fuel with a maximum allowable limit of 15 parts-per-million of sulfur. While reducing sulfur significantly reduces emissions, ULSD brings with it several performance challenges for the end user. The most significant challenges of ULSD fuels are insufficient lubricity, lack of BTU content, moisture content control and wintry weather performance.

Minimal lubricity additives are added as a requirement by ASTM D975. ULSD has a higher wax content, which increases the possibility of filter plugging in cold weather. ULSD also has less solvency, which reduces its ability to keep the fuel system clean by carrying away deposits.

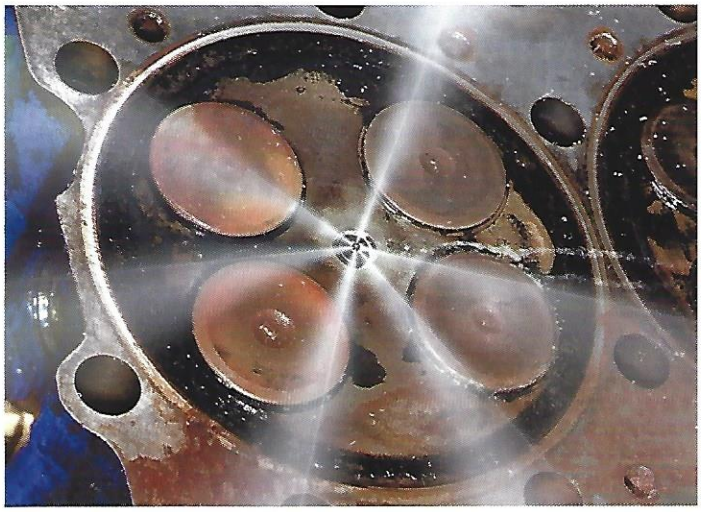
Fuel Additives

All these challenges lead to an increased need for fuel performance supplementation. When choosing a winterization additive, there are three key tests that marketers may mention: pour point, cloud point and cold filter plug point. While each of these can be a positive indication of improved low temperature diesel performance, the most important test of the three is the CFPP test. It is the most severe and most representative of in-service performance.

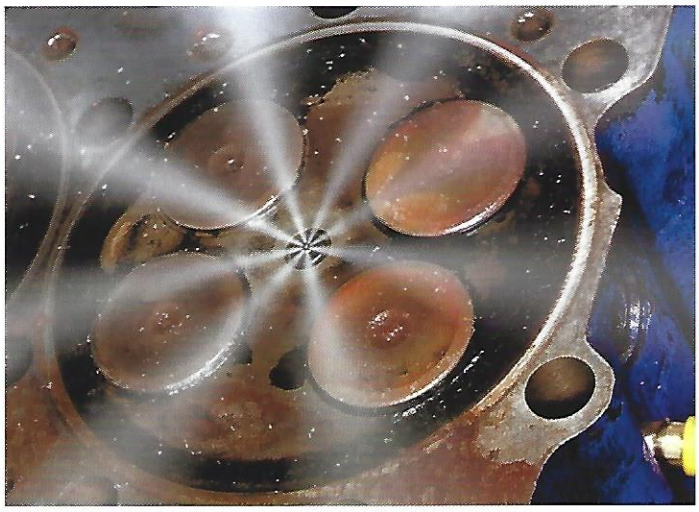
Diesel doesn't readily mix with water, yet it can carry low concentrations as dissolved or emulsified water. Detergent and dispersants keep the water droplets dispersed and very small, thereby protecting injector tips from damage. If water contamination was not identified in advance, a diesel winter additive containing an alcohol-type antifreeze to melt the ice back into water form is recommended.

Having a cetane booster for cold weather starts and improved performance is another benefit for diesel engine end users.

Diesel fuels can vary widely in source, composition and performance. Many operators prefer to take diesel quality into their own hands by purchasing aftermarket additives, such as Biobor or Full Torque. Full Torque, for example, increases a fuel's cetane number by up to three numbers, resulting in faster ignition time, more power, easier starts and less smoke at startup. The diesel supplement also contains detergents that keep injector systems clean and ingredients that protect against wear, water and corrosion. These additives generally work with today's biofuels, ULSD fuels and renewable diesel fuels.



Accumulated varnish on the tips of the injectors degrades performance.



Clean injectors do a better job of atomizing the fuel. Photos courtesy of Scott Irwin.

Others rely on suppliers to do the work. Depending upon testing and marketing, refiners and marketers sometimes introduce additives to ensure the product meets minimum specifications or to make advantageous sales claims. PMM

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