

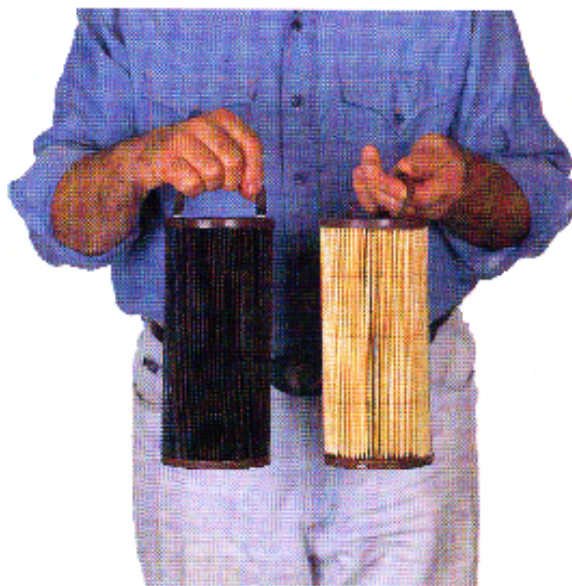
Guide #1

Understanding Diesel Fuel Problems

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Introduction

There has always been a need for fuel management. In the good-old-days, people bought diesel fuel for use in a vehicle, marine vessel or equipment, and never had a second thought about what was going on inside their fuel tank. Marine applications were more susceptible to problems with degraded diesel fuel than most users due to the ease at which water tended to get into tanks, a result of waves lapping up onto a boat, from the lack of tight-fitting tank caps, or from condensation a result of moisture entering through tank vents. As these boats were often used seasonally, diesel stored on-board for long periods would degrade or become contaminated from microbial or bacterial infestation. As is often the case in generator systems kept for emergency power, fuel systems would suffer from clogged filters at the most inopportune time. Commercially available additives that claim to “kill the bugs” or stabilize the fuel would, to an extent, address the symptoms: black, slimy, clogged filters and lots of smoky exhaust. But often the problems would come back as treating the symptoms did not solve the problem. Generally most people that used diesel fuel on a regular basis seldom had problems.



Ultra Low Sulfur Diesel

Since 2006, government mandates have forced a major change in the amount of sulfur in diesel fuel (ultra-low-sulfur diesel, or ULSD), a precedent to additional steps to lowering emissions of particulate matter from diesel engines. ULSD provides less energy, leading to lower fuel economy, and requires more costly crude oil resulting in changes to the refining process. The refining process necessary to achieve these standards also reduces the fuel’s lubricating properties by removing naturally-occurring lubricity agents in diesel fuel.

The problems will become more widespread as all marine, rail locomotive and non-road applications move to ULSD by 2014. The ULSD enables emission control technologies that are required on marine diesel engines in 2014 and for locomotives in 2015.

Changes in the Refining Process

Efforts to refine crude oil utilizing hydrocracking processes that provide ULSD while maintaining or improving the yield of fuels from a barrel of crude oil results in higher asphaltenes (the heavy “asphalt” component of the crude oil) not being maintained in solution. This results in stored diesel becoming

dark, either brown or black, evidenced by the accumulation of a tar-like substance on the bottom of fuel storage tanks.

Bio-Diesel Fuels

In addition to accelerated degradation of diesel fuel from the change to ULSD, increased use of biodiesel blending with petrodiesel presents other problems when related to long-term storage. Biodiesel may contain small but problematic quantities of water. Water being present in fuel not only reduces the heat of combustion, resulting in more smoke and less power, but it also contributes to corrosion in fuel system components and provides habitat in storage tanks for microbes. The reproduction process of the microbes results in slimy materials that float in the fuel (hence the reference to “algae” in contaminated fuel) and produce acids that cause paper fuel filters to become clogged or fail, further resulting in damage or failure to engine fuel system components.

Fuel systems that attempt to address water problems that cause increased fuel gelling in colder temperatures by heating the fuel have been found to aggravate the water problem in other seasons by causing condensation of the moisture drawn into the tank through vents, resulting in more water. Fuel pickup lines in the storage tank are typically one to several inches off the bottom of a tank, so water accumulates over a long period of time before becoming apparent. Sudden agitation, such as adding fuel or moving equipment that has sat for an extended period, stirs up the accumulated debris and water sometimes causing total fuel system failure, or, at a minimum, clogged filters and operation interruptions.



How the Contamination gets into the Tank

Microbial contamination can be introduced to the fuel tank in a number of ways. A fuel supplier, distributor or filling station may have a contaminated storage tank. Contaminants may also be drawn in through tank vents as fuel is used from a tank and replaced with air. Note that it could take months for the contamination, as it resides in the water at the bottom of the tank and reproduces, to develop to the point where it actually results in discernable symptoms of fuel contamination.

Treating the Problem, Not Just the Symptoms

There are a number of symptoms that you may experience indicating that you have a fuel system problem:

Clogged and Slimy Filters. A manufacturer of the diesel engine may recommend you change your filter at 15,000 miles, or, in the case of equipment where operating hours are the standard of measure, 300 hours (or some other interval). You should have acceptable performance up to that point. If, however, you find your engine performance begins to suffer at some fraction of that time (5,000 miles, or 50 hours) and changing the filter seems to solve the problem, then you have a potential fuel problem. If the fuel filter is black, has coarse material on the outside of the filter media, and maybe covered with a slimy material, than you have a definite fuel problem.

Dark and Hazy fuel. Water gets into the fuel tank in many ways. It can come from the fuel supplier, drawn in through the tank vent as fuel is drawn out of the tank, with condensation changing moist air to droplets, or it can



come from bio-diesel, where water is a common problem. Hazy fuel is the result of water becoming emulsified into the fuel.

Sludge build up in the tank. Asphalts, the heaviest constituents of crude oil, is in diesel fuel, but is in solution and is not apparent from a visual inspection of good fuel. Degraded fuel turns dark as the asphaltene component sticks together and grows in size, becoming visible as dark fuel and, as the asphaltene component gains weight, it sinks to the tank bottom and accumulates as a coating of what looks like roofing tar. Also, bio-sludge, from microbial (bacteria) contamination that resides in the water in the tank bottom, creates a byproduct of slime as they reproduce. Attempting to treat this symptom by using a biocide additive will convert this bio-slime into a solid, resulting in a gritty particulate accumulation in the tank bottom that often aggravates the core problem.

Loss of Power and RPM, and Corroded, Pitted Injectors. Fuel flow being reduced by clogged and slimy filters, the degradation of the diesel fuel, and the sulphate reducing bacterial contamination that creates acids all contribute to the compromise of engine components that clog and corrode injectors and compromise efficient engine operation.

Excessive Smoke and Soot from Exhaust. Compromised fuel causes a drop in the cetane number of the fuel, resulting in shorter combustion times for each cycle of the engine, and compromised engine injectors result in substandard spray patterns, all resulting in incomplete fuel combustion. The result is a visible increase in black smoke (unspent fuel) and soot being expelled from the exhaust and higher levels of soot being apparent in engine oil analysis tests. Soot in the motor oil shortens the oil's effective life and increases engine component wear.

Foul Odor from your Fuel Tank. All the above results in a foul "rotten eggs" odor emanating from the fuel tank.

Don't make the mistaken of treating a symptom. Treating symptoms do not solve problems.

The Real Story Behind the Symptoms

As fuel deteriorates, clusters of fuel components, other fuel breakdown residue and water accumulate in the tank. Over time, the combination of degraded fuel and microbial/bacterial contamination from outside the tank results in dark, hazy fuel with poor combustibility. What does this mean?

Diesel fuel is principally refined from crude oil. As fuel degrades over time, certain components of the fuel that are in solution begin to cling to each other. These asphaltene components, the heavy constituents that come from the refining process of crude oil as the heavy asphalts, make the fuel appear dark, possibly black, and as they gain weight will fall to the bottom of the tank. Experienced equipment maintenance personnel are familiar with tanks that look like the bottom has been painted with roofing tar.



This is the asphalts that come from degraded fuel. As these components come out of solution, they change the look and character of the fuel, fuel combustibility changes and engine performance suffers.

The common and well-intentioned recommendation to treat certain symptoms with a biocide additive is problematical. The biocide additive will react with the organic material, but the result is to convert the material to a solid that accumulates on the bottom of the tank. If the treatment is on a partially full tank, the chemicals do not do an adequate job, and further dilution with the next tank fill does not perform the desired results. Without removing the water, the habitat of the contamination remains and the process continues. The particulates in the tank bottom the result of the

treatment become stirred up when a tank is filled with fuel and is picked up by the fuel line suction and can overwhelm a fuel filter, and often several filters, at the most inopportune time.

Another common and more expensive recommended fix is to remove the tank and clean it. This also necessitates removal and disposal of the fuel in the tank. This is not only a very expensive undertaking, especially when the costs of proper disposal of degraded fuel is factored into the cost, it is often difficult if not impossible as some tanks are expensive to remove (underground) or are installed in tight quarters and not accessible (marine vessels). Many tanks are constructed with internal baffles, or do not have sufficient access for thorough cleaning using pressure washers or chemical sprays. Often, after paying for a “best effort” cleaning, the symptoms return several months later.

Many well intentioned operators utilize filtration carts or trailers that circulate fuel and show promise to remove contaminants from the tanks. But filtration alone does not remove the microbial contamination that is several times smaller than what typical filtering medium is capable of removing. Again, most chemicals do not dissolve all the contamination from tank baffles, sides and tops. Suctioning water from the tank can be undertaken, but getting all of the residual water that harbors the microbes is difficult.

Maintaining fuel quality so when the power goes off, the generator comes online and stays running, does require the following of a strict protocol and vigilance of on-going fuel management. Review our Guide to Diesel Fuel Treatment.

What is the Cure?

The problem is quite complicated and impacted by many factors. The fix is not easy either. Just dumping chemicals in the tank will not make the problem go away. There is no single product that works in all circumstances.

But there are steps that can be taken to fix it. The process depends on the extent of the problem, the size of the tank, and the accessibility of the tank for treatment:

- Remove the water and tank debris from the bottom of the tank.
- Use an additive made for cleaning tanks (not a biocide).
- Circulate the fuel through a Fuel Polishing System (not just a filter)
- Maintain good fuel management practices to keep the problem from re-occurring.

This is explained in the www.diesel-fuels.com Guide #2 Fuel Treatment and Continuing Management.

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