

DIESEL FUEL DEGRADATION

ALLIANZ RISK CONSULTING



Diesel Engine Driven Fire Pump

This Tech Talk discusses degradation problems associated with the newer diesel fuels and Allianz Risk Consulting (ARC) recommendations to reduce fuel related problems for critical diesel engine-driven equipment, such as fire pumps and emergency generators.

AT-A-GLANCE

1. Diesel fuels produced today are less stable and degrade faster than the diesel fuels produced 20 years ago
2. Time and water are the main enemies of diesel fuel
3. Diesel fuel should be tested annually to ensure it meets a minimum standard of quality

INTRODUCTION

There are several grades of diesel fuel produced, but this document will use the term diesel fuel to mean **No. 2 Diesel**, since it is used in all on-road vehicles and the vast majority of off-road equipment, including fire pumps and generator sets.

Starting in 1993 in Europe and 1996 in the U.S., refineries were required to produce low sulfur diesel fuel with maximum 0.05% sulfur. Since 2006, they have been required to produce Ultra Low Sulfur Diesel (ULSD) fuel with maximum 0.010% to 0.015% sulfur to reduce emission of sulfur oxides to comply with the more stringent US Environmental Protection Agency (EPA) requirements. In order to meet the new requirements, the refining process for fuels switched from fractional distillation to hydrocracking or hydro-desulfurization. This is a more efficient process, but it also depletes naturally occurring antioxidants and lubricants in the fuel which increases and accelerates oxidation and corrosion. **Diesel fuels produced today are less stable** and degrade faster than the diesel fuels produced 20 years ago.



Diesel Engine Driven Emergency Generators

Diesel fuel is generally delivered clean and within specifications published in ASTM D975, *Standard Specification for Diesel Fuel Oils*, but because it is inherently unstable, it begins to oxidize and degrade as soon as the refining process is completed. This degradation process continues until it is used. The shelf life of diesel fuel is typically 6 to 12 months under normal conditions in terms of temperature and humidity, but various studies have shown that today's diesel fuel can be off-specification after a few weeks of being produced. Diesel fuel is combusted on average within 18 to 24 days after it leaves a refinery, so oil companies are not compelled to produce diesel fuel that can be stored for a longer time.

Diesel fuel is a complex mixture which has numerous naturally occurring components including water, asphalts, waxes and countless other organic compounds. Time and water are the main enemies of diesel fuel. Diesel fuel in storage degrades faster at higher temperatures and in the presence of free water and contaminants. **Keeping water out of the tank** is the most important factor in fuel quality maintenance. There is water content in all diesel fuel that remains in solution until the saturation point is reached and then it becomes free or emulsified water. Water can also enter the fuel in various ways including condensation in the tank, atmospheric humidity, tank leaks, leaking vents, and leakage into the tank from rain or tank washing. Water introduced into the fuel storage tank will increase oxidation resulting in rust and corrosion that produce particulates which can be passed through the fuel system and can cause physical damage to the engine components, usually the fuel injectors. Water can also encourage the growth of bacteria, fungus and mold, which can cause slime and acids that foul the fuel, and corrode the tank and fuel system components.

The new hydrocracking refining process also results in a higher concentration of "asphalts" or "asphaltenes" which are the heaviest fraction in crude oil and are a component in diesel fuel. They are normally in solution, but over time the asphalts can fall out of solution, conglomerate and form a substance on the bottom of the fuel storage tank that resembles roofing tar.

Hard particles such as sand, metal particles, rust, dust and dirt can be introduced into the diesel fuel at any point during storage, transport and delivery. While hard particulates are usually a minor factor in fuel cleanliness, if not filtered out they can cause damage to engine components or the fuel system.

At lower temperatures, waxes are another component of diesel fuel that can crystallize and add particulate matter which conglomerates and can contribute to the build-up of contaminants. This contributor to fuel degradation can be mitigated by heating the fuel, using winter grade fuel or by using an additive to lower the pour-point.

The **symptoms of fuel degradation** include dark color, haziness, sludge build-up in the bottom or on the sides of the tank, clogged fuel filters, smoky exhaust, foul odor, corroded fuel injectors and poorer engine performance. By the time visible signs appear, the fuel is already in an advanced stage of degradation, resulting in damaged engine components or degraded engine performance. Clogged or loaded filters are often the first visible symptom of problems.

Modern high efficiency diesel engines are built with low tolerances that require clean fuel to operate reliably. When diesel fuel is stored as the fuel source for any critical equipment, the quality and stability of the fuel are vitally important. Critical equipment could include diesel engines used to drive fire pumps, cooling water pumps, emergency generators, etc. The only way to be certain diesel fuel has the properties specified in ASTM D975 is to **have it tested** using standard ASTM test methods for pour point, cloud point, flash point, volatility, cetane number, cetane index, sulfur, viscosity, density, color, water and sediment content, ash content, carbon residue, corrosiveness, neutralization number, heating value, aromatics content, fuel stability and lubricity.

There are several measures that can be implemented to help ensure the diesel fuel for critical diesel engine-driven equipment is ready for emergency use and will not cause starting problems, engine failure or damage to the engine components.

ARC RECOMMENDATIONS

While not all-inclusive, recommendations to help reduce fuel-related problems for critical diesel engine-driven equipment include the following:

1. Test the fuel to ensure that it meets specifications in ASTM D975 at first fill and then at least annually. Samples should be taken from the bottom of the tank and from the fuel supply line to the engine to test for specifications and to check for water, sludge and debris. If the fuel does not meet specifications, it should be replaced and testing should be done at least semi-annually until history shows that annual testing is adequate. Additives can be used in the short term to correct problems, but the causes for the use of the additives should be addressed and corrected.

2. Develop and implement a Fuel Supply Maintenance Program and include the following.
 - a. The fuel storage tank should be kept at least two-thirds full at all times.
 - b. The connection from the fuel tank to the fuel supply line should not be located at the bottom, but should be located so that 5% of the tank volume is reserved for sump.
 - c. Fuel should be maintained free of water and foreign material by draining water and foreign material from the tank sump at least annually. This necessitates draining approximately five gallons.
 - d. Ensure that vents and ports are adequately sealed.
3. Ensure the temperature in the area where diesel engines are installed is never less than the minimum recommended by the engine manufacturer. The manufacturer's temperature recommendations for water and oil heaters should be followed. Fuel-heating systems should include thermostatic controls and suitable pressure and temperature gauges to maintain a temperature of at least 40°F (4°C). Fuel should be constantly recirculated from the fuel tank through the heaters regardless of engine fuel demand.
4. Clean the strainer, filter or dirt leg or combination thereof quarterly.
5. Complete one of the following, if the diesel fuel is stored outside.
 - a. Use winter grade diesel fuel
 - b. Provide heat tracing for tanks and lines
 - c. Provide insulation for tanks and linesThe above is needed to ensure that diesel fuel will flow to the engine under the coldest possible conditions.
6. The use of biodiesel fuels should not be permitted due to fuel stability problems.

References:

- ASTM D975, *Standard Specification for Diesel Fuel Oils*
- NFPA 25, *Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems*
- NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*
- NFPA 110, *Standard for Emergency and Standby Power Systems*

QUESTIONS OR COMMENTS?

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