FUEL 301 – DIESEL FUEL

CHARACTERISTICS OF DIESEL FUEL

In Fuel 101 and 201 we looked at crude oil basics, how diesel fuel is manufactured/blended, and how demand is changing the methods of manufacturing/blending. These changes can have a negative impact on the storability of fuel, amount of water that can be absorbed, amount of contaminates, the amount of biomass, and the number of bacteria/microbes. The importance of diesel fuel has historically been to purchase, store, and eventually use the fuel without regard to microbial/bacteria growth, contamination, wax buildup, sludge, and fuel degradation. Today, we do cannot dismiss the storability and characteristics of diesel fuel. If left unmanaged, the quality will degrade very quickly and lead to costly replacement and potential catastrophic damage to the generators/engines.

In fact, water is the most damaging contaminant to diesel fuel, and the primary catalyst to additional fuel breakdown. Other contributors to fuel degradation, like microbial growth, sludge, asphaltenes, wax, and particulate, all have their own unique effect on diesel fuel and the diesel engine. Understanding the complex nature of diesel fuel and its characteristics, along with forms and sources of contamination, is the first step to achieving and maintaining optimal fuel quality. With new technology, such as the High Pressure Common Rail (HPCR) engines, there is little tolerance for contamination of any kind. The warranty for these engines usually states a maximum particle count, measured in microns, that if exceeded will void the warranty. Poor fuel quality and contamination are the main reasons for failures in modern engines and excessive repair costs. It is paramount to change the way users think regarding modern fuel, importance of fuel testing, and appropriate protocol for maintaining fuel systems to keep your very expensive equipment functioning and maintaining your investment.

CONTAMINATION

Contamination is very damaging to fuel, fuel systems, and engines. There are several significant forms of contamination that include water, microbial growth, sludge, wax, and solid particulates. Let's take a closer look at each one of these forms of contamination to see how they affect your systems.

Water

Water is by far the most damaging contaminant found within diesel fuel and is a primary catalyst to additional fuel breakdown.

Diesel fuel is hydroscopic; it attracts and holds water like that of the atmosphere. When it has attracted enough moisture, it will "rain" or drop to the bottom of the tank in the form of free water, which is the biggest problem facing long-term storage of fuel. ULSD can hold up to two-tenths of one percent absorbed water, whereas biodiesel can hold up to one percent of absorbed water. The amount of water that can be absorbed is directly proportional to temperature of the fuel. As the temperature increases, so does the amount of water it can absorb.

Water promotes the formation of gums & varnishes, develops acids, accelerates the formation of bacteria/fungi/algae, and will cause accelerated maintenance issues/corrosion with storage tanks & engines. The gums and varnishes will build up in the generator fuel lines, valves, cylinders, and other parts of the engine as it is heated and cooled through the frequent short term uses required in testing protocol.

Additional effects of water are that when mixed with sulfur, chlorine; or other chemicals in fuel will develop hydrochloric, sulfuric, acyclic, or other acids which will accelerate deterioration.

Microbial Growth

With the reduction of sulfur from 500ppm to 15ppm; this has created a more suitable environment for bacteria, fungi, and algae to flourish. If these organisms have water and fuel, they will grow and multiply; remove the water and they cannot survive. The microbes will grow in the boundary layer between the water and fuel which creates a perfect growth area for them to survive and thrive. Other effects of these organisms are their byproduct is acid which further degrades the fuel and increases corrosion to the tanks. As these organisms dies off, its debris will settle to the bottom of the tank and become food for further contaminates to grow. When stirred up or sucked into the motor, these contaminants that may pass through the filters will become lodged in the very small injectors of modern diesel injection systems/injectors and cause damage/failure.

Wax

The composition of crude oil contains waxes, paraffins, and other elements in various amounts depending on where it originated in the world as we have seen in Fuel 101. This is important to understand as it will help understand why, in cold temperatures, the fuel will first cloud up then gel up. When it starts to gel up, it will cause filter blockage and prevent the engine from running.

Solid Particulates

Solid particulates can cause significant damage to your engines, they can come from the fuel, environment, or from the distribution chain. Solid particulates that come from the fuel comes from the metals, asphaltenes, and other components based on the crude oil composition. From the environment comes dust, dirt, and other particulates. The distribution chain may also pick up contaminates, water, and other chemicals that will affect the fuel and particulates.

All of these particulates, when combined with sludge, can significantly increase the risk to your fuel system, and engines leading to a catastrophic failure. Catastrophic failures can become very expense when talking about massive generators required for healthcare facilities.

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STORABILITY/DEGRADATION

There are many factors that are affecting the storability of diesel fuels such as demand for fuels of all types, the lifespan of the fuel, reduced emissions regulations (decreasing sulfur from 500ppm to 15ppm), and sustainable resources regulations (Biodiesel). As fuel ages it continues to deteriorate, the fuels appearance will darken, and it starts to separate. The separation of the asphaltics, asphaltenes, and the re-modified bottoms (coke and residuum) will come out of solution/mixture to settle at the bottom of the tank in the form of sludge. As it falls to the bottom it will mix with other debris and water to release acids that further accelerate corrosion. Other effects of deterioration include loss of lubricity, reduced energy content, and will cause corrosion and buildup within the engine.

Diesel fuel will start deteriorating as soon as it is manufactured/blended and will become noticeable within 6-9 months. Biodiesel on the other hand will become noticeable in as short as 3-6 months. It is imperative that new processes, procedures, and plans be addressed now to prevent damage to valuable equipment.

CORROSION

The onset of corrosion reports began in 2007; this is also when the EPA started making changes to the fuel supply. During this time, we started seeing significant reduction in sulfur, increases in microbial growth, increases in demand for petroleum, and increases in sustainable/renewable fuels. As the fuel becomes more acidic, it becomes more corrosive to all the metal parts within your fuel tanks, fuel lines, and engines. Therefore, there are decreases in longevity of storage tanks, increase in repair costs of fuel systems, and increases in repair/replacement of engine components.

COLD WEATHER EFFECTS

During the winter, cold temperatures cause wax to drop out of diesel fuel, coagulating together to clog diesel tank and engine filters and shut down operations. Today's fuel is gelling at higher temperatures than normal due to the manufacturing/blending processes and makeup of the products being blended.
ULSD #2 is made up of many compounds and elements like acids, hydrocarbons (paraffins, naphthenes, olefins, and aromatics) water, sulfur, and many other items.

It is helpful to understand why gelling occurs and how additives affect the process. ULSD #2 contains natural waxes called paraffin wax. Paraffin waxes have their perks, they are combustible, which adds power when burned in the engine, however these waxes make up a portion of the energy content. On the flip side, kerosene (also known as diesel #1) has far less paraffin wax, and as a result it has a lower energy content. That's why you may notice lower fuel efficiency and power when burning kerosene blends.

Those paraffins cause problems when they join and plug filters. The cloud point is the point at which diesel fuel becomes cloudy from waxes lumping together. The colder the weather, the more paraffins drop out of the fuel and gel together. Larger paraffin chunks clog filters, preventing fuel from flowing through.

The point at which your filter plugs, and operations cease is called the CFPP – Cold Filter Plug Point. The CFPP is the most important metric, since that's the point at which operations are disrupted. The Cloud Point and the CFPP both vary depending on geography and fuel quality.

Additionally, some gelling incidents are caused by water in the fuel. Like wax, frozen water can clog a fuel filter and cause engines to shut down. Biofuels and water both freeze at much higher temperatures than fuel.