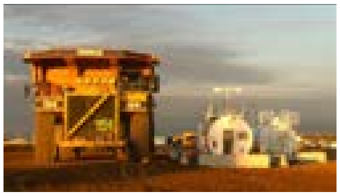
Trends in Diesel: 2013

A special report highlighting changes impacting critical power applications

Financial

Marine



Extreme Environments

Defense

Datacenters

Health Care

Offshore

Municipal Fleets

PURITAS ENERGY

Acknowledgements

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- Stairs Diesel Systems (Halifax, NS)
- Franklin Group (New York)

8 things you need to know about diesel

to protect your critical power application

1 Diesel in the European Union and North America has less sulphur content since the introduction of Ultra Low Sulphur Diesel (ULSD) in 2007. **Oil refiners include additives to compensate for changes in diesel following sulphur reductions.**

2 Diesel is being blended with Biodiesel in the EU (B5-B7), Canada (B2) and by region in the US. Mandated biodiesel content is averaged out annually. **Consumers may end up with ULSD with significantly greater biodiesel content than the percentage stated in the mandate based on geography and fuel supplier.**

3 **Engines created after 2007 are less tolerant of water and particulate matter than pre-2007 engines.** They have very high pressure fuel systems and strict tolerances in an effort to improve efficiency and reduce emissions. Water and particulate matter introduced has dire effects on engine functionality.

4 Biodiesel is considered an additive to diesel fuel. Biodiesel and certain additives are surfactants, meaning **they increase diesels ability to absorb and hold onto water.**

5 Water materializes in diesel in 2 main forms: *freestanding water* where a layer of water settles out below the fuel; and *emulsified water* which are tiny micro-droplets suspended within fuel. **ULSD and biodiesel blends bond so thoroughly to water, that can emulsify. Traditional filters and centrifugal purifiers cannot separate it out, leaving considerable water content in the fuel, damaging the engine.**

6 **The fuel/water interface is a breeding ground for microbial growth;** leading to microbial contamination, aggressive corrosion and sediment buildup. The result is fuel degradation, reduced shelf life of fuel, blocking of filters and pipes, clogging of fuel nozzles, engine failure and in the worst case- total system failure; risking economic loss and reputational harm.

7 **Traditional filters cannot remove emulsified water**. Coalescing filters certified by the Society of Automotive Engineers can. SAE J1488:2010 is a test which determines the ability of a fuel/water separator to separate emulsified water or finely dispersed water from fuel. It is currently the only recognized test that covers emulsified water and specifically targets fuels with a biodiesel component.

8 **A comprehensive fuel management strategy must be employed to protect critical power investments.** Evaluate the tank, piping and generator set up to highlight areas of weakness; consider the impact of likely site temperatures and humidity ranges. Ensure that your fuel management system includes:

i. Regular onsite and offsite testing.

ii. A fuel polishing system with coalescing filters proven to remove emulsified water, such as the DieselPure™ filter, whereby the fuel and subsequently the tank is dried three times weekly, protecting investment and reputation.

Diesel Today

Diesel fuel in use today absorbs more water, holds onto it more effectively and degrades faster than its predecessors.

Fuel degradation:

- Impacts any organization relying on diesel fuel for critical power
- Reduces the ability of fuel to perform
- Damages storage tanks and modern high pressure common rail diesel engines

If you rely on diesel for critical power- **you are at risk.**

Introduction

This paper seeks to educate the reader in the subject area of diesel fuelled critical power applications. Firstly changes in fuel and engine design are described. The relentless and accelerated corrosion rates and stability issues seen in systems utilizing diesel in North America and the European Union (EU) are established (Bessee & Dante, 2012; Uptime Institute, 2010). Lastly, a comprehensive fuel management strategy is described.

Diesel is the most widely used fuel for back-up power supply; spanning all industries in all areas of the globe. The diesel back-up power supply market is currently valued at $14Bn and is set to double in the next 10 years. As a result, diesel has been widely targeted in the battle against climate change. Diesel has been subject to rigorous mandated change over the past ten years as local, state/provincial, and national governments strive to improve air quality, decrease greenhouse gas emissions and reduce reliance on fossil and imported fuels.

Mandates such as the reduction of sulphur and blending of biodiesel have changed the make-up of diesel fuel along with the design of diesel engines. These changes have all had a dramatic, if relatively hidden, effect on critical power applications. Most importantly, diesel today absorbs more water than it used to, leading to a significant degradation in performance and usability if improperly managed. This ultimately increases operational and reputational risk.

Recent history of Diesel Fuel and Diesel Engines

Ultra Low Sulphur Diesel (ULSD)

In 1994, the European Union (EU) prohibited the use of diesel with sulphur limits greater than 2000 parts per million (ppm) for road transportation. Today, sulphur limits in the EU cannot exceed 10 ppm, with certain flexibilities applying for non-road transportation (Transport Policy, 2013). Though later to start, Canada and the US also mandated a dramatic reduction in sulphur content. By 2007, sulphur content in diesel was limited to 15 ppm for road transportation and 500 ppm for non-road transportation (Polaris Laboratories, 2008).

Ultra Low Sulphur Diesel (ULSD) improved air quality; however the fuel's functionality was compromised in many ways. In order to meet ULSD sulphur mandates of <15 ppm, diesel has to go through additional steps in the refining process. These additional steps can reduce fuel's lubricity. As a result of this change, in order to meet the lubricity and additional requirements for ASTM D975 (standard specification for diesel fuel oils), include additives in the fuel. Due to the complex refining supply and distribution chain, fuel testing at the point of use is recommended to ensure fuel is 'engine ready'.

Most fuel deliveries are added in bulk to existing tank supplies therefore fuel testing is required to really know what the composition of the fuel for its final user (Polaris Laboratories, 2008).

Biodiesel

As an additional measure to reduce the environmental burden of diesel, and to boost the burgeoning biofuel industry, the EU, Canada and certain states in the US began to mandate the blending of biodiesel with regular ULSD supplies. Diesel found in the EU has

Biodiesel Blends

ULSD blended with biodiesel is denoted with a B followed by the percentage of biodiesel:

- B2 2% biodiesel
- B5 5% biodiesel
- B20 20% biodiesel

Biodiesel blends increases the degradability of the fuel.

Biofuel in the US

The Federal government provides funding for cities and municipalities actively switching government operations to **B20.** New York City is going through such a switch.

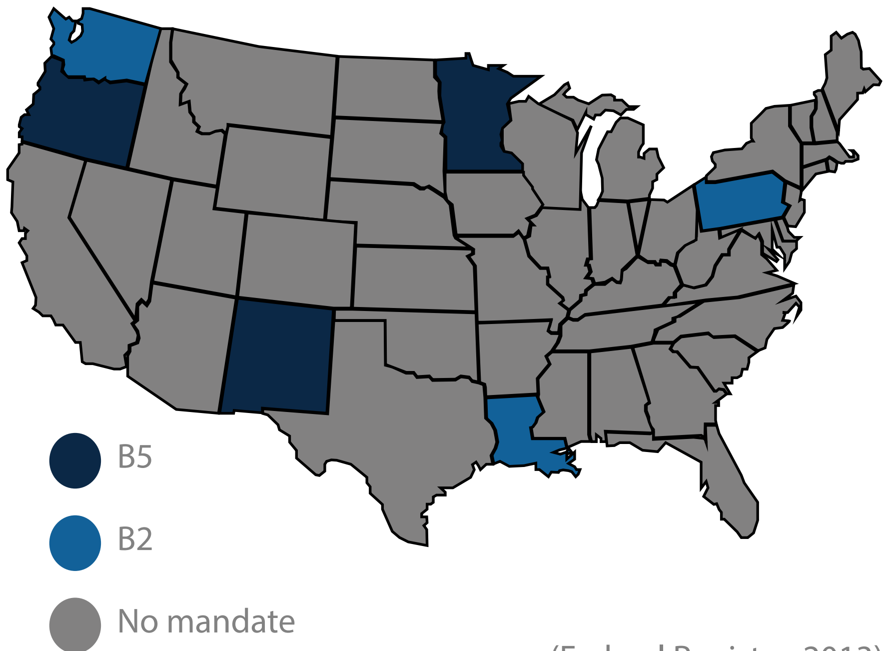
Some municipalities and states offer incentives for biodiesel production, blending or consumption:

- Tax breaks
- Rebates
- Refunds and/or credits

As seen to the right, six states currently have biodiesel blending mandates.

Diesel found in the EU has an average content of 5-7%. Diesel in Canada is mandated to contain a blended average of B2.

an average content of 5-7%. Diesel in Canada contains a blended average of B2 (Wisner, 2013); meaning diesel found in Canada can dramatically exceed B2 in order to balance out any non biodiesel produced. B0 distributed at pumps. Six states in the US have biodiesel mandates and other have legislations in the works (Federal Register, 2013).



(Federal Register, 2013)

Biodiesel is produced from a wide variety of feedstock and is a clean burning fuel alternative to traditional petroleum-based diesel. Sources of feedstock are common vegetable oils (i.e. soybean oil, palm oil etc.), agricultural waste, animal fats and waste oils (i.e. used frying oil). Biodiesel acts as an excellent lubricant additive when blended in low levels to ULSD (Gerpen, Knothe, Krahl, 2010).

The introduction of ULSD changed the composition of diesel at the pumps, as did introducing biodiesel. In the article titled *Impact of biodiesel on biodeterioration of stored Brazilian oil*, researchers Bento et al. conclude that biodiesel increases the degradation of fuel,

High Pressure Common Rail Systems (HPCR)

HPCR systems are built to extremely strict tolerances in order to meet emission requirements and reduce consumption.

Inorganic matter and water contamination can have catastrophic effects on newer components.

The Perfect Storm

Engines are increasingly intolerant to the introduction of water and particulate matter in their systems.

Less sulphur caused more additives to be included in fuel; additives make ULSD in 2013 absorb more water.

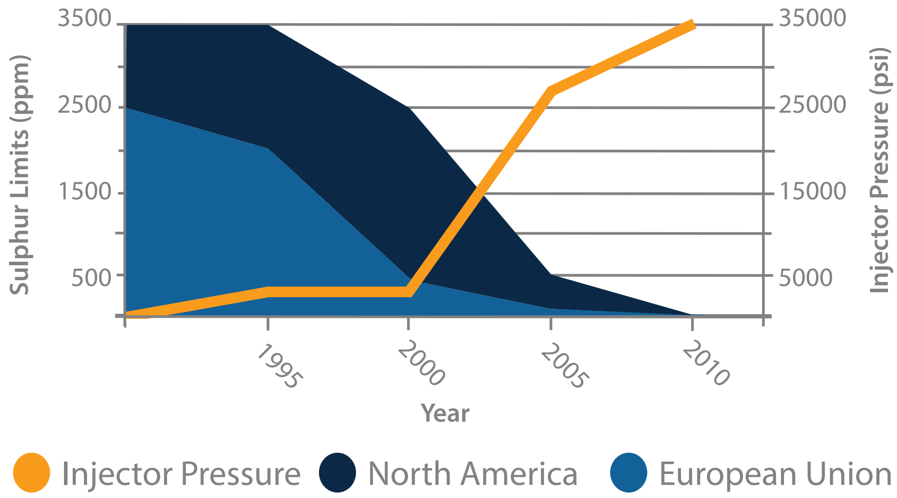
Without effective fuel management, the diesel engine's ability to provide prime or emergency power in critical applications is compromised.

stating: "the results are relevant for the resolution of the decade-long debate on the increase in diesel biodegradability due to the addition of biodiesel" (2010). Biodiesel and subsequently biodiesel blends absorb water more tenaciously, fostering microbial contamination and accelerating engine corrosion.

Engine Changes

Another recent change in critical power generation is the diesel engine itself. In the drive to greater efficiency and emission reductions, diesel engine manufacturers have increased the working pressures during fuel injection, compression and combustion. Ten years ago fuel was typically injected into a cylinder at around 3000psi. Today's more efficient common rail, high pressure injection systems work up to 36,000psi, an increase of more than ten times.

Diesel Sulfur Content for Road Transport Vehicles and Diesel Engine Injector Pressure



High Pressure Common Rail (HPCR) systems are built to extremely strict tolerances in order to meet emission requirements and reduce consumption. Injector tips are now measured in microns rather than millimeters. Control valve operating clearances of only 1-3 µm.

Engine manufacturers recognize that fuel cleanliness significantly impacts overall engine performance. Today's injectors are less tolerant to particles coupled with such that particles go through the system at incredibly high pressures i.e. water, micro-organisms, wax, asphaltines, dirt sediment and rust (Polaris Laboratories, 2008). Symptoms of highly pressurized water and organic contamination in fuel include: cavitation damage to injectors, cylinder lining damage, injector pump issues and internal corrosion.

Water in Fuel

Forms of water found in diesel

If you pour water into oil, the separation between the fluids is usually very distinct and visible at the fuel-water interface (**2**). Fuel forms a top layer, or phase (**1**); water aggregates into a separate bottom phase known as freestanding water. However, as stated by Polaris Laboratories, "Contrary to the cliché that 'oil and water don't mix,' most oils, at some level of water contamination, will mix, or emulsify." Water forms small droplets by a shearing action which are held in a stable-state colloidal suspension, or emulsion (Troyer, 2001). Image **4** is fuel which has been sealed, while image **5** has been left in direct contact with air. Note how the fuel depicted in image **5** has a hazy appearance as a result of emulsification; it has absorbed moisture from the external environment with which it bonded so tightly, an emulsification occurred.

Bacteria, fungi and mould, is likely due to the presence of water in fuel (Polaris Laboratories, 2010), it creates an environment where these harmful contaminants can proliferate, accelerating corrosion.

Interfacial Tension (IFT)

The degree of the ability of two non-gaseous molecules to repel each other. Such as the degree to which fuel and water repelling each other at the fuel/water interface.

How water enters fuel

Water enters diesel during production, distribution and storage. As low as 0.5% volume of water in the dispensing line can result in a phase separation, leading to severe corrosion and blend of fuel which will not meet necessary specifications (Bessee & Dante, 2012). There are many factors that affect fuel's propensity to absorb water. The composition of the fuel is a critical factor along with temperature, types of additives included in fuel along with the quality of such additives, and a fuel's interfacial tension.

Temperature plays a huge role in fuels ability to absorb water and the form of water that results. Freestanding water availability typically increases as fuel cools. Emulsified water settles out as freestanding water once there is a drop in temperature (Troyer, 2001). Depending on location, tank temperatures typically cool in the evening and condensation occurs. Condensation drips down tank walls and can fall through the fuel and add to the free standing layer, water is also readily absorbed as emulsified water depending upon various factors mentioned in this section.

Fuel is usually warm when initially shipped from refineries at the maximum temperature allowed. Whist traveling to storage and depots and during transfer into storage tanks, the product cools and water separates in the same way previously described (Troyer, 2001). Fuel containing 0.1% of water generally will pass ASTM fuel standards and can be transported, however, just because fuel meets this standard does not mean it is free from associated risks (Troyer, 2001).

Interfacial Tension (IFT) refers to the degree of the ability of fuel and water to repel each other at the fuel/water interface. When IFT is lowered, water is able to break into smaller droplets and cling on more tightly to fuel. Lowering a

Surfactants

Molecules whose characteristics form strong bonds in both fuel and water. Lubricants added to diesel when ULSD was introduced are surfactants. They bond with water when they are found in fuel.

Generally, the more surfactants found in diesel, the greater the ability of water to pass through the water/fuel interface and exist in an emulsified state.

IFT Timeline

Pre 2007	36-40 IFT
2007 ULSD	18-24 IFT
B5	14-20 IFT

fuel's IFT means that it has a decreased ability to repel water at the fuel/water interface. Water therefore has a greater ability to pass through the fuel/water interface, leading to an emulsion. Emulsions form easily when the IFT between the oil and water falls below 25 dynes/cm, or when certain additives or contaminants are present that hold the water in suspension (Troyer, 2001). The IFT of fuel today has progressively reduced because of changes in fuel in recent years.

Surfactants are molecules whose characteristics form strong bonds in both fuel and water. Surfactants affect fuel's IFT, water droplet size and emulsion stability. Like dish soap and other detergents, surfactants reduce the IFT of the fuel, allowing it to absorb more water.

Additives can change interfacial tension (IFT), surface tension and emulsion stability, affecting the ability of fuel to absorb water and/or hold onto it in an emulsified form. Some corrosion inhibitors/ lubricity improvers added to fuel particularly after sulphur levels were reduced, are shown to have adverse impacts on water removal performance (Bessee, 2008). Some icing inhibitors are also proven to affect fuel/water separation. These additives act as surfactants, enhancing the ability of water to pass through the the surface of oil. Such surfactants also stabilize water in the fuel (Bessee et al., 2006).

Biodiesel has a relatively unstable IFT, with values varying depending on temperature, length of storage, percentage of biodiesel include in diesel, feedstock or source of fuel (i.e. type of vegetation, used cooking oil, animal by-product etc) and even when the feedstock is harvested. One thing for certain is that biodiesel and biodiesel blends are very hygroscopic and are effective surfactants, absorbing more water than petro-diesel or ULSD and bonding with fuels so strongly (Bento et al., 2010; Bento et al., 2013) that traditional filters are ineffective.

Emulsified Water

All water contamination has harmful effects on fuel quality, microbial contamination and system functioning, however emulsified water is believed to be the most dangerous (Troyer, 2001) the reason being the level of difficulty to remove it. The extraction of freestanding water is relatively straightforward and can be done by running the fuel through a centrifuge or by using traditional absorbent filters that are in widespread use today. Conversely, emulsified water disperses itself so thoroughly in the fuel that traditional filters cannot separate it out. Emulsified water in oil leads to lubrication starvation, sludge formation, corrosive wear and eventually, failure (Polaris Laboratories, 2008). A comprehensive fuel management strategy utilizing coalescing filters proven to remove emulsified water is the only way to effectively remove emulsified water.

Effects of water contamination and related problems to fuel and engines

- Increased microbial contamination in fuel storage tanks
- Fuel degradation and reduced shelf life
- Blocking of filters
- Clogging of fuel nozzles
- Blocking of pipelines
- Corrosion of the tanks
- System failure
- Downtime and reputational risk

Risks associated with water contamination

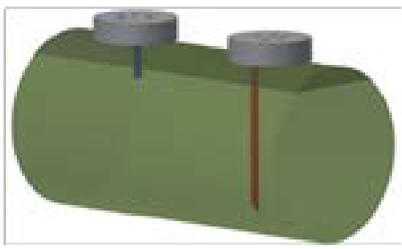
Microbial Contamination

Air-borne contaminants can be introduced alongside water vapor through breathing vents as part of the diurnal cycle of heating and cooling within the tank (Bento et al., 2010). Microbial contaminants are detrimental to engine functioning in them selves as contaminants can clog HPCR systems. The environment fuel finds itself in has a certain physiochemistry which determines the ability of microbes to exist within it (Passman, 2003). Microbiologically influenced corrosion (MIC) in storage tanks occurs when the environment in the tank changes accelerating the amount of corrosion caused by microbial contamination. A droplet of water with a diameter of 1.0 mm is able to host millions of bacteria. Microbes can exist in the absence of freestanding water (Passman, 2003) since water occurs in both vapor and emulsified form.

In the Tank

ULSD and bio-blends absorb large amounts of water during storage after production and in transit.

Water falls through the diesel and settles as freestanding water at the tank base, or emulsifies into the water from this layer due to the lower Interfacial Tension of modern diesel.



In tanks found with MIC observed by the Battelle Institute in their 2012 investigation of the widespread corrosion of storage tanks, a significantly large concentration of corrosive agents, acetic and/or ethanoic acid accumulates at the fuel/water interface and can lead to the formation of sediment, or bottom sludge (Battelle, 2012; Bento et al. 2010). Acid attacks the sides and bottom of the storage tank and any other service components in this region (piping, valves, pumps, sensors etc) impacting serviceable life. The matted layer of sediment build-up and acid further perpetuates MIC, by becoming a breeding ground for other microbial forms. Sediment blocks filters and impacts the burning efficiency of the fuel (Battelle, 2012). These findings are a major concern for the hundreds of thousands of organizations whose services, customers and reputations depend upon critical power availability.

Traditional treatment methods of microbial contamination

The typical way to deal with microbial contamination is to treat the fuel with biocide. In a recent study monitoring the efficacy of antimicrobial products during 60 days of storage simulation of diesel and biodiesel blends, Bento et al., conclude that in a B5 storage tank with a layer of free-standing water, the effectiveness of biocide is reduced and suggests that systems be drained of water before any treatment with an antimicrobial agent (2013). This reinforces the need for a fuel management strategy which maintains fuel in a dry state.

While considering the adverse effect of water on biocide effectiveness, it is important to state that biocides do indeed kill active microbes. However this adds to the issue of sediment and matting as the dead microbes settle in the tank. All this points to a fuel polishing system which removes water, circulates fuel AND cleans the tank by filtering out sediment and debris. Diesel can no longer be forgotten about until the day it is needed. Reliance on diesel for critical power demands a well formulated fuel management strategy. Regular testing, offline filtration and fuel polishing ensures that fuel stocks are engine ready and more importantly, emergency ready.

Operational Risk Factors

Whether an organization is responsible for critical power in a data centre, hospital, bank, remote location or other critical service; exposure to risk is unvaryingly present. Operational uptime is vital and every effort is made to minimize risk in all areas of business. The changes in diesel and engine design have not been highlighted in the news. Operating procedures have typically not been updated and fuel management codes have not kept up. Many of these issues have long been recognized but the industry response has been slow.

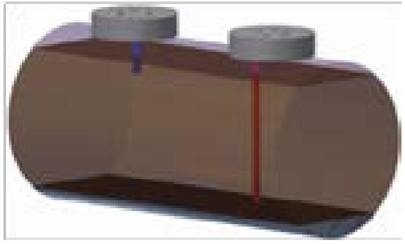
Basing a fuel management strategy on dated intelligence, out of date standards and traditional technology risks severe downtime, loss of revenue and even loss of life. Companies that simply keep to existing codes risk system degradation, fuel and equipment failure and, more importantly, system or fleet downtime due to circumstances not addressed in standards and codes. All of these issues are significant risks that should be the concern of the boardroom and senior management team of any organization that relies on diesel fuel for prime or back-up power.

An increase in extreme weather events is changing the way critical infrastructure components are designed and located. Power systems failed across the board following Hurricane Sandy in 2012. Huge numbers of banks, data centers, heathcare facilities and other critical infrastructure failed completely with backup power plants not transferring, or running for a few hours before stopping unexpectedly. Many of these failures have since been attributed to

In the Tank

Stored water generates microbial growth. The result is a mix of matting, sludge, slime, organic acids and sulphides flourishing within the tank.

The base of the tank is a toxic mix of water, acid and organic sediment. The acid attacks the inside of the tank, the water accelerates corrosion and the free oxygen in the water oxidizes the fuel reducing its burning efficiency.



Uptime Institute

"The addition of the biodiesel component to engine-generator fuels stocks has been reported …the issues include accumulations of water, accelerated growth of biological organisms, and increased contamination in fuel storage tanks. **Any of these issues put at risk a data center's capability to meet continuous availability requirements"** (Uptime Institute, 2010).

"The shelf life of all fuels, particularly diesel fuels, is significantly dependent on: environmental conditions (temperature and humidity) that the fuel is exposed to; the ability to "polish" the fuel: remove water, biological organisms, and other contaminants once the fuel has been placed in storage tanks…"
(Uptime Institute, 2010)

poor fuel quality, which in reality means poor fuel management practices were in place.

Cost of Critical Power Failure

Industry	Impact of Failure	Up to $000 000's/hour	Reputation	Liability/injury/death	Environmental damage	Increased maintenance	Staff safety compromised
Datacenter	Failure to meet continuous availability requirements	X	X			X	
Financial operations	Traders down, building evacuations, doors closed	X	X			X	
Military	Remote & prime power unavailable	X	X	X		X	X
Marine	Single point of failure for power onboard	X	X	X	X	X	X
Food distribution	Frozen food storage, loss of stock	X	X		X	X	
Mining	Trucks/escavators down	X	X	X		X	
911 call centre/ Hospital	Evacuation, failure to provide life saving services	X	X	X		X	
Mass Transit	Bus/train downtime and disruption to passengers	X	X	X		X	X
Casino/ resort operations	Floor downtime, customer disatisfaction	X	X			X	
Navigation Aids/ Air Traffic Control	Loss of situational control, security and safety risks	X	X	X	X	X	X

Most filtration methods cannot remove emulsified water

Coalescing filters proven to remove emulsified water can. **Coalescing filters** work by coalescing finely divided liquid droplets (i.e emulsified water in fuel) into removable masses. Coalescing filters should be part of a comprehensive fuel management strategy.

SAE J1488-2010 is the only recognized fuel/water separator test covering emulsified water which specifically targets fuels with a biodiesel component.

Filtration Methods

Absorbent filters

Absorbent filters can range from a cellulose based filter (kitchen paper towel), to a covalent super absorbent polymer filters, the same compounds as used in commercial baby diaper production. They are highly efficient at removing freestanding water, until they reach capacity, which happens more quickly in more hygroscopic fuels. As a result, filter replacement cycles increase with new diesel and even more with bio-blend. **Neither cellulosic nor covalent polymers can deal with emulsified water.**

Fuel Centrifuges

Fuel Centrifuges, as used on board ships, spin the fuel to remove sediment and water droplets. Centrifuges work on the basis of separation by density variations, and are very effective at this. However they can be expensive pieces of equipment and can be costly to maintain. Several recent multiple engine failures on new ships suggest that centrifuges struggle to remove emulsified water.

Coalescing filters

Coalescing filters are devices that are divided into multiple stages. They work by coalescing finely divided liquid droplets (i.e. water in fuel) into removable masses (Gunston, 2004). A comprehensive fuel management strategy with coalescing filters proven to remove emulsified water is the only way to prevent the threat of emulsified water from entering the engine and degrading fuel. SAE J1488:2010 is still the only recognized test that specifically targets biodiesel blends and addresses a fuel/water separators ability to remove emulsified water.

Onsite fuel testing with Puritas Energy

Making sure your fuel is free of water and microbial activity is simple with Puritas fuel test kits. Designed for regular, in-house use, these indicator kits provide rapid assurance that the fuel you have on site is clean, dry and 'emergency ready'.

Stage one

Biodiesel Indicator Test

This field test will detect biodiesel in diesel fuel.
Detects between 1 - 20% biodiesel.
Results in 5 minutes

Stage two

Visibility and Water Indicator Test

For the detection of emulsified and freestanding water and particulates in diesel and bio-diesel blends.
Results in 5 minutes.

Fuel Management Strategy

It should now be clear that in order to minimize downtime and to reduce operational and reputational risk associated with critical power failures that diesel stocks must be pro-actively managed. It is no longer acceptable to assume that diesel left in tanks for years, months or even weeks is suitable for use in critical power applications.

The following are recommendations by Puritas Energy as adapted from biodiesel management recommendations from the Uptime Institute (2010):

- Evaluate the impact of likely site temperature and humidity ranges on stored fuel
- Evaluate the tank, piping and generator set up to highlight areas of weakness
- Be aware of regional biodiesel blending mandates and associated benefits and risks
- Evaluate the fuel supply chain, understand what is being delivered and in what form
- Integrate and use desiccant breathers on all tank vents or at a minimum the main storage tanks
- Establish a comprehensive fuel management protocol including, but not limited to:
    - Regular on-site and off-site fuel testing to monitor levels of water, biodiesel, biological growth and other contaminates on a site-by-site basis
    - Include a fuel polishing system in the fuel system design which is able to strip freestanding water AND emulsified water
    - Work with the company providing a fuel polishing-system to ensure a site-suitable fuel polishing schedule

Onsite fuel testing with Puritas

Stage three

Microbial Contamination Test
The kit contains flexible plastic dip-strips, complete and ready to use.

The Bacteria test strip is for aerobic bacteria.

The Yeast and Mold test strip is for fungal growth. Our test is able to detect a broad range of these microbes which are implicated in contamination of the industrial environment. Results in 24-48 hours.

SAE J1488:2010 protocol

Determines the ability of a fuel/water separator to separate emulsified or finely dispersed water from fuel

- When choosing a fuel polishing system, ensure a coalescing filter which has been proven to remove emulsified water is used. Follow up on suppliers claims, insist on receiving valid filter certification proof of testing results to a recognized standard (i.e. SAE J1488: 2010).
- Aim to run the fuel through the polishing system three times weekly; this can be done with ease using sophisticated fuel polishing systems
- Work with your system supplier to develop a waste water strategy in line with local legislation. Effective waste water management reduces production of hazardous material and reduces the risk of environmental incident.

Fuel Testing

Fuel Testing should be a regular pattern within a fuel management strategy. This allows you to understand where you are and where you need to be to maximize operational readiness and to minimize risk. Fuel should be regularly sampled and sent away for standardized laboratory fuel testing. This will ensure that cetane numbers, viscosity and other minimum standards are maintained, records should be kept of all fuel tests. Besides this, a monthly sample should be taken and subjected to an onsite test. Rapid, affordable on-site testing allows you to keep a ready eye on immediate areas of concern such as biodiesel levels, water and microbial contaminant presence. As it stands, emulsified water, which leads to microbial contamination (the main culprit in critical system failure resulting from stored use of biodiesel/ULSD blend) have not to date been covered by ASTM/ISO standard fuel testing.

Puritas DieselPure™ fuel polishing systems

Fuel is circulated on a predetermined schedule and flow rate ensuring that sediment in the fuel is kept moving thereby cleaning the tank and maintaining it in a clean state.

Fuel passes through the DieselPure™ filter, removing all the particulates and sediment to <0.2 Microns and extracting both freestanding AND emulsified water.

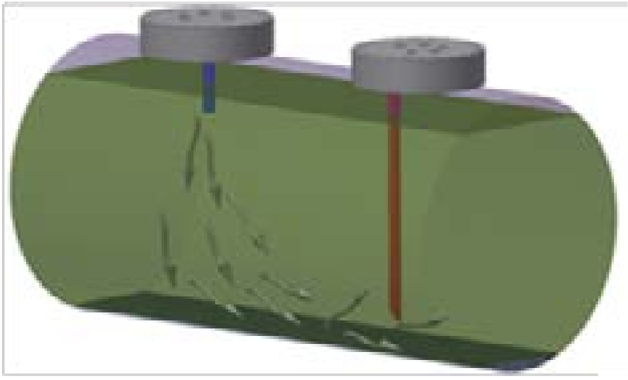
Dry fuel slows down the microbes' ability to thrive and reproduce, reducing sediment and acid build-up, ensuring clean running and longer tank life

- 'Emergency ready' fuel
- Extended tank life
- Reduced generator and engine maintenance is reduced
- Guaranteed power when you need it most.

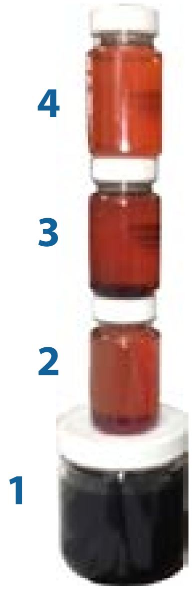
Offline Fuel Management: The Puritas Energy Approach

The mainstay of emergency ready fuel is the offline fuel management system. These systems are installed at or near the storage tank, or at the manifold in a multi-tank setup. Fuel is cycled through the polishing system on a regular basis. The ideal response to the issues outlined in this paper is to turn the whole fuel stock over three times per week. The Puritas fuel polishing system featuring DieselPure™ filters is sized according to the overall tank capacity. It cycles fuel at an appropriate rate to filter fuel to SAE J1488: 2010 standard, and maintains the tank in a clean condition (DieselPure™, 2013). SAE J1488-2010 determines the ability of a fuel/water separator to separate emulsified or finely dispersed water from fuel (SAE, 2013).

In cases where the system is being retro-fitted to an existing dirty tank, the active cycling of fuel will clean the tank in the first cycles, restoring both the fuel and the tank to clean working order. The high frequency cycling ensures the tank and fuel both remain clean, water and contaminant free and that fuel is engine-ready when needed. This approach minimizes sediment concentration, ensures acid buildup is mitigated and keeps the fuel in optimum condition; protecting the tank, the engine and your comitment to provide critical power.



Case Study:
US Transit Authority



1 Raw, contaminated, diesel

2 Second Stage: *Standard Particulate Filter*

> 2 Micron particulates removed

3 Third Stage: *1st pass with DieselPureTM Filtration*

> 0.4 Micron particulates removed

50% of freestanding and emulsified water removed

4 Fourth Stage: *2nd pass with DieselPureTM Filtration*

100% of freestanding and emulsified water removed

DieselPureTM coalescing filters

The unfortunate truth is that the fuel-water bond in today's fuel is so strong, that absorbent and centrifuge style filters cannot remove emulsified water. The first generation absorbent-style filters were effective up to 2007, but with the switch to ULSD, new technology to address emulsified water was required.

Extensive research by DieselPureTM saw the production of the DieselPureTM coalescing filter: the first filter certified by the Society of Automotive Engineers under SAE J1488: 2010 protocol to be 100% effective to remove emulsified water in ULSD and 96.3% effective with ULSD blended with up to 20 percent biodiesel (B20) (DieselPureTM, 2013). DieselPureTM is also ASTM D4807-05(2010) certified, the Standard Test Method for Sediment in Crude Oil by Membrane Filtration (ASTM, 2013).

DieselPureTM coalescing filters have over ten times the amount of filter media (media refers to the type of materials and layers used in a filter to trap water and particulate matter) compared to equivalent absorbent-style diesel fuel filters. This gives the filter the ability to hold heavy concentrations of contaminants and particulate. Review the US Transit Authority case study to the left to see the the effectiveness coalescing filters can have on incredibly contaminated fuel.

The filter media is nano-fibrous, allowing sub micron level particulate removal, while still allowing positive flow rates to coalesce water. Fuel passing through our filter removes particulates and sediments to <0.2 Microns. Due to the large size of the filter, excessive volumes of contaminants trapped in the media do not affect the filter's operating pressure or performance.

Conclusion

Diesel fuel in use today in Canada, the European Union and certain regions in the United States, absorbs more water, holds onto it more effectively and degrades it significantly faster than it used to. Modern engines are intolerant to water and particulate matter. Improperly managed fuel can have devastating effects for organizations reliant upon critical power.

Risks include the costs of downtime, failure to provide critical services and harm to your reputation. The introduction of ULSD and biodiesel blends has ended the era where fuel could be left to sit unused for months at a time.

A proactive fuel management approach must be taken. Awareness of the critical points of failure in a power application and the status of your fuel is central to a proactive fuel management strategy. As the composition and quality of fuel fluctuates, onsite and off-site fuel testing is recommended.

Implementing a comprehensive fuel polishing system using filters which have been proven to protect against emulsified fuel is necessary to protecting investments and reputations. Offline fuel management such as Puritas DieselPure™ fuel polishing systems cycle fuel through an SAEJ1488:2010 filter and maintains your tank, whilst protecting your engine and your reputation.

Fuel passing through the DieselPure™ filter removes particulates and sediments to <0.2 Microns. DieselPure™:

- Minimizes sediment concentration
- Removes all forms of water
- Ensures acid buildup is mitigated
- Restores contaminated tanks

"An on-site fuel polishing system will increase the shelf life of petroleum diesel fuels and could do the same for biodiesel fuels- if the polishing system could successfully remove [emulsified] water"
(Uptime Institute, 2010).

The high frequency cycling ensures the tank and fuel both remain clean, water and contaminant free and ready when needed. Puritas fuel polishing approach using DieselPure™ is a modern response to new challenges in the industry, and remains unsurpassed in the industry of diesel fuel management.

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