

Guide #3

In-line Fuel Tank Cleaning

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Most Engine Performance Problems Start In The Fuel Tank...

Over the last number of years we have seen a sudden, dramatic and worldwide increase in filter plugging tendencies. What has changed? Oil supply and environmental concerns have resulted in important changes in fuel production, such as a change in the refining process to cracking, blending, requirements to change to Ultra Low Sulfur Diesel Fuel ("ULSD"), and the introduction of bio-fuels and bio-fuel blends.

These changes have negatively impacted the inherent instability of our fuel and significantly shortened the shelf life to fuel to as little as three months from the point of refining. Additives, storage and transportation challenges further accelerate fuel degradation.



Reliable power requires the implementation of unique and innovative Fuel Optimization and Maintenance Technology to adequately protect engines and preserve the integrity of stored fuel. Merely giving greater attention to filtration and water separation is no longer the "state of the art".

Fuel degradation has always been an inevitable, natural process. But the time frame where problems begin to occur has shortened significantly. And unless an adequate fuel sampling, testing, monitoring and maintenance program is implemented, fuel breakdown will continue to be a potentially expensive liability and a major contributor to your overall operating costs.

Diesel is a very complex fluid. It is not homogenous and no two batches will ever be identical. Fuel deterioration, filterability and shelf life depend on a variety of factors not the least of which is good housekeeping. Fuel breakdown is dramatically accelerated by changes in temperature, water infiltration, the presence of microbial (bacteria, fungi or yeast) contamination, and exposure to heat and pressure from engine injection systems.

Fuel shelf life and filter clogging tendencies depend on a series of factors such as: transportation and storage, natural oxidation and breakdown, the source of the crude oil, use of production additives, and the addition of bio-fuel. Fuel breakdown is also accelerated by pressurization of fuel and the increased temperature of the fuel that engines return to the tank. Hot return fuel and condensation are important contributors to bad fuel developing in truck and equipment tanks, and emergency generator tanks. Primary particulate filters and water-separators dramatically improve engine protection, but they can only do so much.

AXI-International (formerly ALGAE-X[®]) is at the forefront of three technologically advanced products that address the core requirements



of maintaining fuel to maintain engine operation at peak efficiency and performance:

- [The AXI Magnetic Fuel Conditioner](#)
- [The AXI Diesel Fuel Catalyst AFC-705 and AFC-710](#)
- [The Water Eliminator](#)[®]

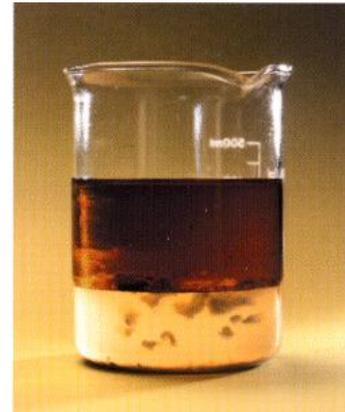
Whatever the nature of your interaction with diesel fuel used as a source of engine power, these three products will keep you running and keep the lights on.



AXI markets these products as part of an extensive line of Tank Cleaning Systems, but these three cornerstones of the AXI product line are also provided to individuals with fuel problems that needed protection on personal equipment. Any of the following are symptoms of a far deeper problem that AXI can help you with:

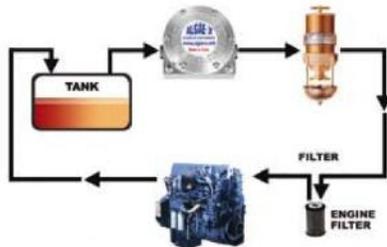
- Visibly dark or black fuel
- Signs of floating debris in the fuel
- Fuel filters covered with black and/or slime
- Unusually short fuel filter life
- Sludge in the tank
- Water in the tank
- Smoke coming from engine exhaust
- Loss of engine performance

These problems can and will result in costly problems with your diesel powered pickup truck, RV, tractor trailer rig, farm equipment, marine craft, construction equipment or other equipment. AXI does not fix the symptom, it fixes the problem.



The AXI Magnetic Fuel Conditioner

Diesel fuel degrades as a result of one or both of two scenarios. In the first scenario, microbial contamination, typically sulphate reducing bacteria, fungi or yeasts, can be introduced to the fuel. These organisms are always present in the air and can be drawn in through tank vents, but it is more common for them to be introduced with contaminated fuel. Normally their presence is not noticed, but if the conditions of temperature and food supply are right, then they can multiply at an enormous rate. So much so that they will eventually form a glutinous mass, that can block pipes and filters and starve the supply of fuel to the engine. In most cases they live in water that has accumulated at the bottom of the tank and feed on additive products (emission improvers, detergents, corrosion inhibitors, etc.) in the fuel. They are therefore mainly found at the interface between water and fuel.



They and their byproducts can cause corrosion of injector pumps, nozzles, and other tank and engine components.

As they reproduce, they form a slimy, glutinous product which when it is drawn through filters, will gradually coat the elements and stop the fuel flow. Alternatively they will eventually coalesce together into a mass that will block the pipes, and seize up gauges. There will often be an unpleasant smell from the fuel tank, like rotting eggs.

A common step taken when the problem is diagnosed is to treat with a biocide additive. This is a toxic substance that kills the bacteria, and several proprietary brands are available. Note however that biocides are as toxic to the operator as to the bacteria, and should be used very carefully. Also, while biocides may kill the bacteria, they do not remove the dead biomass, which can still clog filters and pipes. As biocide treatments do not perform a thorough cleaning, clogged filters and water remaining in the tank continues to provide habitat for the remaining microbes, often still present in the biomass not impacted by the biocides. The organic contamination is converted to a solid that results in tank debris that is stirred up each time new fuel is

introduced to the tank.

The second scenario results from fuel that, with age, turns dark, often brown or even black, the result of the agglomeration of the asphaltene component of diesel fuel. Heavy constituents of crude oil have always been present in diesel fuel. The heaviest part of crude oil is the asphalt, the same as used to pave roads. This asphaltene constituent, however, is in solution in the fuel and does not pose problems as long as the fuel is clear and bright. As fuel deteriorates, clusters of these fuel components and other fuel breakdown residue begin to agglomerate, resulting in dark, hazy fuel with poor combustibility. As the fuel darkens, the clusters enter the fuel system and cause a black coating on fuel filters and, if not yet large enough to be stopped by the filter, passes through the filter and creates a build-up on injectors that compromises injector spray patterns causing uneven combustion and the exhaust of unspent fuel being evident by smoky exhaust. The increase in size and mass of the fuel breakdown products in stored fuel lead to a deposit of what appears to be roofing tar on the bottom of the fuel tank, often mixed in with the debris the result of the organic contamination that is converted to solids with the introduction of biocides.

The [AXI Magnet Fuel Conditioner](#) (“MFC”) conditions and stabilizes fuels and oils. Running the engine or re-circulating pump reverses the process of fuel deterioration and decontaminates the fuel system. The circulating of fuel contaminated with microbial or bacterial infestation through the magnetic fields within the MFC results in the microbes becoming inert. With the microbes now not feeding and reproducing, the growth of the bio-mass is curtailed. The process dissolves the clusters of biomass and breaks the asphaltene clusters apart, returning the asphaltene components to solution within the fuel and resulting in the fuel returning to the clear and bright state returning optimal combustibility to the fuel. The process of returning to this clear and bright state has become known as “Fuel Polishing”. Note that mere filtration will not accomplish this as the microbes and asphaltene clusters are smaller than many filters elements.

AXI Diesel Fuel Catalyst AFC-705

Working with the MFC “hand-in-glove”, the [AXI Diesel Fuel Catalyst AFC-705](#) (“AFC”) is an additive with a formulation that addresses a very specific purpose. Unlike any number of fuel additives at the local truck stop, it was not formulated to just clean injectors and lubricate the fuel pump. Although these functions are part of the work performed by AFC, it also has strong tank cleaning additives that, when used in a full tank of fuel, will dissolve the debris that sticks to the tank sides, top, and baffles, down to the very fine corners of the tank, releases this debris, and allows for it to be circulated as part of the process of cleaning the tank. It will also dissolve the accumulated asphalt buildup from the bottom of the tank. AFC also has an additive to emulsify residual water from the tank bottom, put this residual water in emulsion so that it can be removed by feeding the fuel through the combustion cycle or circulate the emulsified water through a water block filter made to stop the passage of water through the filter element and direct it to a filter bowl for drainage.



Note that if too much water is in the tank, than it is possible that too much water will be put into the fuel, causing the fuel to become hazy and possibly adversely impacting engine performance. For this reason, we recommend you remove water from the tank bottom and as much sludge as can be removed with a recirculation system before introducing AFC into the tank.

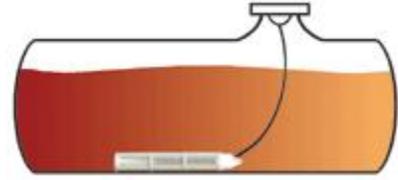


Review the [Guide #2: to Fuel Treatment and Continuing Management](#) for additional information on circulating systems.

The Water Eliminator

The removal of water from equipment fuel tanks and storage tanks can be managed effectively through the use of [The Water Eliminator](#). Free water will accumulate from condensation that enters the tank through air vents that allow air to be drawn in as fuel is used. With temperature changes, and through the heating process of fuel that is circulated through the engine and back to the tank, water droplets form on the tank sides and drop through the fuel to the tank bottom. In addition, water is often

introduced into the tank when fuel is taken on or from seepage from rain and ground water. In winter the problem is more obvious because of freeze-up and gelling.



Though water is primarily recognized as a problem in diesel fuel, it also adversely affects the function of gasoline, fuel oil, mineral spirits, kerosene and hydraulic fluid. These conditions result in additional expenses for the equipment owner. Often these expenses are very significant, particularly if emergency road calls and down time are the results.

[The Water Eliminator](#) was designed as a solution to removing water at the most logical place, in the fuel tank. Removing water at the source affords protection to the entire fuel system. Even the life of the fuel tank will be increased through reducing rust and corrosion. [The Water Eliminator](#) is simplicity in itself. It consists of a cylindrical cage-type cartridge that is lined with a nylon mesh filter. The cartridge is a container for a small measured amount of dry crystals. The crystal is chemically water specific, which means that it will accept only water molecules into its structure. In the presence of water, these crystals will expand to 500 times their bulk. The Water Eliminator can be used as a back-up to a water separator or as the only water trap in the vehicle. It is the first line of defense against water in the fuel. The Water Eliminator is easy to use. Just clip the lanyard to the fuel cap and lower the unit to the bottom of the tank. The Water Eliminator should be checked each time the vehicle is fueled. This visual inspection only takes seconds. [The Water Eliminator](#) should be replaced when more than three-quarters full. A leading automotive testing research laboratory tested [The Water Eliminator](#) and found that it has no effect on the chemical and physical properties of diesel fuel as defined in the applicable ASTM specifications.



[The Water Eliminator Storage Tank Model](#) is a two part system consisting of an outer container fabricated from stainless steel and a replaceable nylon cartridge containing a small amount of water specific crystal. The unit attaches to the fuel cap by a chain and is lowered into the tank where it rests flat on the bottom and extracts water as it is accumulated. The simple "twist to open" - "twist to close" operation requires no tools for the replacement of the cartridge. When first installing the unit on an older storage tank it may be necessary to use several cartridges to remove the water. If the tank contains heavy contamination debris it is recommended the tank be pumped first prior to the installation of the Water Eliminator. The unit should be checked periodically and changed when over 3/4 full.

The analytical data clearly indicates that the chemical and physical properties of the fuel are not altered by the presence of [The Water Eliminator](#) within the environmental parameters of the aging sequence. These conditions represent the average of the extremes that diesel fuel in a truck fuel tank would experience.

Conclusion

When your equipment fuel filters don't seem to last as long as they should, filters are black and slimy, fuel is dark and hazy, diesel engines suffer from loss of power and fuel system components are giving you trouble, the fuel tank is likely the source of these symptoms of fuel problems. The AXI advanced in-line [Magnetic Fuel Conditioner](#), [AFC-705 Diesel Fuel Catalyst](#) and [The Water Eliminator](#) work as a team to solve your equipment performance problems. AXI reverses the process of fuel breakdown, restores fuel filterability, enhances combustibility, and prevents clogged filters and tank sludge. The [Guide #2: Fuel Treatment and Continuing Management](#) and [Guide #4: Determining What Fuel Treatment System is Right for You](#) will further explain the process of maintaining optimal fuel quality.

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