FUEL MAINTENANCE

Fuel conditioning is crucial for peak engine performance and reliability

It is easy to get distracted by all the sophisticated technology and equipment that goes into superyachts today and overlook essentials such as the operating reliability of engines, which affect the safety of guests on board. When engines stop while a yacht is underway, the newest chart plotter, latest GPS or state-of-the-art integrated entertainment system suddenly becomes much less important.

Unexpected engine failure is often caused by the accumulation of sediments that clogs the fuel filters in tanks. Fuel-related engine performance problems, such as clogged filter elements, smoking engines, dirty transoms, losing power and rpm, and injection system failures are occurring more frequently. Instead of being able to run, as should be the case, 1,000 hours or more without having to replace fuel filters, it is now necessary to change them more often and also to have to clean the tanks periodically. Many mariners may wonder whether it is the quality of fuel that has changed or whether engines have become more fuel sensitive – the answer is both.

Enough stories abound about disasters with fuel filters and injection systems to make us curious. Certainly, we would all like to prevent these unpleasant, often dangerous, costly and aggravating situations from happening. The most beautiful yacht, equipped with the latest technology, becomes much less appealing when we find ourselves upside down in a hot engine room changing filters in rough weather.

Clogged fuel filters are symptomatic of poor fuel quality

IMAGES COURTESY OF ALGAE-X

DEVELOPMENT IN ENGINE TECHNOLOGY AND FUEL REFINING

During the last 20 years, there have been important changes in both the evolution of diesel engine technology and the production of fuels. These changes have been driven by demands in the market for performance improvement, increasingly stringent clean air regulations and by what is environmentally acceptable. The consumer and boat builder desire better weight to horsepower ratios, lower emissions and better fuel economy. At the same time, in order to meet the growing demand for fuel products, the oil industry has developed technology to use more of the crude oil they purchase for the production of gasoline and diesel. It is this combination of change and development that has affected engine reliability and performance.

ENGINES AND ENERGY CONVERSION

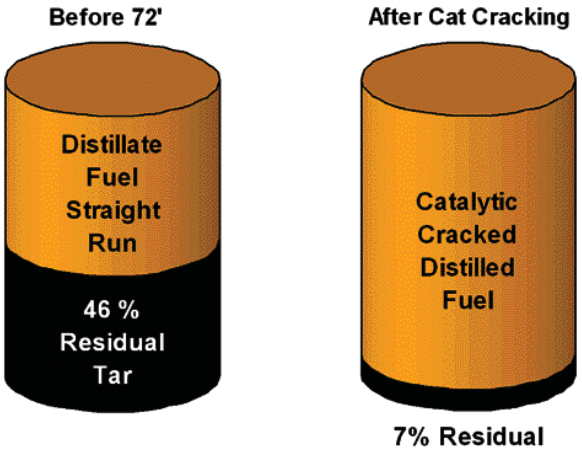
Modern engines have become increasingly sensitive to fuel quality. Higher injection pressures and temperatures and tighter tolerances do not welcome fuel sediments and deposits of paraffin, asphaltene and hard carbon. If fuel is 'food for engines', it could be said that the quality and condition of the 'food' does not always agree with the digestive system of the engines.

Engines convert fuel, or 'chemical energy', into mechanical energy, heat and emissions. The condition of the fuel plays an important role in the efficiency of the energy conversion process. At the same time, fuel instability determines the condition and quality of the fuel. Poor fuel quality has potentially dangerous and expensive consequences, such as damage to engines and injection systems. Optimal fuel quality extends periodic maintenance intervals such as tank cleaning and replacing clogged filter elements and injectors. It also enhances combustion, allowing engines to perform better and smoke less.

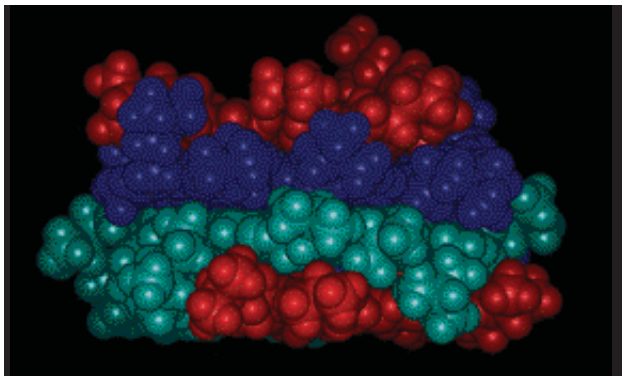
Fuel quality cannot be determined visually. Even fuel that looks clear and bright may still contain incipient solids that are detrimental to the injection system and prevent complete combustion before the exhaust valve opens. Accumulating sludge may sit quietly in the bottom of the tank, but will be dispersed when the engine starts returning hot excess fuel back to the tank. When the vessel gets underway, the motion of the fuel may stir up tank sludge, suddenly clogging fuel filters and stopping the engines.

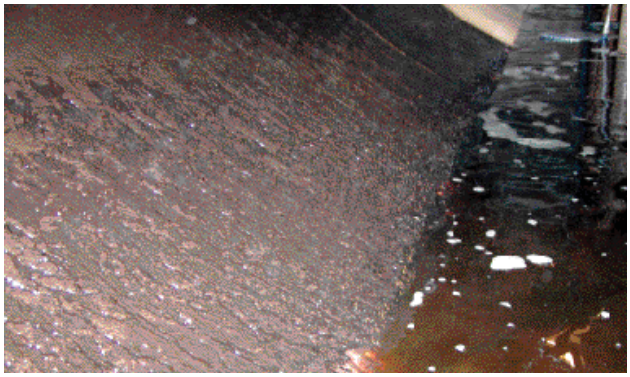
TAKING A CLOSER LOOK AT FUEL

The difference between 'good' and 'bad' fuel is not always immediately obvious. Diesel is a very complex and unstable organic fluid. Its constituents are not homogenous, like water, butane or propane, for example. It consists of thousands of different



Above left: fuel before and after treatment with an Algae-X fuel polishing system; Above right: fuel production has changed since 1972; Below left: fuel molecules, although tiny, cluster together to form larger particles; Below right: sludge accumulated in a fuel tank





combinations of hydrocarbons, varying in size and form. Inherent fuel instability leads to the formation of sediments and sludge that are typically referred to by terms such as algae, dirt, wax, gums, varnish and mud.

Surprisingly, more than 95 per cent of the deposits clogging filter elements are organic materials – fuel compounds of mainly waxes, gums and asphaltene. In particular, the larger, heavy fuel molecules attract each other and nestle together, forming compounds that are too large to pass through a fuel filter element. To get a better idea of how this works and how to prevent the formation of these organic compounds, we need to take a closer look at the building blocks of fuel.

The size of the largest diesel fuel molecule still within specs is approximately 30 angstrom (about 0.003 of a micron), which means that 3,333 of these particular molecules can pass side by side through the 10-micron opening in a filter element. When the building blocks of the fuel are that small, it is difficult to imagine how fuel filter elements get clogged or injectors and pumps get damaged. However, these tiny fuel particles naturally attract each other, forming clusters that keep increasing in size and mass. This process, known as polymerisation, leads to the formation of incipient solids, sediments and ultimately tank sludge.

Changes in fuel production and demands for lower sulphur content also play an important role. In the past, refineries provided straight run distillate products. Now, we feed engines with a variety of blends of distillate fuels mixed with cracked products that are much less stable. This increased instability is accelerated by factors that have always played a role, such as natural oxidation, changes in temperature, condensation, water, microbial activity, the formation of acids, incompatibility and last, but not least, heat and pressure caused by engines, pumps and centrifuges.

MODERN ENGINES ARE VERY FUEL SENSITIVE

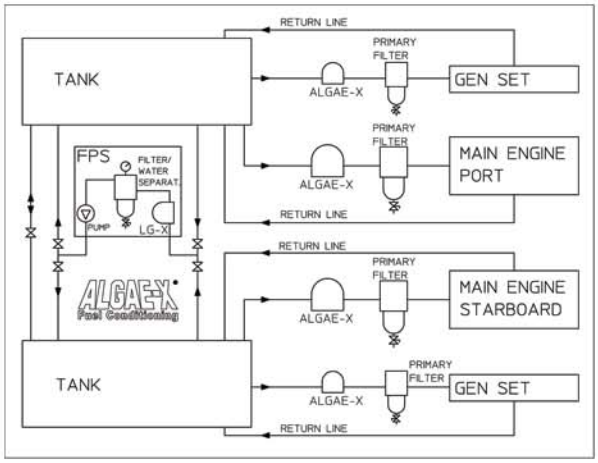
Engine technology has also drastically changed. Tighter tolerances and higher pressures in modern diesels are even more dependent on optimal fuel quality. In common rail injection systems, large amounts of fuel not immediately used for combustion are pumped through the injection system back into the tank or the secondary engine filter. Exposing fuel to heat and pressure accelerates the polymerisation process, negatively impacting on the condition of the fuel and the reliability and performance of the engine.

Engine manufacturers always build the best and most technically advanced machines, but they have absolutely no control over the condition and quality of the fuel that is used in them. It is up to the engine user to make sure that the on-board fuel management systems are up to the task.

ON-BOARD FUEL MANAGEMENT SYSTEMS

In preparing fuel for combustion, there are three key elements to consider: water, inorganic materials and organic compounds.

FUEL MAINTENANCE



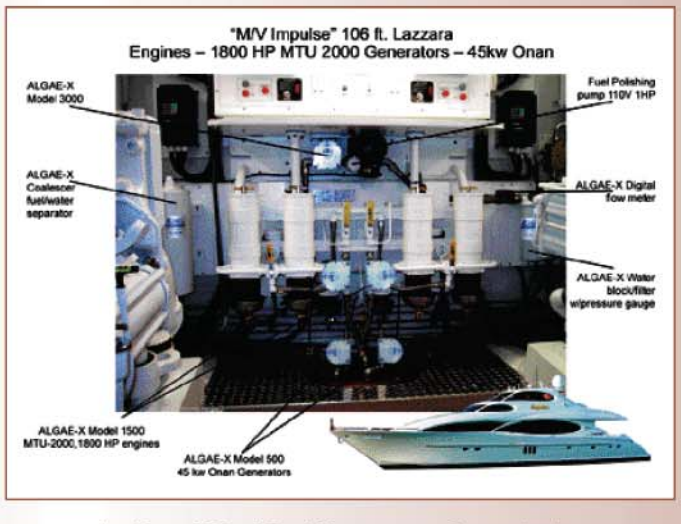
Free and emulsified water will accelerate fuel break down and is detrimental to modern diesels. Water may enter the fuel system during re-fuelling through leaks or as a result of condensation.

Fuel system design has become more critical than ever before. Depending on the size of the vessel, well-designed fuel systems will have to incorporate on-board tank-cleaning/fuel-conditioning and filtration systems to ensure reliability and prevent engine damage. The diagram (left) shows an example of how a built-in fuel-polishing system (FPS) will keep storage tanks clean, remove sediment, particulate, free water and emulsified water, and optimise quality and stability. In vessels where fuel is transferred from the storage tank to the day tank, the FPS system will keep storage tanks clean and only transfer optimised fuel to the day tank.

Centrifuges are very costly, maintenance-sensitive and redundant in most diesel fuel applications. They remove from fuel most of the water and particulate with a different specific gravity. Some water does get through from the storage tanks into the day tanks, however. In addition, the enormous forces centrifuges exert on the fuel are counter-productive to fuel quality, resulting in increased concentrations of asphaltene agglomerations, which have a negative effect on injection systems and the combustion process. The fuel polishing system is a very economical solution, ensuring excellent fuel quality. It eliminates water, sediments and particulate while reconditioning and stabilising the fuel to improve filtration and combustion.

ALGAE-X FUEL MANAGEMENT SYSTEMS

Most debris in diesel fuels and gas-oil are soluble organic compounds that form over time as a result of the inherent instability of fuels and oil. The ideal solution is to remove water and debris while improving fuel stability, reversing and preventing the formation of these organic compounds. Algae-X International's Total Fuel Management Systems are designed to do just that. They combine fuel conditioning, filtration and water separation. The Algae-X standard or custom engineered systems optimise fuel quality to ensure safe, efficient, environmentally friendly and economical engine performance.



An Algae-X Total Fuel Management System in situ; *it conditions fuel by removing water and debris, improving fuel stability and preventing the build up of the solid organic compounds that cause blockages*

Installation of Algae-X fuel conditioners between the service tanks and the primary filters will enhance the combustion process for peak engine performance. A cleaner burn results in significantly lower emissions, a less smelly exhaust and less smoke and soot. More complete combustion also lowers fuel consumption and eliminates and prevents carbon build up, keeping your engine, lube oil and the stern of your boat much cleaner.

Algae-X integrates its patented fuel conditioning technology in a complete line of marine tank cleaning, fuel polishing and fuel management systems, and combines this with AFC-705 fuel conditioning chemistry. The company also manufactures industrial fuel transfer, conditioning and filtration systems to maintain and assure the integrity of long-term stored fuel for emergency power generators, and provides engineering and design services.

Algae-X Fuel Management Systems are installed as standard equipment by several high quality boat builders, and are available through dealers and distributors of major engine manufacturers.

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