Tiny critters, huge losses

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Increasing percentages of bio-components are being added to marine fuels to help meet regulations and reduce the shipping sector's environmental impact. But what difference does this make to fuel husbandry, and are there any risks to the marine operators? There are certainly some areas for concern, and fuel management procedures may need to be adapted to avoid unnecessary maintenance costs or damage to engine systems. Let us look at how the increased percentage of biofuels can raise the cost of fuel as well as leave it susceptible to microbes.

In 2017, the 6th edition of ISO 8217 allowed additional distillate fatty acid methyl ester (FAME) (DF) grades: DFA, DFZ, and DFB with a FAME content of 7.0 v/v %, another potential facilitator of increased water content and microbial contamination. These are complemented with new biofuels, created using innovative refining processes, such as hydroprocessing of vegetable oils (the increasingly popular HVO, particularly in the Nordic) and the co-processing of waste products (oils, plastics) and other raw materials to substitute conventional crude oil, which may have different trace contaminants. While these reduce greenhouse gas emissions (GHG-E), their different chemistry can pose additional risks to marine assets.

Water finds its way

The increased threat comes from a higher potential for microbial contamination. Dormant spores of microbes, including yeast, filamentous fungi and bacteria, are present in the fuel and, when water and air are in the system, create an ideal breeding ground for them to multiply and grow. The bio-component (biodiesel) within marine fuels, generically referred to as FAME, gives these fuels a greater affinity to retain water, exacerbating the risks of microbial contamination.

Water will typically separate from fuel but introducing FAME into its chemical composition means retaining water at greater concentrations. At the refinery, fuel contains <200 parts per million (ppm) water content. Once exposed to the elements, DF grades can hold over 500 ppm of water. Typically, the higher the FAME content, the greater the potential for an increased amount of emulsified water, reaching up to 1,500 ppm.

Indeed, **100% biodiesel can hold 15 to 25 times more water than 100% diesel fuel**. Water can find its way into fuel throughout the fuel supply chain. Anywhere air is present, there is potential for moisture to condense – and there is plenty of opportunity for that in a marine environment! Water can be present in the fuel as free droplets, entrained water, or a separated layer of free water beneath the fuel. The risk of contamination grows significantly with a higher organic content of biofuels for the microbes to feed on. Even if general maintenance procedures have prevented or controlled contamination in the past, shipowners and operators should consider taking additional steps to minimise the threat and protect their vessels.

Why it's an issue

Microbial contamination covers multiple types of organisms, the presence of which will vary according to individual site conditions, based on factors such as temperature and humidity. The microbes work together in communities to degrade fuel and affect fuelling equipment. They form biofilms: complex structures of sticky, slimy polymeric substances that provide a protective habitat for microbes growing within them. These biofilms can clump with any other floating cellular material to form microbial biomass clusters that can plug filters, screens, or other small orifices within the fuel system. Furthermore, these biomass layers generate organic acids that corrode metal surfaces, causing damage to fuel tanks and other ancillary equipment. If left untreated, vessels are at risk of costly damage to systems, breakdowns while at sea, and being out of service for several days.

As we look to increase the percentage of FAME further to reduce the environmental impact of marine fuels, the risk of microbial contamination also increases. On top of this threat, technological advances to produce more efficient combustion engines increase the machinery's susceptibility to the dangers of microbial contamination. Recent engine advancement has introduced precise, higher internal pressure fuel nozzles, whose smaller orifices have a lower tolerance to sediments and particulate matter that might be generated by off-spec fuel. This 'perfect storm' in the advances to control GHG-E requires better fuel management steps to ensure valuable equipment is not damaged, and huge costs aren't incurred.

Photo: Conidia Bioscience

Before realising there is a problem

Removing as much water as possible from fuel supplies is good practice, but a sound testing regime will also help ensure contamination does not lead to corrosion or system damage. Understanding the contamination levels means taking maintenance actions, such as tank cleaning and adding biocide, which can be tailored and optimised to avoid unnecessary costs.

Sampling to identify microbial contamination is carried out in a laboratory or onboard. Testing frequency can be honed according to microbial test results, observed trends, and operational experience. The issues with sending samples to shore-based laboratories for testing derive from the fact that microbes are living, dynamic organisms. It means that the microbial population can change while the sample is in transit and during time delays, and the results may not represent the tank environment. Therefore, samples must be stored and transported under environmentally-controlled conditions, which presents logistical issues. The time taken to get results may mean the ship has visited a port and returned to sea before realising there is even a problem.

Rather than sending fuel samples to a laboratory, testing the fuel in situ, whether in port or at sea, provides a quick, easy, and cost-effective alternative. Test kits based on antibodies, such as the FUELSTAT® test kit from Conidia Bioscience, are a proven method for identifying microbes with the ability to degrade fuel and provide an accurate indication of contamination levels. These low-cost, single-use test kits are simple to use, require minimal training, need no special handling, and can be readily integrated into day-to-day operations. They provide a result in a matter of minutes, scanned into a mobile app to log and share results immediately from ship to shore. They offer an economical and quick way to determine levels of microbial contamination in fuel and enable fuel tank testing while at sea and any required remediation work to be scheduled for when the ship returns to port.

While we wait

We must reduce GHG-E. Increasing the percentage of FAME in marine fuels is a clear and easy 'winner' in the short term while we wait for the development of technology and infrastructure to support zero-carbon alternatives. However, the chemical change in the composition of biofuels means we need to recognise the increased risk of microbial contamination. Subsequently, we should adapt routine operations to ensure advanced corrosion and damage to system components do not threaten vessel availability and burden the bottom line with additional costs.

Although shipowners may have previously had minimal issues with microbial contamination, fuel management procedures should be updated to protect vessels. Contamination can occur throughout the fuel supply chain, and simple onboard testing provides instant results, facilitates optimisation of maintenance procedures, and may save thousands in repairs or lost operating time. ■