Microbial infections onboard ships during lay-up

The causes and treatment of microbial infection in hydraulic and lube oil explained.

It is well known that microorganisms can break down oil spilled at sea. The oils produced today make use of these properties to make them more environmentally friendly than they were a few years ago. Toxic substances naturally occurring in crude oil are removed in the refinery process while substances easily biodegradable by seawater microorganisms remain at a higher concentration.

Although this development is good for nature it makes microbial growth in fuel and oil systems a more frequent problem, particularly in inactive vessels in layup. Detrimental activity in oils has been reported down to -1.1°C, but the optimal temperature is between 30 and 40°C.

Hydrocarbon oils kept in closed systems for long periods are subject to microbiological growth. The presence of water, even in minute quantities, and the ambient temperatures during lay up provide excellent growing conditions for bacteria and fungi which attack the oil and destroy it.

The consequences of microbial growth are sludge formation (biomass) and corrosion as a result of the microorganisms' metabolic products (bio-corrosion). This biological activity may result in:

- Corrosion of steel and metal surfaces
- Sludge formation (biomass)
- Emulsification of water contaminants
- Development of toxic gases (H_2S)
- Deterioration of the oil product
- Reduction of lubricating properties

In the worst cases, complete systems need to be emptied, cleaned and the corrosion damage repaired.

Microorganisms can live and multiply in distillate fuels, lubricating oils and hydraulic oils. This is particularly the case if water settles at the bottom of storage tanks, which is most common during lay up, or is finely distributed in the oils. Just 100ppm water is sufficient for microbiological growth.

Detrimental hydrocarbon microorganisms can exist in all types of oil systems where water and oxygen are present. Even in oxygen-free zones, anaerobic microorganisms can live on partly mineralised hydrocarbons. Oil provides the microorganisms with energy for growth so they are always concentrated at the interface between oil and water. A large number of species are able to use hydrocarbons as their sole energy source. A number of fungus types have the potential to metabolise hydrocarbons, and fungi survive better than bacteria at low pH values. It is also common to find yeast contamination in oils.

As oil degrades, its characteristics change. This is partly caused by the degradation itself, but also because the microorganisms produce extracellular biopolymer (slime). Generally, the microorganisms start to produce surfactants and biopolymer when they come into contact with a hydrophobic culture medium (e.g. oil) that they are able to break down. The first step in the breakdown process of hydrocarbons is always incorporation of an oxygen molecule. The presence of air is therefore a condition for initial growth, but when a bio-film is established it blocks the oxygen, allowing the even more harmful anaerobic sulphate reducing bacteria (SRB) to grow.

Hydraulics or lube oil systems

Microbial contamination in hydraulics or lube oil systems can cause machinery to malfunction by blocking vital parts. Bio-film and slime from bacteria can block filters and nozzles and can form sticky surfaces on machinery parts. A typical cause for leakage through rotary seals is bio-film forming glue between the seal and the surface of the shaft. If the machinery is operated intermittently, the glue between the rotating parts will tear off the sealing lips of the seal during start up.

Bacterial activity producing slime in the oil of a thruster distribution box

The presence of water in lubricating oil, either caused by condensation or by leakage of cooling water, provides excellent growth conditions for microorganisms. Bacteria will change the characteristics of lube oil, causing corrosion, water emulsification and clogging of filters.

Bacteria in oil hydraulic and lubricated machinery can damage seals and cause breakdowns in hydraulic pumps and motors.

Common microbial factors causing breakdown of piston pumps and motors:

- Microbial growth causing blocked valves, nozzles and regulating functions
- Piston shoe damage and wear caused by the bio-film making stick friction at the piston surface

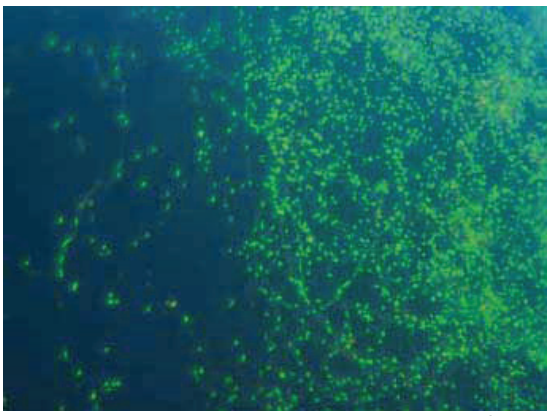
- Air/gas pollution (bubbles) in oil; a frequent problem in closed loop systems
- Incorrectly dimensioned drain line
- Poor suction conditions

Sampling and testing
Oil systems should be tested regularly for microbial growth. How often depends on variables such as temperature, oil type, water concentration and whether biocide treatment has been applied.

Distillate fuel tanks should be sampled from the bottom drain or as close as possible to the bottom of the tank where the concentration of microorganisms is highest. The sample should be tested as quickly as possible onboard using the dip slide method. If positive, the tank should be immediately treated with MAR 71 from Wilhelmsen Ships Service - a highly effective biocide based on methylenebis (5-methyloxazolidine).

The correct sampling method from lubricating and hydraulic oil systems depends on the possibilities for getting representative samples. Water containing bacteria may be trapped in dead legs where sampling is impossible, while sampling of the oil on top may not show any bacteria at all. To make sure representative samples are drawn, special sampling devices, such as those available from FRAS Technology in Norway, should be used.

Dip slides are relatively cheap, easy to use and available on site for instant analysis. However, they lack sensitivity as they can only detect a small percentage of bacteria present, and they also require large numbers of bacteria to be efficient. Therefore, a positive result from a dip slide means that the problem has reached an advanced stage and secondary damage has most likely occurred. Filter elements will often have a higher concentration of microorganisms as slime and biofilm can be trapped inside.



Microorganisms in oil seen through a florescent microscope

Analysis of oil/fuel samples and filter elements from suspected infected systems can be performed at third-party laboratories, such as FRAS Technology. Using fluorescence microscopy and DNA analyses, even small amounts of microorganisms can be rapidly detected and treatment with MAR

71 can be performed before extensive problems and mechanical failure occurs.

Prevention and treatment
Prevention of microbial growth in oil systems starts with good housekeeping and frequent drainage of water. Even then, growth may occur, so an effective biocide is necessary. MAR 71 has a broad-spectrum effect against bacteria (including SRB) and against yeasts and fungi. Due to its alkalinity, MAR 71 neutralises the acids formed through microbial growth, thus providing effective and lasting protection against corrosion. It is soluble in both hydrocarbon oils and water but is present in greater amounts in the particularly susceptible water phase.

Engine manufacturers have confirmed that MAR 71 does not form any corrosive combustion products. It does not add to the AOX value (a measure of halogen content) in the waste water when tanks are de-watered and it is rapidly and completely biodegradable. MAR 71 has been tested in accordance with the Harmonized Offshore Chemical Notification Format, the environmental regulation for the North Sea offshore activities, achieving a “Yellow” classification. MAR 71 may be added to the fuel tank while bunkering (preventive treatment) or dosed directly into the tank for decontamination.

Regular control and necessary action to combat contamination can help prevent these problems. It is important to follow the recommended procedures for decontamination, which our chemicals specialists will be happy to explain to you.

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