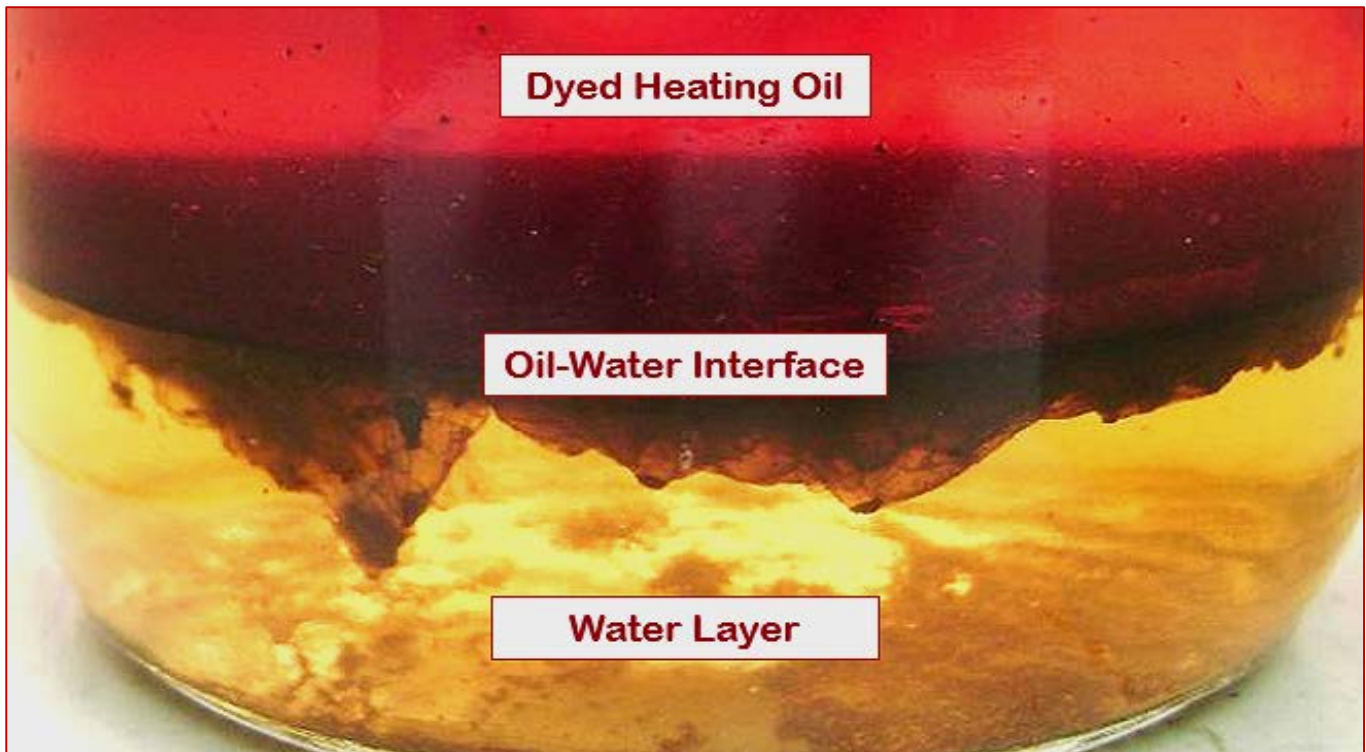


We're Going Global

Microbial Contamination in Petroleum Products

Microorganisms will degrade fuels and fuel systems if left unchecked. Microbial contamination of fuel is caused by two main groups of microorganisms, bacteria and fungi. These bacteria and fungi require two things to thrive, food and water. In a fuel oil storage tank their 'food' is the oil. They get their food from the fuel-water interface and their water from water bottoms at the bottom of the storage tank. The resulting microbial slimes (biofilms) is from the unchecked growth of these microorganisms that are always present in air, fuel, and water.

Microorganisms can be air or waterborne. Microbes can be introduced into fuels as products cool in refinery rundown tanks. Bacteria and fungi are carried along with dust particles and water droplets through tank vents. For many of the species present in the water bottom, hydrocarbon fuels are an excellent nutrient source and the microorganisms proliferate at the fuel-water interface. These type of microorganisms live on organics found at the interface but reside in the aqueous layer.



Microbial contamination is more prevalent in middle distillates but can also occur in marine, aviation, automotive and home heating fuels and systems. When fuel and water come into contact in a storage or distribution system, microbial contamination is likely to occur. Microbial contamination is more severe in warmer and humid conditions.

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Uncontrolled microbial contamination in fuels and fuel systems is a costly problem at all stages of the petroleum industry from crude oil production, through terminal and transportation operations and to the consumer end use.

Microbial contamination in storage tanks and fuel systems can cause a variety of problems. They include corrosion, filter plugging, decreased stability, odor, color degradation and deterioration of fuel/water separation characteristics.

Microbes growing in slime films (biofilms) and aqueous interface in storage tanks creates an environment that is conducive to aggressive corrosion of tank metal.

Can they really eat the metal in my storage tank?

The microorganisms are either aerobic or anaerobic. Some microbes may be present in the organic phase but in a dormant state. Lower pH conditions typically found in the aqueous phase in this environment are suitable breeding grounds for these organisms. If the aqueous layer is not removed on a regular basis, the water becomes infested with this microbial growth.

In the initial stages of growth, the organisms present are predominantly aerobic, using the dissolved oxygen in the water for respiration.

As this supply of oxygen is depleted, anaerobic bacteria, known as sulfate reducing bacteria develop. These organisms do not require oxygen for respiration and form corrosive waste products. One waste expelled by the organisms is hydrogen sulfide.

Sulfate-reducing bacteria also use the enzyme hydrogenase, which scavenges hydrogen ions from the metallic surfaces beneath biofilms. Hydrogenase activity accelerates galvanic corrosion. Other anaerobic bacteria growing produce weak organic acids. The weak organic acids react readily with chloride, nitrate, nitrite, and sulfate anions to form strong inorganic acids, which attack infrastructure surfaces.

Microbial Induced Corrosion: Hydrogen sulfide is produced by sulfate reducing bacteria. This enters solution and is highly corrosive, causing severe pitting of fuel tanks and pipework.

Sludge Formation: Microbial debris is deposited on the tank bottom where it forms a layer of sludge. This sludge creates an environment which favors microbial induced corrosion. If it is not removed, it will seed and infect good product on every inbound.

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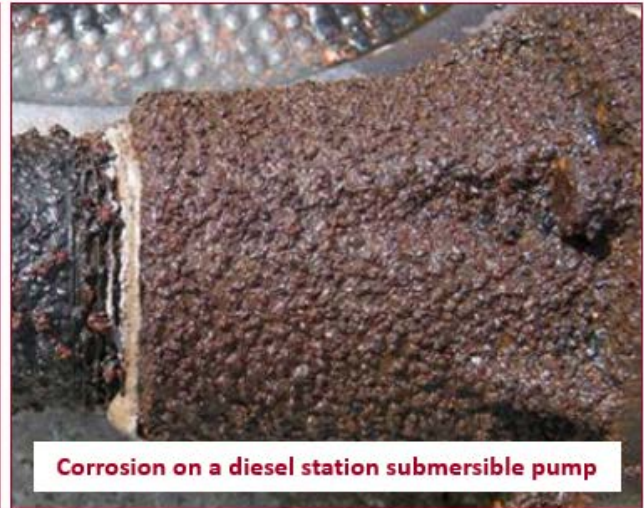
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Filter Plugging: There are gummy products formed during microbial growth. These gummy products along with dirt and debris are deposited on filters and in lines and pipes leading to reduced flow rates and blockages.

Odor: A problem commonly associated with microbial contaminated fuel is that of foul odor. This is a result of hydrogen sulfide production by the sulfate reducing bacteria.



Bacterial slime on a diesel engine filter



Corrosion on a diesel station submersible pump

Retail Station Diesel Tank Corrosion

In June of 2010, a special industry task force was set up to try to find the cause of serious corrosion issues that were cropping up in underground tank systems storing ULSD at retail stations. The issues observed were dispenser meters freezing, filters clogging and sump pumps and steel parts eaten away by rust.

Normal corrosion inhibitors were not correcting the issue. It was determined that microbes were producing acetic acid waste. In the confined atmosphere of these small 10,000-gallon station tanks, severe corrosion issues resulted. Retailers began to treat individual station tanks with small amounts of biocide to alleviate the problems.

Actions to Prevent Microbial Infestation

Fuel tanks at terminals, stations storage tanks and even truck saddle tanks require proper maintenance to ensure consistently good performance.

All supply points need to create an effective maintenance strategy. Water vapor condensing in diesel fuel tanks can create conditions for microbial growth and create a microbial contamination of the fuel system. Remember these microbes are dependent on water

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contamination for growth. Without available water, there is less opportunity for fuel 'bugs' to develop and thrive. Water should be drained on a regular basis to prevent stagnant water accumulation in storage. A maintenance biocide treatment program can be used to prevent infestation or limit microbe activity

Biocide

Proactive maintenance steps may be insufficient to stop stored fuel from being heavily contaminated with microbial growth. At this stage, the fuel and water bottoms need treatment to control the infection, and removal of the resulting dead biomass is required.

Heavily contaminated microbial growth must be treated using a diesel fuel biocide at a shock level. After treatment, fuel clarification and mechanical processing of the fuel, water bottoms and bottom sludge is recommended.

Biocide selection and application is based on several variables including:

- Water/fuel solubility.
- Compatibility with fuel and other additives.
- Compatibility with other system components.
- Handling, disposal and safety considerations.
- Regulatory and industry approvals.

Testing for Microbial Issues

Proper sampling is critical to assess storage tank bottoms. To properly evaluate for microbial contamination, an oil-water interface sample must be obtained. Based on the tank's water cut, use a bacon bomb with the proper extensions to pull the samples.

Example: if a tank has a 2.0" water cut, use a 3" extension to pull the interface sample. Next pull dead bottoms 6" oil sample using a 6" bacon bomb extension.

Finally pull a dead bottom water sample by using the bacon bomb without an extension.

Submit the samples to your laboratory, where they will culture the samples. They will utilize a test kit similar to the Liqui-Cult kit that is listed below. The bacteria culture takes 30 hours and fungal growth culture takes 72 hours.

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Additional Reference Information

For more information, refer to the following ASTM standards or email any biocide treatment questions to AmSpec Additives at Additives@AmSpecGroup.com.

ASTM D6469 Guide for Microbial Contamination in Fuels and Fuel Systems

Discusses microbiological symptoms and consequences of chronic microbial contamination and focuses on microbial contamination in refined petroleum products and product handling systems. ASTM Practice D4418 and D2880 on handling gas-turbine fuels.

ASTM D6974 Practice for Enumeration of Viable Bacteria and Fungi in Liquid Fuels—Filtration and Culture Procedures

ASTM D7463 Test Method for Adenosine Triphosphate (ATP) Content of Microorganisms in Fuel, Fuel/Water Mixtures and Fuel Associated Water

ASTM D7464 Practice for Manual Sampling of Liquid Fuels, Associated Materials and Fuel System Components for Microbiological Testing

The **ASTM Manual 47 Fuel and Fuel System Microbiology** includes chapters on fuel microbiology fundamentals, sampling and treatment of microbial contaminated fuel systems. Manual 47 also includes a compilation of ASTM guides, practices, and methods that can be used to facilitate the microbial contamination detection.

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