THE ACCURATE TANK ADVISOR

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ULSD Corrosion: Finally, an Answer?

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Premature corrosion of fuel storage and dispensing equipment for ultra low sulfur diesel (ULSD) has been widely reported since its introduction in late 2006. Many theories have been proposed as to what causes the corrosion—including improper pump/tank grounding, fuel soaps, microbial contamination and others. Though still far from a certainty, recent investigation and testing indicate that microbial contamination is likely the predominant contributor to this problem. Microbial growth secretes waste products, including weak acids that may cause the fuel to become corrosive.

In testing ULSD samples from multiple fuel suppliers across the United States during the last several years, Innospec Fuel Specialties has found that, on average, almost two-thirds of the samples have borderline or failing corrosion results (NACE TM-0172). Many of the more recent samples show positive microbial growth. In addition, recent work has shown service station underground storage tank (UST) systems and the terminal storage tanks supplying those systems testing positive for microbial growth. Acid levels also increase as the product moves from the terminal to the service station.

CAUSES OF MICROBIAL-INDUCED CORROSION

Microbial growth is an infection that can come from a number of sources—always related to water intrusion. Among other possibilities, water may intrude while the fuel is being transferred from one tank to the next, or enter through vents or other openings. The bottom line is that microbial growth needs water to exist; if there is no water, there won't be any bugs!

In the change from low sulfur diesel (LSD) (500 ppm sulfur) to ULSD (15 ppm sulfur), naturally occurring biocide-like compounds, such as sulfur and certain aromatics, are reduced severely or removed from the

fuel. Additionally, the newer ULSD simply doesn't have the water-holding capacity of LSD, which means that there are generally more tank water bottoms today. Environmental concerns and increased costs also are making proper disposal of tank water bottoms more difficult for fuel infrastructure operators.

	Changes in ULSD From LSD		Impact on Microbial Growth
↓	Sulfur reduction from 500 ppm to 15 ppm	↑	Sulfur is antagonistic to microbial growth.
↓	Aromatic and/or olefin content (includes phenolic compounds)	↑	Aromatic and phenolic compounds are good growth inhibitors.
↑	Saturates	↑	Saturates are a preferred food source, as compared to aromatics.
↑	Water (free, non-dissolved)	↑	More available free water.

(NOTE TO DESIGNER: EMBEDDED GRAPHIC IS FPO. WILL NEED TO REBUILD AS A MORE VISUAL GRAPHIC)

With all of these changes, the propensity for bug growth in ULSD fuel systems has increased dramatically. The bugs can be either aerobic (needing oxygen) or anaerobic (needing no oxygen) and can be found in both the fuel and water phases. In some cases, bugs have been found even in corrosion "barnacles" in the overhead space.

Typically, the anaerobes generate the damaging acids. These weak acids have higher vapor pressure than the diesel fuel and thus rise to the top of the storage tanks, lines and dispensing equipment. This appears to be one reason why so much "above the fuel level" corrosion has been reported in ULSD systems.

Unfortunately, the more common tests for detecting corrosion, weak acid presence or microbial growth don't always indicate a problem. Bugs can be present in a diesel tank—and the fuel and tank water bottoms can still pass NACE, be "normal" for pH, and look good on other indicators.

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Figure 1. UST Steel Caps (Inside View) from a newer fiberglass ULSD tank (highest point in the vapor space, with little or no fuel contact).

CORROSION-INHIBITED DEPLETION

Though fuel is typically treated with sufficient pipeline corrosion inhibitor at the refinery, some of the inhibitor may get used up as it travels through the distribution system and the fuel continues to make contact with metal surfaces. This is entirely normal.

Though less frequent, some inhibitors also may react with caustics or salts in tank water bottoms. The caustics and salts often are traceable to the pipeline. Most pipelines require a "B+" NACE specification (TM-0172) or better upon entry of the fuel. However, this is the last steel corrosion specification that the fuel must meet. There are currently no downstream steel corrosion specifications for gasoline or diesel fuel in ASTM D 4814 (gasoline) or D 975 (diesel fuel) standard specifications.

When added at the terminal level, other surface active lubricity additives may slightly improve the NACE rating of the fuel. However, this only protects end users and cannot be counted on to keep pipelines and terminal tanks from rusting. Having a "retail-level" NACE corrosion specification within ASTM D 975 along with regularly checking for microbials would help ensure that the customer always receives non-corrosive fuel.

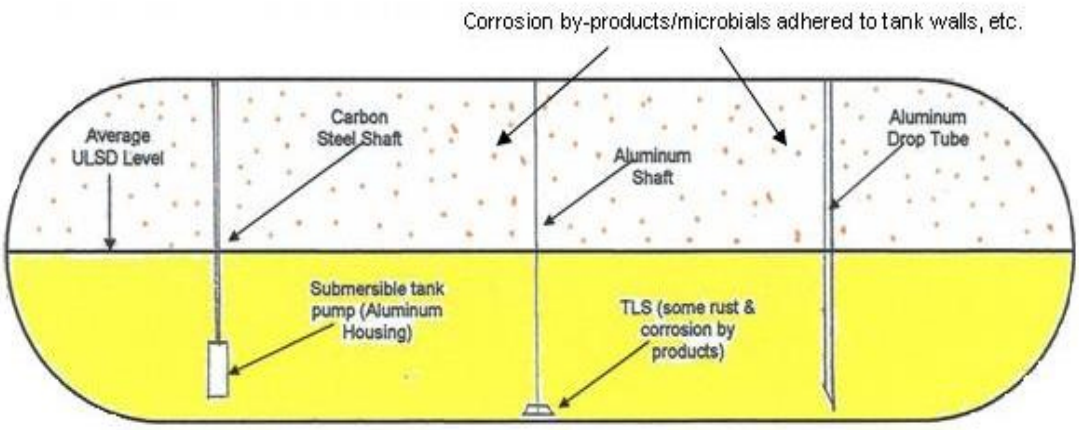
WHAT TO DO

Experts say that the most important thing that can be done to prevent microbial growth is to eliminate the water. Remember: no water, no bug growth. Draining water regularly and thoroughly from any fuel holding storage tank will go a long way in reducing the possibility of acquiring or supporting a bug infection.

Water also is an excellent solvent for many impurities, so removing it also removes many of these potentially fuel filter and fuel system clogging compounds. Using an appropriate fuel-soluble biocide at the correct treat rate may be necessary to kill any lingering infections and ward off future ones. As a word of precaution, using a biocide inappropriate for the circumstance or at too low a treat rate will not rectify the problem and may actually make matters worse.

Fuel re-sellers and end users should ensure that their supplier is giving them clean, bug-free, reasonably dry and non-corrosive fuel. If a problem is suspected, the "White Bucket Test" (see "White Bucket Test" – ASTM Manual of Aviation Fuel Quality Control Procedures, 2nd Edition) will aid in disclosing unacceptable fuel prior to delivery. However, that test may not show microbial contamination or corrosivity of the fuel.

There may be instances where USTs already have corrosion in and above the fuel level. These areas can actually act as a "sink" or trap for spots of microbial growth. This pattern has been found even in tanks that are only a few years old. Unfortunately, only physically cleaning the tank through a high-pressure water or water-soap washing and rinsing along with fuel filtering will remove these potentially infested corrosion spots. A simple bottom-sucking tank cleaning or fuel polishing won't remove all of the corrosion and microbial contamination. Once the tank walls and equipment are thoroughly cleaned, a regular fuel-tank monitoring program combined with continued use of an effective fuel soluble biocide should keep the bug and corrosion problem under control.



(NOTE TO DESIGNER: GRAPHIC IS FPO; please not "by-product" should be hyphenated in the yellow area and please spell out "and" instead of using the ampersand)

Figure 2. UST showing corrosion and possible microbial corrosion spots.

SUMMARY

The advent of ULSD—while necessary to meet tightening environmental air quality requirements—has brought about fuel changes that can lead to storage tank microbial contamination and corrosive diesel fuel. Good housekeeping to remove the excess water, along with proper tank cleaning, effective and continuous biocide treatment, and a fuel monitoring program should help eliminate the ULSD corrosion problem in most cases.

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