NIST research on ethanol "corrosion:" What it really says

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Clarifying NIST's research on corrosion in sump headspaces

The National Institute of Standards and Technology (NIST) published a study titled, "Corrosion of copper and steel alloys in a simulated underground storage tank sump environment containing acid producing bacteria" in the October issue of the peer-reviewed journal *Corrosion Science* (www.sciencedirect.com). NIST is a federal agency under the Department of Commerce. Its mission is "to advance measurement science, standards, and technology in ways that enhance economic security."

The intent of this NIST study was "focused on investigating the potential cause" of "rapid corrosion of components in some underground sumps," according to Jeff Sowards, the NIST researcher interviewed for this article. Another goal was to "develop a repeatable, lab-based test methodology for evaluating corrosion in a headspace environment."

While the intent and scope of the NIST research is made clear in its paper, some reports about the study[1] extrapolated its conclusions to imply that the study included ethanol blend vehicle fuel storage tanks themselves, not just the sump environment.

> ***"This study was not aimed at investigating underground storage tank corrosion, but...at looking at the sump corrosion reported by inspectors."***
> ***—Jeff Sowards, NIST***

NIST studied sump environment, not tanks

Lorri Grainawi, STI's Director of Technical Services, recently interviewed NIST metallurgist Jeff Sowards to clarify the agency's study intent, methodology, and conclusions. Sowards stated that:

"The research originally began when we were introduced to accounts from state inspectors by Steel Tank Institute (STI). Inspectors noticed rapid corrosion of components in some underground sumps at gas stations and were beginning to report them from around the country. The reports indicated an unusual, sporadic and unexpected pattern of corrosion on components inside liquid-tight sumps. This corrosion was reported to occur in as little as a few months. When the covers of the sumps were opened, a vinegar smell had been reported. Visually, the metallic components are seen to have experienced aggressive, accelerated corrosion."

"Specifically, in this case, our research was focused on investigating the potential cause of this accelerated corrosion of materials exposed to biofuels and microbes inside a sump. We planned to use a few materials (1018 steel and copper) and exposed them to a "simulated sump environment" where water, ethanol, and acid producing microbes, specifically Acetobacter sp, were present. We chose the test conditions based on research that was first conducted by EPA's Office of Research and Development."

Controlled conditions for microbial growth

"Our test was based on one set of conditions that we could control in the laboratory, mimicking those reported in an EPA study on sumps,"[2] Sowards said. Tightly controlled conditions included temperature, same number of microbes inoculated into identical growth media, and ethanol concentration of 5%.

The microbes reproduced under these ideal conditions "processed the ethanol into acetic acid, so the vapor phase contained ethanol, water and acetic acid vapors,"Sowards said. "In actual conditions, the ethanol concentration could vary depending on fuel type and how well sealed the sump pump chamber is."

Conclusions: Sump headspace components exhibited corrosion

In the test phase of NIST's research, metal test coupons were exposed to both a liquid and vapor environment and inoculated with *Acetobacter sp*. Sowards noted these conclusions:

"The corrosion rates of copper coupons submerged in liquid and those exposed to vapors were similar and exhibited pitting and intergranular corrosion due to the acetic acid exposure.

"The corrosion rates of steel (coupons) were greatly accelerated when exposed to vapor with acetic acid and exhibited pitting corrosion.

"Corrosion rates were dependent on formation of corrosion product in the headspace. It was observed that headspace samples experienced the greatest corrosion rates and immersed coupons experienced lower rates.

"The laboratory test method developed for this study demonstrated that *Acetobacter aceti* can cause the accelerated corrosion observed in sump pumps."

"We do not know if…reports of corrosion inside underground storage tanks have any link to Acetobacter sp. investigated in our study, or any other cause (e.g. ethanol vapors)."
—Jeff Sowards, NIST

Ethanol storage not linked with steel tank failures

"The NIST research study focused only on the sump pump components of underground storage tanks," Sowards said, "and the corrosion in storage tanks was not within the scope of the work." Therefore, STI/SPFA maintains that this research should not be extrapolated to imply that microbial contamination in ethanol blend vehicle fuel storage tanks can be linked to corrosion other than in the sump head space.

Fiberglass reinforced plastic (FRP) tanks, on the other hand, have developed cracks, blisters, and delamination, believed to be caused by storage of ethanol. "In some regions of the country, mounting evidence from failures and field observations...suggest there may be some impacts (from storage of ethanol blended fuels) to fiberglass USTs."[3]

STI/SPFA has performed research to support that ethanol storage is not linked with steel tank failures. **In fact, steel tanks have been conclusively shown to be compatible with all ethanol blends.** [4]

References and Footnotes

[1]*Kiplinger Letter*, Vol. 91, No. 32, August 8, 2014.

[2]"Corrosion of copper and steel alloys in a simulated underground storage tank sump environment containing acid producing bacteria," by Jeff Sowards and Elisabeth Mansfield. http://www.nist.gov/manuscript-publication-search.cfm?pub_id=914581

[3]"Compatibility of UST Systems with Biofuels," Association of State and Territorial Solid Waste Management Officials. http://www.astswmo.org/Files/Policies_and_Publications/Tanks/2013.06-Biofuels_Compatibility-Alt_Fuels.pdf

[4]"Steel Facts: Newer fuels and storage tank corrosion," STI/SPFA. http://www.steeltank.com/Portals/0/About_Us/Steel%20Facts%20No.%206-Newer%20fuels%20and%20storage%20tank%20corrosion%20v.1.pdf