What wine makers can teach tank owners.

Every fall, our family gets together to make wine. We buy the best grapes we can afford; we carefully clean our equipment; we crush the grapes; add some yeast and then begin to debate about how much sulfur to add. We could eliminate the sulfur entirely, let nature take its course and avoid the “contains sulfites” confession that you see on almost all commercial wine labels. But we always add at least a little sulfur to avoid letting nature takes its course too far. The culprit is a bacteria called *Acetobacter oboediens.* Sulfur kills the *Acetobacter* and if you don’t kill the bacteria, you will very likely end up with a barrel full of vinegar.

So what does this beautiful glass of Zinfandel have to do with the corroded turbine pump? The answer is acetic acid and how it all comes together is a great story.

First a little background in wine and whiskey: Most everyone is aware that yeast is a single cell organism that converts carbohydrates to alcohol and carbon dioxide as it reproduces more yeast cells. If you start with grape juice, you just let the yeast organisms do their thing, you end up with wine somewhere between 12% and 15% ethanol. Start with corn mash and you end up with about the same initial concentration of ethanol which then gets distilled several times to end up with bourbon whiskey to drink … or commercial ethanol to blend into gasoline. *Acetobacter* comes in at the next stage. It’s a very common bacteria and not limited to wine. *Acetobacter* consumes ethanol and oxygen to reproduce more *acetobacter* and produces acetic acid and water as a byproduct. (As you are probably aware, the sharp taste of vinegar is in fact acetic acid). But wait…why doesn’t all wine turn to vinegar? Because the sulfur added when we crushed the grapes kills the *acetobacter*. For whisky and commercial ethanol, it’s the distillation process and high alcohol concentration kill off any *acetobacter* present.

How does this all lead to a corroded turbine pump?

It may come down to two changes at the retail end of the fuel industry and a classic case of unintended consequences:

Change 1: Blending ethanol with gasoline. The concept dates back to the early 20th century but it really got a kick start in the U.S. with the Energy Policy Act of 2005 which mandated the 10% to 15% ethanol blended into gasoline that we see in many parts of the U.S. today. There is still debate as to whether it makes good economic policy, but it's certainly been good for the corn industry. We'll give Congress credit for good intentions.

Change 2: Converting to Ultra Low Sulfur Diesel or ULSD. Since 2006 all diesel fuel in North America and Europe has been refined to an Ultra-Low Sulfur standard of 15 ppm or less. Gasoline by contrast was capped at 300 ppm until 2006 and it wasn't until 2017 that the cap was lowered to 80 ppm for any given batch with an annual average of less than 10 ppm after 2017. Less sulfur means cleaner exhaust gas emissions. Once again the policy is made with good intentions.

But guess where wine makes target their sulfur concentration? Answer: 40 ppm to 50 ppm

Which leads us to the unintended consequence:

Prior to 2006, both diesel and gasoline contained more than enough sulfur to kill *acetobacter*. After 2006, cleaner ULSD no longer contained enough sulfur to kill *acetobacter*. While gasoline (until early 2017) was still produced with more than enough sulfur levels to kill the bacteria.

But wait, ethanol is not blended into diesel, so what's the problem? Even if there is zero sulfur in diesel, there is no ethanol "bacteria food" either so how can the ubiquitous *acetobacter* reproduce and create acetic acid?

Here's the most likely explanation: the last link of the commercial fuel distribution system may have unintentionally been (and probably still is) causing a problem with cross-contamination. Commercial gasoline tankers delivering ethanol blended gasoline to the corner gas station today may be used to deliver ULSD to a different gas station tomorrow. There is no standard procedure to completely drain or clean the tanker after each delivery. Small amounts of fuel left in the tank from one delivery are blended in with whatever is added to the tanker truck for the next run. The small fraction of residual fuel of a different type or grade has little impact on engine performance so there is no reason (from a fuel management point of view) to do anything about it. But the likely consequence is that small amounts of ethanol have been making their way into diesel storage tanks since 2005 and where since 2006 acetobacter have been lurking with very little sulfur to inhibit their re-production.

Is this real? In July of 2016 the federal EPA Office of Land and Emergency Management published a press release with the ominous title of: EPA Research Shows Moderate or Severe Corrosion in Majority of **Diesel** Fuel Underground Storage Tank Systems Studied -- Agency Calls on Tank Owners to Check for Corrosion. The release goes on to say that moderate or severe corrosion was found in 83% of the tanks they examined. And further says: "*Scientific evidence has not identified a specific cause of corrosion in diesel tanks, although microbiologically-influenced corrosion is suspected to be involved. EPA is continuing to work collaboratively with partners in the UST community, industry, and scientific experts on additional laboratory research about the cause of corrosion*."

Connecting the dots:

- Around 2005 ethanol made a big move into commercial gasoline blends.
- In 2006 North American (and European) market switched over to ULSD and normal delivery practice has no procedure to prevent at least some ethanol from getting into diesel tanks.
- 10 years later 83% of the EPA examined diesel USTs appear to have moderate or severe corrosion.

Why the heavy corrosion? The fumes from acetic acid are highly corrosive to steel… more than 1 mm of wall thickness can be lost per year. Even a tiny leak from the fitting within the manholes and access risers above the tanks allow the corrosive acetic acid fumes to escape and attack the steel. Acetic acid fumes are about twice the density of air so they tend to accumulate in the void spaces below steel covered manholes. Take a look at the picture of the turbine pump at the top of the article with this in mind.

And the elephant in the room: Starting in 2017 gasoline sulfur content is targeted to be at 10 ppm, well below the winemaker's rule-of-thumb 40 to 50 ppm. So virtually every underground fuel storage tank in the U.S. (there are 500,000 or more of these) and their associated fittings may be at risk for rapid corrosion.

Is this too much dot-connecting? More of a remote possibility than a real chain of events? Just a coincidence? As the EPA says: *"…evidence has not identified a specific cause of corrosion in diesel tanks…"* But there is no denying that 83% of the diesel UST tanks observed are in trouble. And 400,000 or more gasoline USTs may be next in line.

It's certainly worth thinking about over you next glass of wine.

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