Fall 2023

Dear No-Rosion Customer,

With winter just around the corner, it's time to prepare your cars for storage and/or less frequent driving…

In last Fall's newsletter, we took a detailed look at how/why ethanol in today's gasoline exacerbates and accelerates accumulation of performance-robbing engine deposits. And we briefly mentioned its corrosivity.

In this newsletter, we'll explore how/why ethanol damages metals, seals, gaskets, plastic, and rubber, is chemically unstable as it resides in your vehicle's gas tank, and increases friction-related start-up wear. And we'll explore preventative measures you can implement to protect your car's fuel system and engine.

Before we begin, a brief look at the current state of affairs – where we are now, and what comes next.

Only 2,300 of the roughly 150,000 gas stations in the US sell E15 (gasoline that contains 15% ethanol). That's the good news. The bad news is that it has become increasingly difficult to find gasoline containing no ethanol. Worse yet, in some states ethanol is added, by law, to a minimum level of 5.9%. Seven states – Louisiana, Minnesota, Missouri, Montana, Oregon, Pennsylvania, and Washington – mandate that ethanol be blended in all gasoline, at varying (and permissibly undisclosed) levels. So if you live in one of these states, even when you think you're buying gasoline that contains no ethanol, you're actually getting it.

Unfortunately there's no end in sight. In June of this year, our government announced plans to increase the amount of ethanol that refiners must blend into the nation's fuel mix over the next three years. The EPA plans to finalize ethanol blending volumes at 20.94 billion gallons in 2023, 21.54 billion gallons in 2024 and 22.33 billion gallons in 2025. The final rule increases total renewable fuel volumes by 8% from 2022.

As identified in previous newsletters, **ethanol contains about 33% less energy than gasoline**. This results in pure gasoline with 0% ethanol (E0) delivering 3% better fuel economy than E10 (10% ethanol). But this is offset by the fact that E0 typically costs MORE, anywhere from $0.30 to $1.00 more per gallon for equivalent octane number.

Some gas stations have used this as a "*marketing opportunity*." One such gas station even claimed that ethanol-free gasoline increases fuel economy enough to save customers "up to 25%!"

This is a preposterous claim, of course. But it does beg the question: Just what is the "breakeven point" between E0's increased fuel economy, and E10's lower price per gallon?

To find out, we ran a test that combined the metrics of miles per gallon (MPG) and price per gallon (PPG) into a different measure that we'll refer to as "***miles per dollar***," or MPD.

Our test vehicle was a 2018 BMW 320i, with a 2.0-liter twin-turbo four-cylinder engine that makes 180 hp and 200 lb-ft of torque, and is mated with an eight-speed automatic transmission. It was a 500 mile drive-test, with equal parts city/highway driving, travelling the same routes, with tire pressures monitored/equalized, and all other variables being equal EXCEPT the E0 and E10 test fuels.

We sourced the test fuel from a local gas station that offers 87 octane gasoline both WITH and WITHOUT ethanol, per the photo to the left. As indicated, the E0 gasoline was priced $0.55 more per gallon than the E10 gasoline.

To confirm the stated octane numbers and ethanol contents were as-advertised at the pump, before testing began, we sent a sample of each fuel to a third-party test lab. Results confirmed that both figures were indeed as-advertised.

Lastly, drive-test data were statistically analyzed using a 2-sample T-test to determine if there truly was a performance difference between the two fuels.

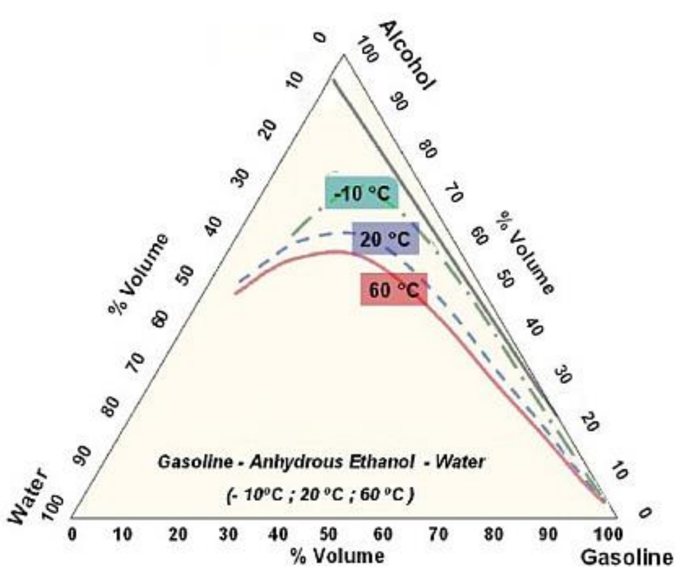
Here are the results. E10 yielded average fuel economy of 24.6 MPG. At a PPG of $3.499, this results in a MPD of 7.03. E0 yielded average fuel economy of 26.0 MPG. At a PPG of $4.049, this results in a MPD of 6.42.

So, our testing demonstrated that using pure gasoline instead of E10 did improve MPG by about 6%. But it also reduced MPD by about 9% due to E0's higher cost per gallon. Meaning, even though fuel economy increases by about 6% with pure gasoline instead of E10, at current fuel prices one actually ends up being financially penalized due to E0's higher cost, as shown by the 9% drop in miles per dollar. Certainly a far cry from the aforementioned gas station's advertised claim of: "SAVE UP TO 25% ON GAS MILEAGE!"

That's the direct, most obvious, easily quantifiable cost. But what about the **hidden costs** of damage to your car's engine and fuel system, both short-term and long-term, due to the corrosive side effects of ethanol?

The problems with ethanol in gasoline are numerous. Perhaps the biggest among them is its tendency to readily and continuously absorb water from humidity in the air. As you may recall from your high school chemistry class, "***likes dissolve likes***." Ethanol is an alcohol, and so is water. Meaning, these two "likes" have an affinity toward one another that is chemically impossible to counteract.

As soon as E10 starts to absorb water, which begins literally within hours of being introduced to humidity-containing air, a water/ethanol emulsion begins to form. The ratio of water to ethanol increases as more water is absorbed. When it reaches saturation, the emulsion breaks down by a process known as "**phase separation**." The heavier water-laden layer then settles out of the solution, and sinks to the bottom of the fuel tank.



Detailed investigative laboratory analysis has been conducted to study the relationship between gasoline, ethanol, and water. The results are best demonstrated by what is referred to as a **Ternary Phase Diagram**, as pictured at left.

The diagram expresses one-phase mixtures above the curves at various temperatures, and phase-separated mixtures below the curves. Gasoline with higher ethanol content will absorb – and then correspondingly phase separate – higher quantities of water – particularly at higher temperatures. This holds certain ramifications if, for example, you live in a hot humid area of the country, and use gasoline with a higher percent of ethanol content.

Once the heavy water-laden layer sinks to the bottom of the fuel tank, **corrosion** begins. While it takes an extended period of time before said corrosion penetrates the thickness of the tank, resulting in a leak, other shorter-term issues can result. Tiny rust particles can get sucked into the fuel, clogging fuel filters, or possibly damaging the fuel pump. If they make their way to the carburetor/ injectors, they'll interfere with proper delivery/nebulization of fuel. Not to mention that if water makes its way to the engine, it results in hard starts.

Ethanol-induced water in fuel also increases its electrical conductivity, resulting in galvanic action electrolysis that occurs between dissimilar metals in the fuel system. This is especially the case with older cars that were manufactured using ferrous metals not well-suited to accommodate ethanol's corrosive tendencies.

It's not just metals that fall prey to ethanol's (and water's) corrosive effects. Alcohols, in general, cause swelling, cracking, and premature failure of elastomers, rubbers, plastics, and gaskets of many different types. As case in point, here is a note we received from Jeff Ohlson of Carmel Valley, CA, a No-Rosion customer since 2004:

I run a 680 cfm double pump Holley on my 302 engine and after sitting for about 3-4 weeks between starts (been doing this for several years), it ran horribly so took the carb off to see if I could sleuth the issue. I suspect over time the ethanol affected the power valve diaphragm and I did see that the needle O-rings looked a little cracked and brittle. Tried to take a close up photo of the needle O-rings but it's harder to do than I thought. The O-ring on the left was broken when I removed it – a testament to how brittle it became. I think this really was my fault in not rebuilding the carb every 3 or 4 years – but life intervened. I'm now in the process of rebuilding the carb with a new Holley Trick Kit.

So, with all these awful properties, just why is it, then, that refiners blend ethanol into gasoline?

A big reason is that it boosts octane, and is the least expensive means of doing so. As detailed in our newsletter from Spring 2014, found on www.NoRosion.com along with all of our other past newsletters, the three ways of chemically boosting octane are: (1) OXYGENATES (such as ethanol), (2) AROMATICS (such as toluene/ xylene), and (3) ORGANOMETALLICS (such as tetraethyl lead/methyl manganese).

The absolute best, most effective way of boosting gasoline octane is with ***organometallics***. This is why tetraethyl lead was so widely used, for so many years, before the EPA banned its use. The next best option is ***aromatics***. However, for reasons related to cost, storage, volatility, and environmental limits/concerns, use of aromatics is now more limited by refiners as well.

Which brings us back to ethanol. The biggest reason for its widespread use today is, of course, that our Federal Government mandates such. In essence, mandating its use at certain minimum levels allows the government to report "claimed" air-quality improvements. This word "claimed" is in quotes because, depending upon the metric, this may or may not actually be the case. And it depends on which version of "science" to one subscribes. Suffice to say, anytime the government gets involved in "science," the facts seem to get murky.

As ethanol is far less concentrated than are organometallics or aromatics, it requires a substantially higher concentration to be blended into gasoline in order to boost octane on an equivalent basis. Therein lies the rub.

Knowing all this, you'll more easily understand why (in most instances) when you see E0 sold at the pump, it is lower octane than ethanol-containing gasoline. And that assumes you actually KNOW whether the gasoline indeed contains ethanol. As mentioned, seven states allow gas stations to sell gasoline containing up to 5.9% ethanol without the legal requirement of divulging its content. But this is constantly changing. A state-by-state listing of up-to-date ethanol fuel legislation can be found at: https://afdc.energy.gov/laws/state.

Now that we've identified ethanol's myriad problems, let's turn our attention to solutions…

If you live in one of the seven ethanol-mandate states, or even if you don't, you can use a simple, relatively inexpensive, accurate Ethanol Test Kit to know exactly how much ethanol is in your gasoline. We recommend www.Fuel-It.com. They have a **Glass Ethanol Content Tester Kit**, available for $23. It works well.

What to do when you find E0 gasoline, but the octane is lower than you desire? **Add No-Rosion Octane Booster.** It contains the organometallic octane boost ingredient MMT (Methylcyclopentadienyl manganese tricarbonyl), also known as methyl manganese. Aside from tetraethyl lead, it is by far the most concentrated, most effective means of boosting octane that is still legally permissible.

We tested 87 octane E0 gasoline with single, double, and triple doses of **No-Rosion Octane Booster**, to quantify octane gain. The single dose boosted octane to 88.3, double dose boosted to 89.5, and triple dose boosted to 90.5. Caveat emptor, double or triple dosing is only recommended for non-catalyst vehicles, as repeat use of MMT at higher levels can eventually cause issues with catalytic converters and oxygen sensors.

What to do when you can't find E0 gasoline, are unsure of gasoline's ethanol content, or have no choice but to use ethanol-containing gasoline? **Add No-Rosion Fuel System Combustion Optimizer.** It contains NACE A-rated corrosion inhibitors that protect all metals from corrosion/electrolysis. It also contains a demulsifier that helps prevent ethanol's water-absorption from humidity in air, which in turn, protects against phase separation. And it chemically stabilizes fuel by helping to prevent oxidation.

The final item to cover is **ethanol's negative impact on engine oil lubricity**. SAE studies indicate that, due to its higher latent heat of evaporation versus gasoline, ethanol accumulates in oil. This allows it to chemically degrade oil's antiwear agents, and erode protective surface films they form inside cylinders. The net effect is increased wear, especially during engine start-up. **For this, we recommend No-Rosion Lubrication System Passivator.** It forms resilient surface films that help prevent start-up wear, even in the presence of oil-accumulated ethanol.

We tested friction-related wear in a 1971 Camaro 350 engine. It had pistons with one 0.1875" and two 0.0781" rings. Starting with fresh oil, we performed a series of 5 cold starts. After each, the engine was brought up to temperature, and driven 50 miles, for a total of 250 miles. This was done using E0, after which oil was drained and tested. This same procedure was repeated using E10, after which oil was drained and tested. Lastly, it was done using E10 and oil treated with **No-Rosion Lubrication System Passivator**. This same test was then repeated with a 2012 Corvette LS7 engine having pistons with one 0.1181" and two 0.0472" rings. Bearing in mind that **iron contaminant in oil is interpreted as friction-related wear**, here are the test results:

Wear Test, ppm iron	E0	E10	E10 w/Passivator
1971 Camaro	9	22	5
2012 Corvette	4	10	3

Please find the enclosed order form that you can use to place your next order. Or for quicker service, visit our web site and order online at: www.NoRosion.com.

We thank you very much for your support, and look forward to continuing to be of service to you and your cars.

Applied Chemical Specialties, Inc.