Spring 2017

Dear No-Rosion Customer,

Hopefully this letter finds you well, and readying your cars for another season of driving pleasure.

Aside from the octane level, what else do you really know about the chemistry of the gasoline you buy at the pump these days? There are many political, economic, and industrial factors that impact the price and composition of fuel that you purchase at your local gas station. Examples include the EPA's Renewable Fuel Standard (RFS), the 2025 Corporate Average Fuel Economy (CAFE) and CO_2 emissions standards, and industry trade and lobby groups, such as the Renewal Fuels Association (RFA).

Tetraethyl lead (TEL) was phased out during the mid-1970s because of its cumulative neurotoxicity, and its damaging effect on catalytic converters. Since then, there has been a significant decline in the octane level of gasoline available in the US. Fuel refiners have replaced TEL with other materials, such as aromatics and ethanol. Absent the requisite level of octane, detonation can wreak havoc in your engine. What you may not know, however, is that the OEMs are now doing their best to leverage the 2025 CAFE and CO_2 emissions targets as cause for <u>increasing</u> the octane rating for gasoline in the US. How? And why?

Currently most of the US offers 87 to 93 AKI octane gasoline. But OEMs are now pushing the government and refiners to begin offering higher octane ratings, similar to what is available in Europe. As it is now, 95 AKI (100 RON) octane gasoline is available all across Europe. OEM automobile manufacturers say an increase to 95 AKI in the US would help them to meet the stringent fuel economy and CO_2 emissions regulations due to hit in 2025, in which fuel economy targets for the OEMs will increase from today's target of 35.5 mpg to 54.5 mpg.

What's the difference between AKI and RON octane ratings? In the US, we use the AKI, or Anti-Knock Index. In Europe, they use RON, or Research Octane Number. The difference involves the test methodology used to score the point at which fuel begins to knock. With AKI, the octane number is an <u>average</u> of the RON and MON (Motor Octane Number) ratings. That's why you see a placard at the pump that indicates the (R+M)/2 method.

In today's global economy, many of the same engine platforms are being sold in both the US and Europe. So it's not unreasonable for OEMs to ask that the US offer gasoline with the same octane rating as Europe. What is interesting is that things seem to be coming full circle. Many of us need higher octane gasoline for the high compression engines in our older cars, which were built back when leaded gasoline was available. Interestingly, today the OEMs see the benefit of running a higher compression ratio in newer engines for a number of reasons.

Higher compression allows a more efficient burn of the available energy in gasoline by increasing the thermal efficiency of the engine. This "efficiency" translates into less energy (i.e. gasoline) entering the engine and being wasted in the form of heat and unburnt fuel. This increases the specific output (horsepower per unit of engine displacement), meaning OEMs can extract more power from smaller engines. So, higher compression engines emit less CO_2 – which ironically, helps OEMs achieve the 2025 fuel economy and CO_2 emissions standards. That's what we mean when we say: It's coming full circle. With current maximum octane levels in the US of 93 AKI, the OEMs are banging their heads trying to achieve the required emissions standards.

There are many examples of modern engines that have a compression ratio of 11.5:1 or higher – something that just a few years ago was considered the edge of "street friendly." But with advancements in engine technology, such as Gasoline Direct Injection (GDI), higher compression ratios are becoming the norm in new OEM engines.

For example, Mazda's SKYACTIV engines can run a compression ratio of up to 15:1, but are limited to running 13:1 in the US, due to 93 AKI being the highest octane gasoline available at the pump. Mazda already has plans underway to increase compression ratios of future engines up to 18:1 as a means of achieving a 30% increase in fuel economy, and reduced emissions.

In the photo to the left, we see a unique hypereutectic piston from a Mazda SKYACTIV engine. It features a center-dome cavity, designed to improve combustion efficiency, and achieve high compression ratios.

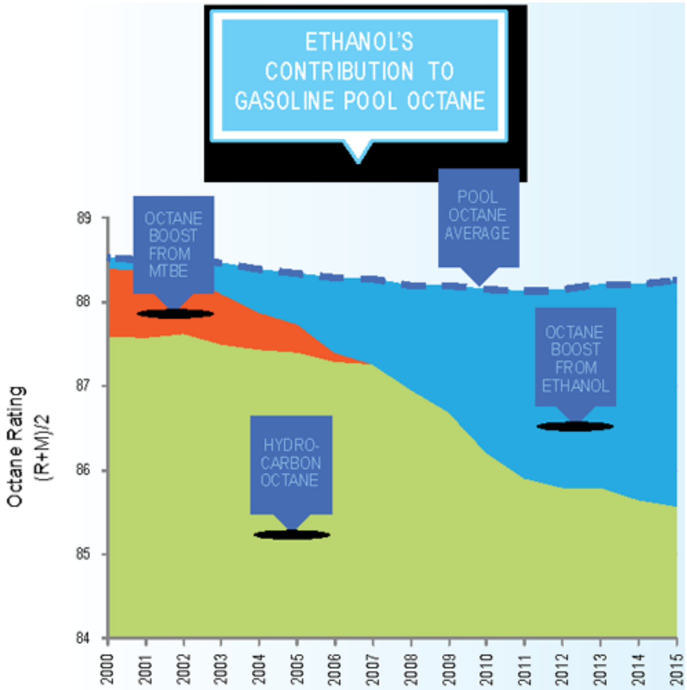
Ford, GM, Chrysler, Honda, and Fiat discussed the issue of compression ratio as it relates to availability of higher octane gasoline at a recent panel discussion at the Society of Automotive Engineers (SAE) World Congress. They unanimously agreed that the availability of 100 RON (95 AKI) gasoline in the US would provide exactly what they need in order to meet the 2025 fuel economy and CO_2 emissions standards. One can't help but find it a bit ironic that the same legislation that initially took away good fuel in the US may actually end up returning it.

At first glance, this may all seem like good news for those of us with classic and high performance cars that have a thirst for octane. Unfortunately, it's probably not. It would only be good news if improvements in octane were achieved by means other than further enrichment of gasoline with ethanol. But last year was another banner year for the US ethanol industry, with record production, unprecedented demand, and growing exports. And the outlook for 2017 calls for even more ethanol, as the Renewable Fuel Association is already in process of working with the new administration to establish further increases for renewable fuels.

Last year, over 200 bio-refineries in 28 states produced a record 15.25 billion gallons of ethanol for use in gasoline, along with roughly 42 million metric tons of high-protein animal feed. Low oil prices sparked record gasoline consumption, leading to unparalleled ethanol use in E10 blends (10% ethanol, 90% gasoline). But higher blends of ethanol also experienced growth, as hundreds of retail stations installed the infrastructure to offer E15 and E85. Like it or not, E15 is coming. And if you don't like what E10 has done to the fuel system and/or engine in your classic or vintage car, just wait until you see what E15 does… It's not good.

E15 is now available at nearly 400 gas stations across 28 states. Manufacturers of more than 80% of model year 2017 vehicles list E15 as an approved fuel, including Hyundai and Kia for the first time. They join Fiat-Chrysler, Ford, General Motors, Honda, Toyota, and Volkswagen as major automakers that explicitly approve the use of E15. Meanwhile, the EPA's fuel waiver allowing the use of E15 in all vehicles built in 2001 or later means approximately 90% of the vehicles on the road today are legally approved to use E15 fuel blends. Not surprisingly, the EPA did not comment in much detail regarding vehicles built prior to 2001, which are not properly designed, built, or equipped for running fuel enriched with ethanol content.

With an octane rating of 113, ethanol offers the most "bang for the buck" for refiners to (inexpensively) boost octane in modern fuel blends. In the past, they relied almost exclusively on petroleum hydrocarbon for octane boost. But that approach is far more expensive and energy-intensive than the lower-cost alternative of ethanol enrichment. Thus, as ethanol availability has grown, refiners have reduced costs by replacing hydrocarbon octane production with lower-cost ethanol – as is clearly illustrated on the graph at the top of the next page. Most refiners today produce gasoline blend stock with an octane rating of 83 or 84, then add 10% ethanol to boost octane to 87 – the minimum allowed in most states. Boosting octane with ethanol instead of hydrocarbon reduces costs, reduces energy use, and reduces emissions at the refinery.



There is already talk of refiners offering a high-octane, mid-level ethanol blend in the range of E20 to E40. They are "advertising" the fact that it could deliver the same—or better—fuel economy as regular gasoline when paired with an optimized engine, with less energy expended per mile and fewer emissions. OEM's are listening, and some are already in process of testing new experimental engines using fuel blends consisting of 20% to 40% enriched ethanol.

In May 2016, the EPA proposed a 2017 conventional renewable fuel blending requirement of 14.8 billion gallons—just shy of the 15-billion-gallon volume established by Congress. However, the EPA listened to the many farmers, ethanol industry employees, and lobbyists who "encouraged" the Agency to follow the law in setting the final 2017 volumes.

As a result, not only did EPA's 2017 final rule include a 15-billion-gallon requirement for conventional renewable fuel, but it also increased blending obligations for advanced biofuels. Overall, the total renewable fuel volume required is set to grow by 1.2 billion gallons from 2016 to 2017, a 6 percent increase. In the end, the final rule for 2017 RFS blending requirements marked a major win for the biofuel and agriculture sectors, and firmly established the fact that higher ethanol-content fuel is not only here to stay, but will continue to increase.

What's wrong with ethanol? Well for one thing, it contains less energy than gasoline – so its use in fuel actually DECREASES fuel economy in engines not designed specifically for its use. But that's the least of our worries…

Ethanol in gasoline readily and continuously absorbs water from humidity in the air. When gasoline reaches saturation point, "phase separation" occurs, in which water separates to form a heavy layer that sinks to the bottom of the fuel tank and causes corrosion. Passing water-soaked gasoline through an engine and fuel system causes corrosion of all metals. Gasoline with high ethanol content is also chemically unstable, and oxidizes to form gums, varnishes, and other non-combustible byproducts. Running oxidized fuel damages your vehicle's fuel system components, and causes deposit build-up inside the engine. Gums and varnishes also clog fuel system components, which disrupts proper fuel delivery and results in hard starts and poor running engines.

No-Rosion Fuel System Combustion Optimizer stabilizes gasoline, and protects against ethanol's harmful effects. It passes the ASTM D525 Oxidation Stability of Gasoline test by a greater margin than any commercially available fuel additive, and contains corrosion inhibitors that achieve an "A" rating in the NACE TM0172 corrosion test.

C B+ A

In the NACE TM0172 test, a steel test pin is immersed in a mixture of gasoline and distilled water for 3.5 hours, after which the test pin is dried and analyzed for corrosion deposits. Our test results revealed that the pin exposed to untreated E10 fuel achieved a score of "C," which represents a fail. We then tested E10 fuel treated with a leading competitor fuel additive that is advertised for fuel stabilization performance. It achieved a score of "B+", which is good enough to pass, but not good enough to entirely prevent issues. Lastly, we tested E10 fuel treated with our No-Rosion Fuel System Combustion Optimizer. It achieved a score of "A," which represents the highest achievable score in this test – essentially, zero corrosion.

No-Rosion Fuel System Combustion Optimizer also contains an industrial-grade demulsifier, which decelerates and largely prevents water absorption in fuel. It actively sheds water, and prevents emulsion. Without an emulsion, gasoline never reaches saturation point, and phase separation will not occur. This provides additional protection against corrosion and damage related to water absorption.

No-Rosion also contains a powerful, proprietary PEA (polyether amine) detergent that removes gums and deposits from engines, and prevents new ones from forming. There's a difference between our detergent, and those found in other products. Ours completely solubilizes deposits. This allows them to be dissolved, and safely burned during combustion. Facilitation of deposit removal with many other products results in chunks breaking off, that can lodge in exhaust valve seats, catalyst elements, and other areas inside engines to cause damage.

When using No-Rosion Fuel System Combustion Optimizer in gasoline that contains ethanol, for absolute best results we recommend adding a bottle in the fall before winter storage, and then another bottle in the spring after winter storage. This all but guarantees easy starts, smooth running, and no damage to your fuel system.

Before we wrap things up, we'd like to address the issue of our shipping charges. We've received complaints that our shipping charges are too high—especially for single bottle orders. Please note, due to the commercial-grade strength of our formulations, by law, our products must be shipped under the designation of "**ORM-D,**" or "Other Regulated Materials for Domestic transport only." Packages shipped **ORM-D** are defined as containing hazardous material in a "limited quantity," and are therefore subject to higher shipping and insurance charges.

We acknowledge that our shipping charges are high. But, there's only one way we could solve this issue. We would have to dilute the concentrations, thus allowing us to ship without the **ORM-D** designation. Even though this would greatly reduce shipping costs, it would also greatly reduce the performance and effectiveness of our products – meaning, you'd be buying basically the same formulas that you can already find on the shelf at your local parts store. Producing "me-too" products goes against our core business precepts. So we'll keep producing the highest performing, commercial-grade products available. Please do accept our apologies for the shipping charges – but please also understand the reason why this is necessary.

We have increased shipping charges only three times in the last 20 years. Before the most recent increase, we absorbed four separate increases from UPS – to the point that we were actually LOSING money when we shipped some orders. It's in nobody's best interest for us to ship orders unprofitably, as that's unsustainable.

Fixed costs associated with shipping **ORM-D** means it costs almost as much to ship/insure a single bottle as it does for an entire 4-pack or 6-pack. So henceforth, we'll no longer ship single bottles. We can ship 4-packs and 6-packs for $16.00, and 12-pack cases for $24.00. By shipping in packs, per-bottle shipping costs are greatly reduced. Whereas it costs $12.00 to ship a single bottle, your per-bottle shipping cost is only 4.00/bottle for a 4-pack, $2.67/bottle for a 6-pack, and $2.00/bottle for a 12-pack case. Additional 4-packs or 6-packs can be added to your order for only $4.00 each – regardless of product type or pack size – so you can mix and match.

Thank you for being a customer. We appreciate your support, and look forward to continuing to be of service.

Sincerely,

Applied Chemical Specialties, Inc.