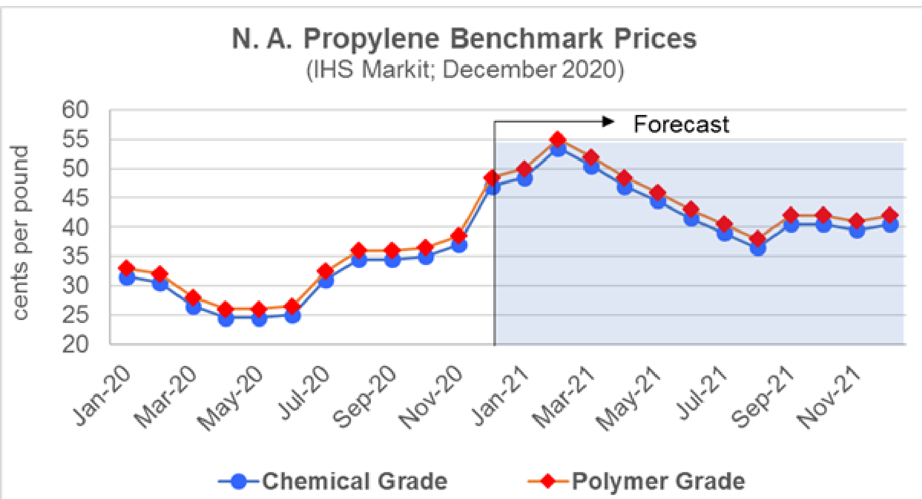
Spring 2021

Dear No-Rosion Customer,

We hope this finds you and your family well during these unusual and unprecedented times.

Over the last several months, we've seen dramatic changes in lead times, pricing, and availability for raw materials. As a result of the pandemic, demand for certain packaging raw materials has spiked. At the same time, disruptions from late-winter storms in Texas have put further kinks in supply. These dynamics have combined to create tremendous strains on external supply chains to keep pace and control costs. Certain of our suppliers have been hit harder than others. Plastic bottles, caps, and boxes have been particularly impacted, with average price increases of 5-10% across the board, and lead time extensions of 6-9 months!



In addition, spikes in demand (and pricing) for certain chemical raw materials continue to pervade the market. Since September, prices for surfactants and dispersants (used to blend No-Rosion and HyperKuhl) have risen ~18%. And since last June, pricing of dipropylene glycol (used to blend HyperKuhl Pre-Mix) has doubled, with continued increases still occurring in the first part of 2021, per this graph.

We are working proactively with suppliers to minimize disruptions due to lead time irregularities. And we are negotiating long-term price hedges as a means of achieving protection against additional short-term increases. Through it all, we've held your No-Rosion pricing steady, and continued shipping your orders on a timely basis.

In last fall's newsletter, we briefly reviewed the third component of our three-pronged approach to preventing engine damage and performance loss during hot summer operation: **No-Rosion Octane Booster**. As mentioned, it is blended with the premium organometallic ingredient *methylcyclopentadienyl manganese tricarbonyl*, or **MMT** for short. It's the closest thing to genuine *tetraethyl lead*, or TEL, legally allowed by the EPA. And it's the gold standard when it comes to boosting gasoline octane.

In this newsletter, we'll do a deeper dive into the chemistry that makes No-Rosion Octane Booster unique, especially as it relates to various other products in the marketplace that may (or may not) contain MMT.

Combustion of MMT in gasoline engines necessarily yields byproducts composed of various forms of manganese oxide salts, which appear as **reddish-brown** powder-like materials. If MMT octane booster is dosed too high, for too long, in a hot enough engine, these manganese oxide byproducts can deposit on spark plugs and, over time, cause fouling. When dosed properly, the detergent blended into No-Rosion Octane Booster's formula **prevents** manganese oxide deposits on spark plugs. But of course there will always be a few folks who prescribe to the theory: "If ***more*** is better, then ***too much*** is just right!" In these instances, overdoses may still occur.

It's admittedly easy to end up over the recommended dose if/when the fuel tank is not fully emptied before refilling and adding another bottle, as this can result in the multiplicative effect of "*dose creep*."

If this occurs, MMT produces enough manganese oxide combustion byproducts that detergent alone may be insufficient to prevent deposits on the plugs in some engines – especially race engines. The composition of said deposits is primarily Mn_3O_4, which is semi-adherent in nature. Some exits the engine through the exhaust, while the rest remains in the engine. If repeatedly and heavily overdosed, it will foul plugs, but potentially cause issues with some catalytic converters/O_2 sensors (if present) and accumulate inside the engine.

Keep in mind, manganese oxide deposits are inert. Meaning, the most harmful effect of deposition is premature fouling of spark plugs. But on vehicles with emissions equipment, reduced efficiency of catalytic converters/O_2 sensors is more problematic, as it may cause failure of a DMV emissions test.

We have performed in-depth research in this area, and identified the full range of chemical compositions of manganese oxide combustion byproducts. They include MnO, MnO_2, and Mn_3O_4, manganese phosphates and manganese sulfates. Each of these different salts has a different: (a) molecular weight, (b) particle size, and (c) adhesion quality.

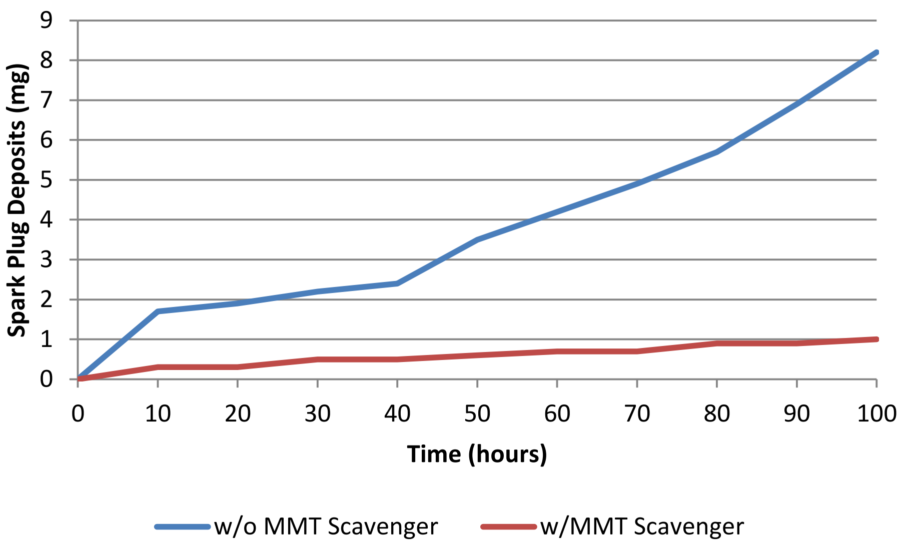
The **most adhesive** deposit-forming particles are typically larger than 0.5 µm in size, whereas the **less adhesive** particles (emitted from the tailpipe) fall within an approximate size range of 0.1 to 0.5 µm diameter. While Mn_3O_4 tends to be the primary constituent of larger, heavier molecular weight adhesive particles, the majority of smaller emitted particles (70% to 90%) consist of lighter molecular weight MnO, MnO_2, manganese phosphate, and manganese sulfate.

There is also a direct relationship between Mn_3O_4 adhesion rates and **temperature**. Deposits are less likely to form below 700°C, whereas deposition rates can increase by greater than 10x when temperatures increase from 705°C to 843°C. Because it is uncommon for temperatures over 700°C to occur in the engines of most street driven vehicles, this means the majority of applications where this becomes an issue are in racing engines and airplane engines. Not coincidentally, our work in those two areas was the impetus for this research.

With this learning in place, we went about formulating an MMT-specific **scavenger**. The result was a compound that is a proprietary alkyl halide chemistry developed in-house. The alkyl halide acts as a catalyst to convert Mn_3O_4 particles to a more crystalline structure. This reduces particle size by magnitude of 4 to 8, and increases reactive surface area. The more reactive crystalline Mn_3O_4 is then more easily bound by the polar head of the hydrophilic nitrogen-containing amine in the Polyether Amine (PEA) detergent blended into our No-Rosion Octane Booster. A dispersant is also blended into our formula, which aids in scavenging and carrying away the smaller particle size manganese oxide salt via combustion, and emitted from the tailpipe.

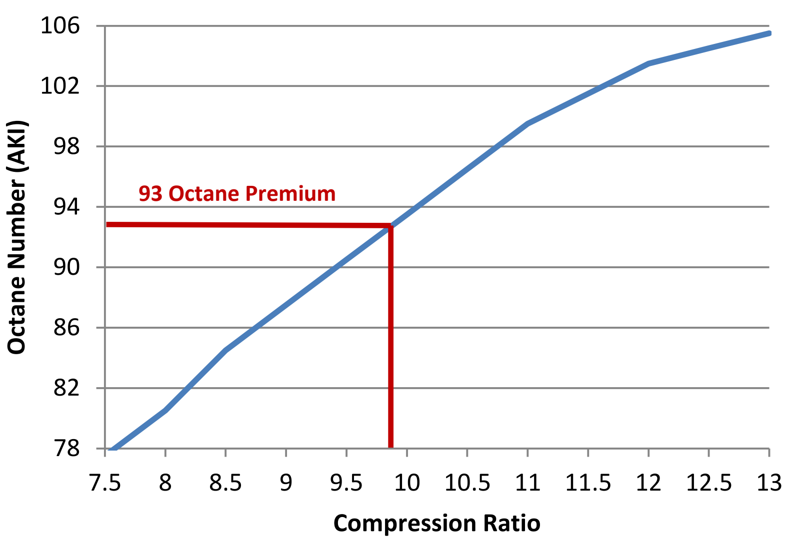
Detergent alone, without MMT scavenger

Detergent with MMT scavenger



Just how effective is our alkyl halide-catalyzed MMT scavenger + detergent? This graph shows test results of quantified spark plug deposits in two test engines, both running gasoline that was heavily dosed w/No-Rosion Octane Booster at 6 bottles per 20 gallons. As you will note, the one inclusive of our MMT scavenger saw average plug deposits of about 1.0 mg versus over 8.0 mg on plugs without the MMT scavenger.

Not only does this provide protection against overdose, it allows you to use the product at higher doses in order to achieve extra boost in higher compression engines – without concern of deposit buildup, fouling the plugs, or clogging catalysts. No other automotive MMT octane booster product contains this scavenger technology.



How much octane does your engine need in order to prevent detonation or preignition on even the hottest days? This graph shows octane requirement for different compression ratios, assuming a typical carbureted engine with cast iron cylinder heads. These "rule of thumb" values will vary based on fuel delivery type, cooling system efficiency, cylinder head metallurgy, air/fuel ratio (AFR), ignition timing, ambient air temperatures, combustion chamber shape, as well as various other factors including combustion chamber cleanliness.

By including MMT-scavenger + robust PEA detergent + dispersant in its formula, No-Rosion Octane Booster allows you to derive the full benefit of its metallic octane-boosting capabilities without the side effects of deposit buildup. This allows you to have your cake and eat it too, so to speak. The only other applications in which we've seen MMT-scavenger chemical technology applied are specialized racing and aviation fuels.

How much does No-Rosion boost octane when added to a typical 20 gallon fuel tank? One bottle boosts octane 1 number, two bottles boosts octane by 2 numbers, and four bottles boost octane by 4 numbers.

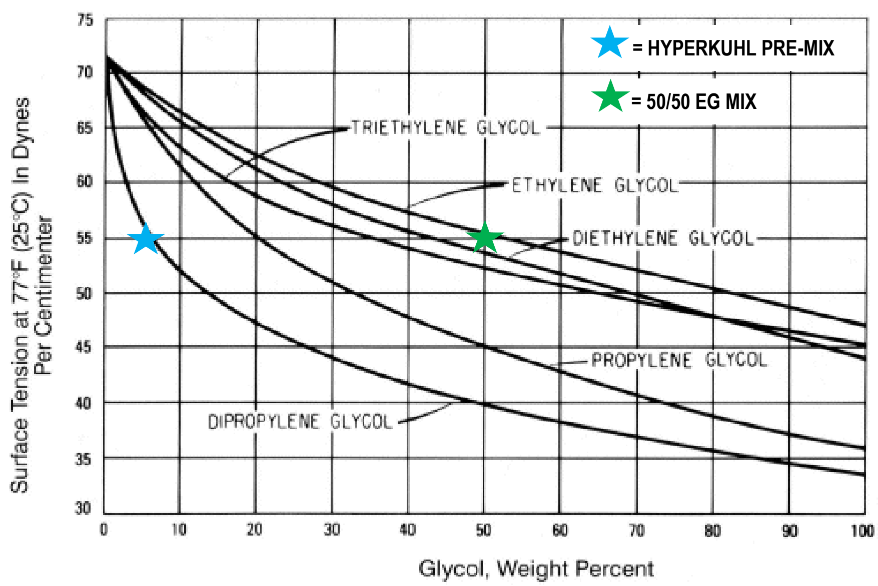
As mentioned above, **cooling system efficiency** plays a key role in an engine's octane requirement. Other than mechanical modifications/upgrades to your cooling system, the best, easiest, and most cost-effective way of reducing engine temperature is by increasing the engine coolant's ability to absorb and transfer heat.

Last summer we performed extensive R&D in different forms of racing to include IMSA, Formula 1, GT World Challenge, and NASCAR. The data collected was used as a means of optimizing the formula of our new **HyperKuhl High Performance Pre-Mix** engine coolant. The point being: HyperKuhl Pre-Mix is much more than just a simple mix of HyperKuhl SuperCoolant additive and RO water.

HyperKuhl Pre-Mix is actually a sophisticated, fully-formulated engine coolant that meets all the same ASTM D3306 specifications as OE engine coolant – except freeze protection. The biggest difference is its ability to reduce nucleate boiling at critical coolant-to-metal interfaces inside hot engine cylinder heads. This allows it to absorb more heat, and transfer it to the external environment via the radiator – resulting in cooler engines.

How much cooler? That depends of course on how much heat your engine generates, and how much heat your radiator is able to "drain." Using a Chevy LS1 dyno test engine with aluminum heads, high performance radiator, and high-flow water pump, switching from a standard 50/50 mix to HyperKuhl Pre-Mix engine coolant yielded a 57°F reduction in cylinder head temps, and a 17°F reduction in the stabilized coolant temperature.

Temp reduction is optimized by blending **dipropylene glycol** (DPG) into the Pre-Mix's formula. DPG provides synergistic surface tension reduction when combined with the high cloud point surfactants and wetting agents in HyperKuhl. For this reason, the new Pre-Mix contains 6% DPG, resulting in approximately 25% enhancement of surface tension reduction performance within engine cylinder heads, and translates to 5-10% improvement in heat transfer as compared to a simple mix of HyperKuhl SuperCoolant additive plus water.



As this graph shows, DPG at **6%** delivers the same surface tension reduction performance as does ethylene glycol (EG) at **50%**! But the important difference is that DPG at a low concentration of 6% has roughly the same viscosity as water. So, whereas DPG at 6% in HyperKuhl Premix has a viscosity of 0.20 cP, the viscosity for a standard mix of 50% EG engine coolant increases to 0.70 cP @200°F. Higher viscosity decreases coolant's velocity through radiator tubes, and therefore reduces heat transfer when a 50/50 mix is used.

HyperKuhl Premix, with only 6% DPG, has the same specific heat capacity as water, at 1.0 BTU/lb.°F @200°F – the highest of *any* fluid. Comparatively, 50/50 EG coolant has specific heat capacity of 0.85 BTU/lb.°F @200°F, or 15% less. This further reduces 50/50 coolant's ability to transfer heat from cylinder heads to the radiator. So with HyperKuhl Pre-Mix, you get the benefit of glycol's surface tension reduction, without glycol's undesirable side effects of viscosity increase and specific heat capacity reduction. Once again, have your cake and eat it too.

Because total DPG content is only 6%, the friction coefficient of HyperKuhl Pre-Mix remains the same as water. So if spills/leaks occur at the race track, it won't cause dangerous slippery conditions, as is the case with 50% EG.

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.

Sincerely,

Applied Chemical Specialties, Inc.