Fall 2020

Dear No-Rosion Customer,

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

Here in Omaha, we've wrapped up one of our hottest, driest summers on record. Suffice it to say, the engines of our cars feel the heat as well. With our older cars, they sometimes speak to us in language that none of us like to hear: pinging and knocking. In this newsletter, we'll have an in-depth look at the root causes of **preignition** and **detonation**, and discuss how both can be prevented and eliminated.

Audibly they are indistinguishably similar. But functionally they are different. Whereas "preignition" results from the spontaneous ignition of the air/fuel mixture *before* spark occurs, "detonation" is autoignition of gaseous combustion remnants *after* spark occurs.

While today's lower octane fuel certainly doesn't help, most instances of preignition/detonation result from buildup of deposits in the combustion chamber, referred to as **CCD's** (Combustion Chamber Deposits).

Technically defined, an engine's **Octane Requirement (OR)** is defined as the highest octane number gasoline that will provide a repeatable audible knock when tested by a trained rater using the Coordinating Research Council (CRC) Octane Requirement Test Procedure.

As miles accumulate, OR increases as a result of CCD formation. The mechanism by which CCD's increase OR is twofold: (1) deposits **reduce heat transfer** from the combustion chamber to coolant, so cylinder heads remain hotter, and (2) deposits **reduce combustion chamber volume**, thereby effectively increasing the mechanical compression ratio. Research shows that the first has a greater overall tendency to influence than the second.

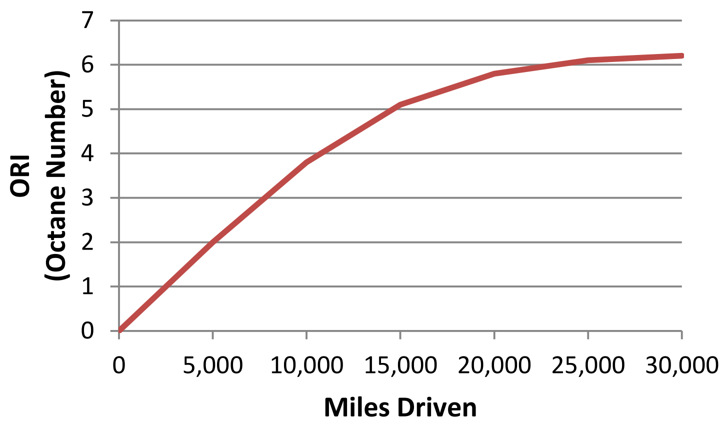
This results in what is referred to as **Octane Requirement Increase (ORI)**, causing localized hot spots within the combustion chamber and cylinder heads, resulting in engine knock.

Left unchecked, preignition and detonation can and will result in damaged pistons, rods, valves, melted spark plugs, and blown head gaskets, per the nightmare images below.





The CRC has performed extensive research into this matter. They evaluated ORI in brand new engines that were driven in 5,000 mile test intervals. Across a range of different engine types and fuel types, they observed ORI occurs at a predictable rate, per the graph at the top of the next page. The data in this graph represents **average** repeatable results across a wide range of engines (old and new) and fuel types.



The results show OR increases rapidly in the first 10k miles of driving, then begins to taper between 15k-20k miles. Total increase of 4-6 octane numbers is typical in first 20k miles. In most cases, it then remains fairly constant beginning at 20k-25k miles, assuming normal maintenance, and no fuel additives are used. After additional drive time, rings and valve guides begin to wear, allowing oil to blow by and enter the combustion chamber. Deposits build up again, resulting in further ORI. This second increase usually occurs after 80k-100k miles.

Consider the following scenario: Cast iron engine with cast iron heads, 10.5:1 compression ratio (CR), stock timing and cam, 70,000 miles with combustion chamber deposits. This engine has a baseline OR of about 94. Now add to that another 6 points due to ORI, and the engine will require **100 octane** fuel in order to prevent preignition/detonation.

Let's further assume you only have access to **92 octane** fuel at your local gas station. Adding a bottle of octane booster takes you to **95 octane**, meaning you're still 5 octane numbers short of the engine's OR. So unless you pull some timing from the engine, or keep your foot out of the throttle, you will experience pinging – especially on a hot day, and ESPECIALLY if you dare run the A/C on said hot day.

This explains how/why you may still experience pinging even after adding the proper dose of octane booster. The point being, there are clearly some scenarios where simply adding a bottle of octane booster to the tank remains insufficient to entirely resolve the issue without detuning the engine, making mechanical modifications, and/or modifying the way you drive (and enjoy) the car.

Damage from preignition/detonation is largely a non-issue in **modern** engines. Knock sensors detect pinging and the ECU (Engine Control Unit) instantaneously retards ignition timing and/or provides additional fuel to prevent detonation and, to a lesser degree, pre-ignition. However, even though damage is prevented by the ECU, performance loss is **not**! When the ECU modifies timing and/or fuel curves to prevent pinging, there is a loss of power, performance, and fuel economy. Making matters worse, there is normally no way for you to know when this process occurs, because you won't hear the pinging, and no diagnostic trouble codes are set in the engine control computer memory. Meaning, there's **hidden performance** locked away in your engine.

As already mentioned, the difference between pre-ignition and detonation relates to what phase of the combustion cycle the pinging occurs. **Pre-ignition** occurs when carbon deposits in the combustion chamber remain hot enough to glow during the compression stroke, igniting the air-fuel mixture before the spark plug fires. **Detonation** occurs when the expanding flame front initiated by the spark plug compresses the air/fuel mixture in another part of the combustion chamber to the point where it self-combusts.

Prior to accumulation of deposits in the combustion chamber, an engine's baseline OR depends on a number of factors, including the compression ratio, cylinder bore size, cylinder head metallurgy, operating temperature, air inlet temperature, cooling system efficiency, and barometric pressure. Recognizing this fact, CRC's ORI test procedure specifies a controlled temperature and humidity for testing, thereby effectively removing these elements from the equation.

But of course driving our cars in the real world is anything BUT "*controlled*." Varying conditions have a very real impact on an engine's tendency to preignite/detonate. For example, both are less likely to occur with the oxygen-rich cool air of **mornings**, compared to the thinner hot air of **afternoons** – when you probably also have the A/C on and the cooling system is stretched to the limit!

Combustion chamber deposits have a number of negative effects on engine operation and performance. Fuel type, fuel additives, fuel to air mixture ratio, lubricant, coolant temperature, engine design, operation duration, operation frequency, and ratio of acceleration-to-cruising all contribute to the quantity, rate of formation, and composition of combustion chamber deposits.

Recognizing all these factors, how can you level the playing field, and prevent damage and/or performance loss as a result of preignition/detonation in old cars, as well as new ones?

1) Prevent / remove CCD's and stabilize fuel, with: **No-Rosion Combustion Optimizer**.
2) Reduce temps by enhancing heat transfer, with: **HyperKuhl SuperCoolant**.
3) Increase the octane number of pump fuel, with: **No-Rosion Octane Booster**.

As discussed in previous newsletters, **No-Rosion Fuel System Combustion Optimizer** contains a robust PEA (Polyether Amine) detergent that fully solubilizes CCD's, allowing the byproducts to be burned off during combustion. In developing this detergent, we conducted research into the chemical composition of CCD's, and devised detergent chemistry specific to these materials.

CCD's consist of both **organic** carbonaceous and **inorganic** chemical components. They form from the combustion of fuel, as well as from lubricants that enter the combustion chamber. The heavy ends of gasoline molecules, such as polycyclic aromatics, do not combust easily. This results in partial-combustion that forms **organic** carbonaceous deposits. They are also chemically unstable, breaking down to form gums that act as deposit precursors. **Inorganic** chemical components originate from either contaminants in fuel, or from anti-wear additives that are formulated in engine oil.

CCD's trigger a **chain reaction of damaging issues.** Extra heat from the insulating effect of deposits, plus increased mechanical compression ratio due to smaller volume of combustion chamber, combine to cause increased NOx emissions and plug fouling/misfire. When CCD's glow incandescent, they act as the ignition source for preignition/detonation. Accumulated partially-burnt hydrocarbons find their way into engine oil and form sludge in the crankcase and elsewhere. Valve overlap and exhaust gas recirculation (EGR) in some engines cause partially burned hydrocarbons to form piston crown deposits. In engines with small squish clearances, the deposits can cause interference, whereby physical contact occurs between piston top deposits and cylinder head. This causes loud metallic banging noise. Piston crown deposits can flake off and interfere with proper valve seating, resulting in reduced compression pressures… These are just a few examples.

Preventing combustion chamber deposits is important. But so is reducing engine operating temperatures.

We tested our **NEW HyperKuhl SuperCoolant Pre-Mix** on a dyno using a Chevy LS engine. The test compared cylinder head temps using HyperKuhl to temps using a standard 50/50 antifreeze mix. An infrared thermometer with dual-laser targeting was used for measuring metal surface temps at 10 different locations of engine cylinder heads after running at 5,000 rpm for a period of 20 minutes, to achieve full operating temperature.

Location	50/50 Mix (°F)	HyperKuhl (°F)	Reduction (°F)
1	854	790	64
2	856	792	64
3	847	794	53
4	848	793	55
5	845	790	55
6	844	789	55
7	845	788	57
8	847	794	53
9	853	795	58
10	849	797	52
Average	**849**	**792**	**57**

Yes, you read that correctly – we have a new product!

We now offer **HyperKuhl SuperCoolant** in a convenient **Pre-Mix** form. It contains HyperKuhl blended with ultra-pure Reverse Osmosis (RO) water at the exact correct dose. As compared to Distilled or De-Ionized (DI) water, Reverse Osmosis water is more electrochemically stable, and therefore does not have the risk of leaching electrons from sensitive alloys as a means of establishing electrochemical balance. HyperKuhl Pre-Mix is packaged in a 5-gallon oblong pail with built-in handle and large-mouth opening, making it easy to pour. Five gallons is enough to fill most cooling systems. No mixing. No dose calculating. Just pour it in. It's easy.

The dyno test proved HyperKuhl Pre-Mix reduces engine cylinder head temps by an average 57°F as compared to coolant consisting of a standard 50/50 mix. As a 100% water-based formula, it contains ZERO glycol. For this reason, it has a thermal conductivity of 0.39 BTU (ft)/hr (ft^2) @ 200°F, versus 0.25 BTU for a 50/50 mix. And its viscosity is 3-6x lower than a 50/50 mix, allowing optimal coolant flow through radiator tubes, where heat is drained via radiator fins. **Meaning, it transfers 55% more heat based simply on its superior physical properties!**

But the more significant engine temperature reduction comes as a result of high cloud-point surfactants in HyperKuhl's formula. Surfactants, also known as "***wetting agents***," reduce nucleate boiling of engine coolant at critical liquid-to-metal interfaces in the cylinder heads. Better contact with the metal heat source allows coolant to absorb more heat, and transfer this additional heat to external environment via the radiator. The net is cooler cylinder heads, and an overall reduction in stabilized coolant temps. In the context of the aforementioned dyno test, the 57°F reduction in cylinder head temps yielded a stabilized coolant temperature reduction of 17 °F.

Importantly, HyperKuhl Pre-Mix contains corrosion inhibitors sufficient to pass the all-important **ASTM D3306** specification that all OEM's require. This means that it provides the same level of corrosion protection as a standard 50/50 fully-formulated engine coolant – but without the undesirable physical properties of glycol.

Population increases and changing global conditions have resulted in higher-than-ever levels of contaminants in municipal and well water. **Chloride** is the often the most damaging, and is especially high in coastal areas where desalination plants are used. Well water is often high in **iron**, **sulfur**, and **chlorides** – each presenting its own set of damaging issues if/when mixed with, or used as, engine coolant. In its new Pre-Mix form, HyperKuhl SuperCoolant makes all these worries go away.

And finally, the third component of our three-pronged approach to preventing engine damage and/or loss of performance during hot summer operation: **No-Rosion Octane Booster**. It is blended with the organometallic ingredient methylcyclopentadienyl manganese tricarbonyl, or MMT for short. It's the closest thing to tetraethyl lead that you can legally buy, and is the gold standard in boosting octane – without harming catalysts.

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.

In this, our 25th year of operation, we thank you very much for your support. And we look forward to continuing to be of service to you and your cars.

Sincerely,

Applied Chemical Specialties, Inc.