Fall 2018

Dear No-Rosion Customer,

Hopefully your summer was filled with trouble-free driving and enjoyment of your cars…

We often receive inquiries regarding the supposed benefits of running **"waterless" engine coolant.** Because there seems to be some confusion in this area, we've decided to dedicate this newsletter to that topic.

As the name indicates, "*waterless*" engine coolant consists of 100% glycol, without any water. It is formulated with ethylene glycol or propylene glycol, and marketed as a "*lifetime coolant*," thus never requiring draining, flushing, or refilling. Additional marketing claims include the prevention of boil-over, reduced corrosion, improved engine performance, and less wear on components as a result of running at zero pressure.

Before we dive into the details, a quick review of the physical properties of the subject coolants may prove helpful. In the table below, we see some key properties of waterless coolant, a 50/50 mix, and straight water.

Property	**Waterless Coolant***	**50/50 Mix***	**Straight Water**
Viscosity (cP, @77^{o}F)	17.5	2.90	0.90
Viscosity (cP, @200^{o}F)	2.40	0.70	0.20
Thermal Conductivity (BTU (ft)/hr (ft^{2}) @ 77^{o}F)	0.16	0.24	0.35
Thermal Conductivity (BTU (ft)/hr (ft^{2}) @ 200^{o}F)	0.14	0.25	0.39
Specific Heat Capacity (BTU/lb.^{o}F @77^{o} F)	0.58	0.81	1.0
Specific Heat Capacity (BTU/lb.^{o}F @200^{o} F)	0.66	0.85	1.0
Boiling Point (^{o}F @ 0 PSI)	> 375	225	212
Boiling Point (^{o}F @ 15 PSI)	> 375	265	250
Freeze Point (^{o}F)	- 4	- 34	32
Flash Point (^{o}F)	260	N.A.	N.A.
Friction Coefficient	0.16	0.30	0.65
Surface Tension (dynes/cm @77^{o} F)	48.0	55.9	71.8 50.5** 37.2***

* Typical values; may vary based upon specific products or formulations
** Straight water with proper dose of No-Rosion Corrosion Inhibitor
*** Straight water with proper dose of HyperKuhl Super Coolant

As you'll note, certain properties above are listed at 200^{o}F and 15 PSI, which represents the temperature and pressure at which most automotive cooling systems run.

First let's consider **Specific Heat Capacity**. It is defined as the amount of heat required to change a unit mass of a substance by one degree in temperature. Think of it as the capacity of a substance to hold or carry heat. Water has a Specific Heat Capacity of 1.00. It transfers heat more effectively than any other fluid, and thus is used as the benchmark reference point for all scientific testing of heat transfer. With a Specific Heat Capacity of 0.58-0.66, waterless coolant has roughly half the heat capacity of water.

Similarly, **Thermal Conductivity** quantifies heat transfer, with the main difference being that it includes a time unit that quantifies net transfer of heat over a specified period of time. Likewise, we see that waterless coolant has roughly half the Thermal Conductivity of straight water.

Next, let's consider **Viscosity**. Waterless engine coolant has a viscosity almost 10 times higher than water, and almost 3-6 times higher than a 50/50 mix (depending on temp). This extra Viscosity creates drag (and possibly additional wear) on water pumps, since modern OE pumps are designed for the viscosity of a 50/50 mix. (Vehicles built before the 1950's used alcohol as antifreeze, and thus had pumps designed for the viscosity of water.) In our research, we have observed a 20-25% reduction in coolant flow through radiator tubes when waterless coolant was used with OE pumps. As coolant flow rates through radiator tubes drop, the ability of coolant to transfer heat via the radiator has a corresponding drop as well, per the equation:

$$Q = M \times Cp \times \Delta T$$

Where:
Q is the heat load
M is the mass flow rate of coolant
Cp is the specific heat capacity of coolant
ΔT is the change in temperature of coolant in the radiator

So as coolant flow rate drops, temperatures will necessarily increase. Depending on system configuration, design, radiator tube diameter, etc., reduced coolant flow may also hold some especially troubling repercussions for the rear cylinders of some engines that already have flow rates lower than other parts of the system.

A cooling system exists to transfer heat. Water is the best, most efficient fluid conductor of heat. Admittedly, there are a few strikes against its use as engine coolant: (1) it lacks corrosion protection, (2) it has a high surface tension, (3) it lacks freeze protection, and (4) it has a low boiling point. Let's address each of these four issues.

1) Corrosion protection: Both No-Rosion and HyperKuhl provide 100% corrosion protection, sufficient to pass the all-important ASTM D3306 specification. This is the same spec that all OE antifreeze/coolants are required to pass. Comparatively, as noted in the sales literature of one waterless coolant: "*Performance specifications and test methods for waterless coolants used in light and heavy duty vehicle applications are under development within ASTM D15*." What this means is that the ASTM has yet to actually define a specific test methodology or performance criteria for waterless coolants. In essence, waterless coolant hasn't passed ASTM tests, because no such tests yet exist! The fact that the ASTM D15 Engine Coolant Committee has yet to actually write a spec around the use of waterless coolant says quite a lot. Make of it what you will.

2) Surface tension: Both No-Rosion and HyperKuhl contain wetting agents that reduce coolant surface tension. This allows coolant to make better contact with metal surfaces in the engine, heads, and radiator, resulting in enhanced heat transfer. HyperKuhl contains multiple surfactants that perform across a broader, higher range of temps, whereas No-Rosion contains a single surfactant that performs in a somewhat narrower, lower range of temps. If engine temperature reduction is important for your application, HyperKuhl is the product of choice.

3) Freeze protection: Both No-Rosion and HyperKuhl are 100% water-based products. On one hand, this is good because they do not change the desirable properties of water. On the other, this also means that using either with water will not provide freeze protection. If you do require freeze protection during the winter, it is advised that you switch to a 50/50 mix before outside temps drop. Then, in the spring when it warms up, you can switch back to straight water coolant with No-Rosion/HyperKuhl. In this way, you'll have the best of both worlds.

4) Boiling point: In a standard pressurized cooling system, you will never need waterless coolant's boil-over protection of 375°F. Remember, as cooling system pressure increases, so does boiling point. Most automotive radiator caps are 13-16 psi. In this range, the boiling point of water is 250-260°F – high enough for all but racing and some towing applications. For racing, switch to a 20-35 psi radiator cap for further elevation of boiling point.

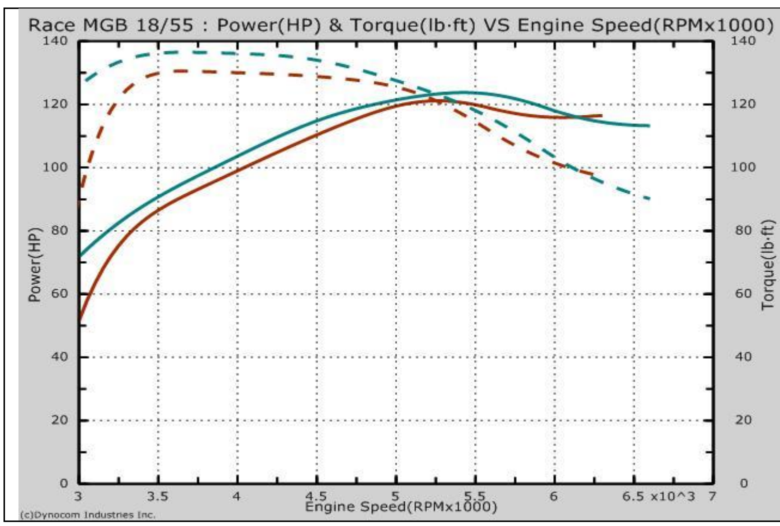
Regarding racing applications, **Flash Point** is an important factor to consider as well. Waterless coolant has a Flash Point of 260 °F, so it could flash and cause a fire if leaked onto a hot engine component. Comparatively, there are no conditions or circumstances under which water will flash, so water has no Flash Point.

Another important factor to consider for racing applications is **Friction Coefficient**. Assuming a baseline reference of 1.00 for dry pavement, the friction coefficient of water-on-pavement is roughly half that of dry pavement, whereas the friction co-efficient of waterless coolant-on-pavement is roughly 16% that of dry pavement. So it is significantly more slippery than water. This is a reason why many race tracks ban the use of any coolant that contains glycol, including waterless coolant. They require engines to run straight water.

Beyond the scientific data points, let's consider two real world "case studies" presented to us during the last year, from customers who tried waterless engine coolant, and wanted to share with us their experiences.

The first is from Mr. Peter Burgess, an engineer who runs a performance engine shop in Alfreton, England:

I have been producing championship winning heads and engines for MGBs since 1987, and I have written two softback books: one on how to modify cylinder heads, and the other on how to build MGB engines. The first two times we tried running waterless engine coolant in MGB race engines, we had problems both times. The first time, we had a problem with pinging, and the horsepower was short of what we had 'hoped' for when we set it on the rolling road. On track, the engine ran hotter and hotter until it nipped up the rear piston, which runs hottest due to coolant flow (specifically, lack thereof). Being the person I am, I just thought I must have done something wrong, tighter than I thought on the bore or a little too advanced on the timing. A new rear piston was installed, as were rings for the others, a quick glaze bust, and off we went again. The same problem happened with pinging on rolling road. (I run my own rollers, so no one else to blame). On track the same nipping up of number 4 recurred, with reports the heat slowly increased. While we had the engine in the shop again for another new piston, the customer fitted an old engine he had from another builder and lower performance specification. We set this up showing 20 horsepower less at the wheels than our race engine, and all seemed ok. And yet again, the same problem on track, and piston nipped in a well-used engine! My customer, a qualified engineer, then added two and two together. Realizing it isn't the engine we supplied at fault, he thought about the boundaries of his system, like any good engineer should. The only thing that changed in the 10 years or so that we have worked together and built his engine with no failures was the addition of waterless engine coolant. So we ran the race engine we had just rebuilt with water only in the system. A total difference! We found a four horsepower gain, as this must be the amount of power lost to pump the thicker, more viscous waterless coolant through the cooling system. We also found far more low rpm and mid range power as we were not having to retard so much to stop pinging which lost low and mid-range power. The graph below clearly shows the best we were able to achieve with water was much better than the waterless coolant. (Blue line is water)



Since making this discovery, we have answered many queries regarding overheating issues related to removing waterless coolant and going back to straight water. This started as a trend with the likely candidates such as MGAs and Healey 100/4s which have a history of running on the warm side, followed by Jaguars and TR4s and MGBs and MG Midgets – all showing improvement when water was put back into the system. Sadly, before switching to straight water, a fair few people have had engine and cylinder head component failures which are caused by overheating.

As a result, I now make the following recommendations to all our customers and racers: "Waterless Coolant: In our experience, using coolants other than water with corrosion inhibitor will cause the engine to run too hot, and result in problems such as sticking valves, pinging, and piston damage. We offer no warranty on our engines and heads if waterless coolants are used. Water is the best liquid for transferring heat."

To Peter's point, **ORI (Octane Requirement Increase)** results when engine cylinder heads run at elevated temps as a result of engine coolant removing insufficient quantities of heat. Unless timing is dialed out of the ignition curve, and/or gasoline of higher octane is used, detonation can damage pistons and valves. In our testing, we have seen temps reduced by over 150^{o}F at the cylinder heads after converting from waterless coolant to HyperKuhl with straight water, for example.

In one such test, we converted a Chevrolet LS-1 engine from waterless coolant to straight water with HyperKuhl. This resulted in a decrease of 118^{o}F at the cylinder heads, and a stabilized bulk coolant temp reduction (at the gauge) of 34^{o}F. In this scenario, prior to removal of the waterless coolant, a number of heat-related performance setbacks were observed: (1) octane requirement had been elevated by 5 numbers, (2) the computerized ignition system retarded timing by 8-10^{o} to avoid trace knock, and (3) horsepower was correspondingly reduced by 4-5%, as confirmed on a chassis dyno.

The second is from Mr. Harold Henderson, a muscle car enthusiast with a pristine 1962 Chevy 409 Impala show car. After a complete engine rebuild, to include aluminum heads, water pump & radiator, Harold had this to say:

I would like to share my experience with waterless engine coolant, in the hopes that you can advise others and help them prevent making the same mistake I made. I used waterless coolant in my completely rebuilt 409 Chevy engine. After reading about this supposed "high performance coolant" that doesn't require a pressurized system and has a nice high boiling point, I was sold and decided to give it a try. What I actually discovered is that my engine temp rose very quickly above 180 degrees. This caused the electric fan to kick on, after which the temp continued to rise above 200 degrees after driving it only a couple of miles. I stopped, checked the timing and engine functions, made sure the cooling system was completely full and devoid of any air pockets, and then drove another ten miles. The engine temp then rose above 220 degrees – entirely unacceptable! After making some adjustments with timing & fuel mixture, and seeing no appreciable difference, I changed the coolant to a conventional 50/50 mix. The temps immediately dropped to 200 degrees – but still the fan was running all the time. That's when I contacted Applied Chemical and asked you for information, and your advice. Per your directive, I completely drained and flushed the system, including the block and heater core. I blew the system out with air, then refilled with purified drinking water and a full dose of HyperKuhl Super Coolant. This time, NO ANTIFREEZE. The engine now runs at a steady, reliable 180 degrees, with the fan cycling on & off as it should! Thanks for SAVING my $15,000 Engine! I'll keep you posted.

Waterless engine coolant isn't inexpensive. At $50/gallon, it costs roughly $200 to fill an average 16 quart cooling system. This doesn't include the cost of the conversion fluid ($30/gallon), which is necessary to completely evacuate the system of any remaining water residuals. Comparatively, purified drinking water can be had for about $1.59/gallon at your local supermarket. Add to that another $10-$12 for a bottle of No-Rosion or HyperKuhl, and your engine will run cooler, at a fraction of the cost.

You have many choices when it comes to engine coolant. It is our hope that the information contained herein will help you to make the best choice for the long-term well-being and enjoyment of your cars. Please find the enclosed order form that you can use to place your next order. Or, for quicker service, visit our web site and place your order online at: www.NoRosion.com.

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

Sincerely,

Applied Chemical Specialties, Inc.