Spring 2023

Dear No-Rosion Customer,

In previous newsletters, we've referenced the all-important **ASTM D3306** engine coolant specification to which OEM's adhere. The **"Standard Specification for Engine Coolant for Automobile and Light-Duty Service"** establishes requirements for base engine coolants used in automobiles or other light duty service cooling systems to effectively protect against freezing, boiling, and corrosion.

In this newsletter, we'll do a deep-dive into the ASTM D3306 engine coolant spec – what it encompasses, what performance levels are necessary to achieve a pass, and how/why each aspect is important.

As neither **No-Rosion** nor **HyperKuhl** are designed to protect against freezing or boiling, we'll focus primarily on the corrosion protection performance aspects.

With the exception of certain branded performance coolant additives that we manufacture under private label for customers in the automotive aftermarket, **No-Rosion and HyperKuhl are the only ones that pass ASTM D3306 as stand-alone additives.** At your request, any manufacturer of engine coolant, antifreeze, or coolant additive should be able to provide you with the following data for their products:

D3306: Physical & Chemical Tests **Test Number & Description**	**Passing Result** **per D3306 spec**	**No-Rosion** **@3.1% dose**	**HyperKuhl** **@4.2% dose**
D-5931 Specific Gravity	N.A.	1.1151	1.1172
D-1882 Auto Finish Effect	No Effect	No Effect	No Effect
D-1119 Ash Content	max 5.0%	0.3%	1.5%
D-1287 pH: 50% vol. in distilled water	7.5 to 11.0	10.70	8.28
D-5827 Chloride	max 25 ppm	1 ppm	1 ppm
D-1121 Reserve Alkalinity	N.A.	2.3 mL	3.8 mL
D-1881 Foaming Tendencies	max 150 mL volume	50 mL	120 mL
	max 5.0 secs break	2.6 seconds	3.0 seconds
D-4340 Corrosion of Cast Aluminum Alloys	max 1.00 mg wt loss	0.03 mg	0.06 mg
D-1384 Corrosion Test in Glassware			
Copper	max 10 mg wt loss	3 mg	1 mg
Solder	max 30 mg wt loss	1 mg	0 mg
Brass	max 10 mg wt loss	2 mg	1 mg
Steel	max 10 mg wt loss	1 mg	1 mg
Cast Iron	max 10 mg wt loss	1 mg	0 mg
Cast Aluminum	max 30 mg wt loss	2 mg	0 mg
D-2809 Cavitation Corrosion/Erosion of Aluminum Water Pump	min rating of 8 (scale of 1 to 10)	9	8
D-2570 Simulated Service			
Copper	max 10 mg wt loss	1 mg	2 mg
Solder	max 30 mg wt loss	0 mg	1 mg
Brass	max 10 mg wt loss	2 mg	2 mg
Steel	max 10 mg wt loss	0 mg	0 mg
Cast Iron	max 10 mg wt loss	0 mg	0 mg
Cast Aluminum	max 30 mg wt loss	-1 mg	0 mg

Reviewing each of these tests one by one, **"Specific Gravity"** is simply a measure of product density. There is no spec for this, as indicated by N.A. **"Auto Finish Effect"** tests the product, at user dose, to determine if leaks, spills, or spray out of a radiator will etch into painted surfaces, causing damage to the finish. **"Ash Content"** is an easy way of quantifying a coolant's inhibitor content. If it's too high, it could result in a coolant causing, or exacerbating, scale/deposit formation on surfaces inside the cooling system.

"pH" of course measures coolant's acidity/alkalinity, which impacts corrosivity. **"Chloride"** tests the amount of chloride ion in coolant. It combines with water to form weak acids of hypochlorous/hydrochloric varieties, which are corrosive. In ion form, chloride is particularly small, and can pass into the molecular structure of metals and alloys. If concentrated too high, chloride in coolant can penetrate metal surfaces resulting in "*intergranular*" type corrosion. Left unchecked, it can become "*autocatalytic*," meaning it continues until the entire thickness of metal has been penetrated, resulting in pinhole leaks. It is not uncommon for municipal water sourced from desalination plants to contain too much chloride. So if you live in a coastal area, where tap water comes from desalinated ocean water, it's especially important you use **RO (Reverse Osmosis) water,** not tap water, in your cooling system. You'll find it in gallon jugs at your local supermarket labeled as "<u>Purified Drinking Water</u>."

"Reserve Alkalinity" quantifies a coolant's ability to self-buffer into safe pH ranges if/when ***acidic contaminants*** make their way into the cooling system. The most common sources of "*acidic contaminants*" are: (a) glycol in antifreeze chemically breaking down to form glycolic acid, and (b) acidic byproducts of combustion entering coolant through tiny in-leakages inside cylinder heads and/or head gaskets.

"Foaming Tendencies" evaluates foam produced by coolant – both the quantity, and stability. Foam is an enemy of liquid in a cooling system. It causes cavitation corrosion/erosion of impellors inside water pumps, reducing life span. It also reduces coolant flow as a result of impellor blades whipping against air instead of liquid. And it can form air bubbles/pockets inside a cooling system, which reduces critical heat transfer.

<u>In low-pressure or non-pressurized cooling systems, such as those in some antique vehicles, foam presents an even greater issue</u>. Depending on the configuration of the system, it can cause overflow, and therefore coolant losses. Not only does this require constant refilling, but it can result in a real mess. For example, if one used coolant that does NOT pass the Foaming Tendencies test, and does NOT pass the Auto Finish Effect, in a non-pressurized system in a classic antique automobile, the result could be ruined paint!

<u>Now to the most important tests of all, corrosion</u>. Each corrosion test evaluates coolant that has been blended with deliberately-corrosive water. Corrosive water is prepared in accordance with the ASTM D1176 procedure using sodium sulfate, sodium chloride, and sodium bicarbonate as the corrosivity agents.

"Corrosion of Cast Aluminum Alloys" measures a coolant's ability to combat corrosion of cast aluminum alloys under heat transfer conditions that are present in aluminum cylinder head engines. The test method involves establishing heat flux through a cast aluminum alloy puck, exposed to coolant mixed with corrosive water under a pressure of 28 psi. The temperature of the aluminum specimen is maintained at 275°F for one week, and corrosion is quantified in terms of weight loss.

"Corrosion Test in Glassware" evaluates the effects of engine coolant on different metal specimens under controlled, stagnant (zero flow) laboratory conditions. The test method involves immersing six different metal specimens in aerated coolant mixed with corrosive water, and maintained at 190°F for two weeks. Corrosion is quantified in terms of weight loss.

Similarly, **"Simulated Service"** evaluates the effects of engine coolant on different metal specimens. Except in this test, coolant flow is used to simulate actual in-service conditions. Six different metals are immersed in circulated coolant mixed with corrosive water, and maintained at 190°F for 44 days. A flow loop is established, consisting of a metal reservoir, a water pump and radiator, and connecting rubber hoses. Corrosion is quantified in terms of weight loss, as well as by visual examination of the specimen surfaces.

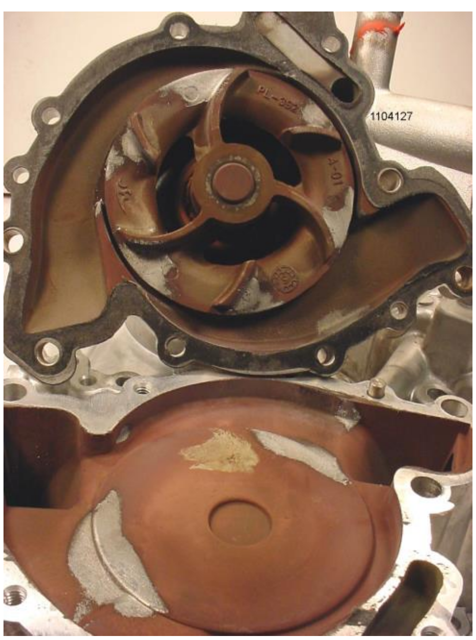
In Simulated Service testing, the aluminum specimen for No-Rosion yielded a slight negative weight loss. So in other words, a slight GAIN. Whereas, HyperKuhl yielded zero weight loss. **<u>This demonstrates the difference in mechanisms of corrosion protection between the two</u>.** No-Rosion utilizes IAT (Inorganic Acid Technology) inhibitors that accumulate on metal to form passive, protective surface films consisting of ingredients of the product itself. For this reason, we refer to its surfaces films as **"*exogenous*."** Comparatively, HyperKuhl utilizes OAT (Organic Acid Technology) inhibitors that stimulate the metal to form its own passive, protective surface film consisting of the oxide form of the metal itself. For this reason, we refer to its surface films as **"*endogenous*."**

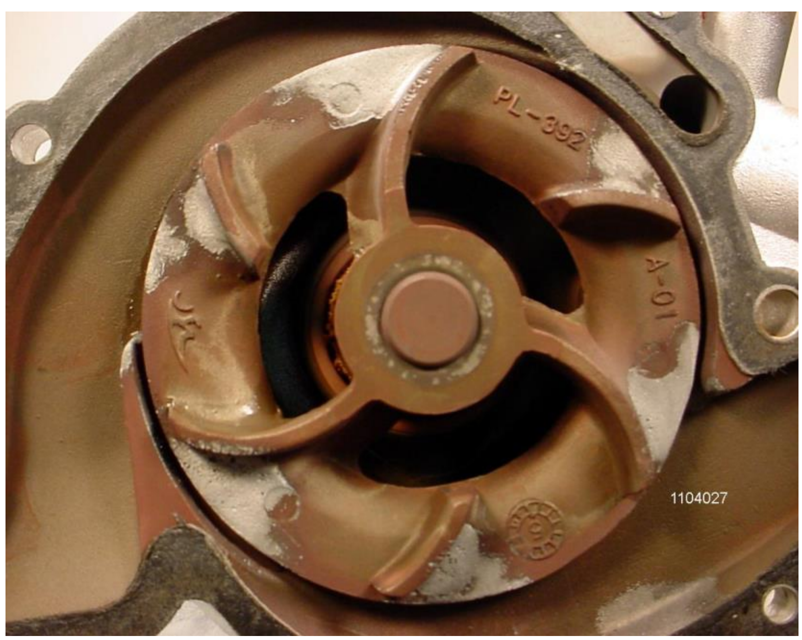
<u>Over the years, we've conducted numerous tests comparing differences between exogenous and endogenous surface films</u>. The biggest difference relates to depletion. Exogenous films slough-off with flow, and constantly replenish from inhibitors in coolant passing over them. Endogenous films, once formed, remain attached and only require inhibitors in coolant to promote their continued resiliency. For this reason, endogenous films tend not to deplete as rapidly, and therefore provide longer service intervals. <u>This is why we recommend No-Rosion be added every year, whereas HyperKuhl only needs to be added every other year</u>.

Lastly, the **"Cavitation Corrosion/Erosion of Aluminum Water Pump"** test evaluates a coolant's contribution to cavitation corrosion and erosion-corrosion of aluminum automotive water pumps. This test method involves pumping coolant mixed with corrosive water at 235 °F through a simulated automotive coolant system at 15 psi, using an aluminum water pump driven at 4600 rpm by an electric motor for four days. When complete, the pump's inner surfaces are examined to determine damage, which is rated using the following numeric system:

10 - No corrosion or erosion; no metal loss. No change from original casting configuration. Staining permitted.
9 - Minimal corrosion/erosion. Founding of sharp corners and/or light smoothing, or polishing of working surfaces.
8 - Light corrosion/erosion may be generalized on working surfaces. Dimensional change not to exceed 0.4 mm.
7 - Corrosion/erosion with dimensional change not to exceed 0.8 mm. Random pitting to 0.8 mm permitted.
6 - Corrosion/erosion with dimensional change not to exceed 0.8 mm. Depressions, grooves, clusters of pits, or scalloping, or both, within 0.8 mm dimensional change limit permitted.
5 - Corrosion/erosion with dimensional change not to exceed 1.6 mm. Localized areas of metal removal in high-impingement regions or random pits to 1.6 mm permitted.
4 - Corrosion/erosion with dimensional change not to exceed 1.6 mm. Small localized areas of metal removal in high-impingement regions, clusters of pits within 1.6 mm dimensional change. Random pits to 2.4 mm permitted.
3 - Corrosion/erosion. Dimensional change not to exceed 2.4 mm. Depressions, grooves, pit clusters and/or scalloping.
2 - Corrosion/erosion with any dimensional change over 2.4 mm, and short of pump case failure.
1 - Pump case leaking due to corrosion or erosion.

Here is what an "8" rating looks like:





Now that we've covered ASTM D3306 for No-Rosion and HyperKuhl in ADDITIVE forms, a quick word regarding HyperKuhl Pre-Mix in READY-TO-USE form. It is blended with ultra-pure (semiconductor grade) RO water, and packaged in 5-gallon pails. It functions the same as fully-formulated D-3306 compliant OEM engine coolant, but without freeze protection. It DOES have some additional ingredients NOT contained in HyperKuhl additive that provide a bit of boiling point elevation. And of course, switching to a higher pressure radiator cap is an easy way to further increase boilover temps regardless of which engine coolant is used, per below:

Radiator Cap Rating	**Standard 50/50 Antifreeze mix**	**No-Rosion/HyperKuhl added to RO Water**	**HyperKuhl Pre-mix**
0 psi	226°F	212°F	215°F
12 psi	259°F	242°F	248°F
16 psi	267°F	252°F	260°F
20 psi	275°F	260°F	272°F
24 psi	280°F	265°F	276°F

Neither No-Rosion nor HyperKuhl (in additive or pre-mix form) offer any freeze protection. So if you do wish to take advantage of the many benefits these products provide when used in straight-water during hot summer months, yet require freeze protection during the winter, here's what we advise. When fall arrives, drain the water/additive mix, and replace it with a standard 50/50 mix. As long as you keep the drained mixture in sealed bottles, and protect it from freeze/thaw, you can then re-use it when spring arrives and you no longer require freeze protection. Many of you have taken this approach over the years, and find it works quite well.

Wondering if a certain coolant additive will pass the ASTM D1881 Foaming Tendencies test? Do a shake test! Many are packaged in clear, long-neck bottles. Shake it vigorously for 5-10 seconds, then look at how much foam forms in the bottle neck – and how long it takes for the foam to dissipate. The longer it takes to dissipate, the more stable it is. And the more likely it is to foam when used in a cooling system.

An important note regarding our shipping charges. For 28 years, we've shipped by UPS or FedEX. But recently, runaway inflation has caused their rates to increase – exorbitantly! Worse, the algorithms they provide for calculating shipping charges are now often incorrect. Too many times this has caused us to under-charge, and over-pay, resulting in net losses. For example, we've charged customers $16 to ship orders that actually cost us $30 or more! In some instances, when shipping to rural areas, it cost over $100! This just doesn't work.

For this reaon, we've switched to Priority Mail with the US Postal Service (USPS). Their flat-rate eliminates the possibility of deviant/deleterious overcharges. On our order form, and on our web site, you'll see the new charges, which are: First 4-pack/6-pk ships for $20, additional 4-packs/6-packs ship for $10/each. If you prefer we ship by UPS/FedEX, please write this on your order form, or request it in the notes section of your online order. We will ship, and charge, accordingly.

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.