



ABOUT THIS WHITEPAPER

This whitepaper was developed to guide professionals through the formulation of corrosion inhibitor packages and their different uses in HD engines. In it, we will examine:

- THE CAUSES OF ENGINE CORROSION
- WHAT ARE CORROSION INHIBITOR PACKAGES?
- THE DIFFERENT CLASSIFICATIONS OF COOLANT
- HOW TO TEST YOUR CORROSION INHIBITORS

HD Expert provides a variety of coolant solutions for HD engines. Our team of expert engineers has developed an array of proprietary formulas specifically for HD applications. These precise formulas keep your engine cool and clean, so you can get the job done.

Intro to Corrosion Inhibitor Packages

Several different chemicals can be found in coolant, including dyes that visually demarcate different types (and brands) of coolant fluid and bittering agents that ward off accidental consumption. However, the most important component of a coolant is its corrosion inhibitor package.

Compared to the deionized water and glycol fluid that make up the majority of HD coolant, corrosion inhibitor packages might seem like an afterthought. But while these only comprise 3-8% of the total solution, corrosion inhibitor packages are the key ingredient that distinguishes different types of coolant from each other. Without this proprietary mix of compounds, not only would coolant be much less effective at maintaining your engine's health, but it would also be actively harmful towards it.

CORROSION IN HD ENGINES

As we mentioned, the three main ingredients of coolant are:

- DEIONIZED WATER
- GLYCOL
- CORROSION INHIBITORS (CI)

Deionized water and glycol may seem relatively harmless on their own. But when combined with heat while flowing through a cooling system, they form a potent mixture that can damage even the strongest engine components as the glycol degrades into acid over time.

Together, they enable ideal conditions for engine corrosion, such as rust, which can spread across wide surfaces or eat deep holes into metal. Their mix can also liberate particulates in the fluid that accumulate to clog vital ducts within the radiator, reducing its ability to remove heat and subsequently reducing engine performance – or in severe cases, even causing engine breakdown. Additionally, tiny bubbles may form as a result of aeration, causing pitting ("cavitation erosion") throughout the cooling system. Wet sleeve cylinder liners and water pumps are especially susceptible to pitting.

Faced with these threats to engine functionality, a coolant's ultimate performance and lifespan is directly related to the corrosion inhibitor package it contains. Corrosion inhibitors are designed to chemically bind to the metals of your cooling system; forming a protective layer several molecules thick on its surface. By providing valuable engine components with this protective layer, corrosion inhibitor packages extend the lifespan of the entire system.

USING COOLANT TO PREVENT CORROSION

There are many different coolants you can use to help fight corrosion, but all of them are broken down into three main applications/classifications based on the type of corrosion inhibitor package that they contain.

- ▶ **CONVENTIONAL COOLANT**
- ▶ **ORGANIC ADDITIVE TECHNOLOGY (OAT) COOLANT**
- ▶ **HYBRID COOLANT**

Let's break each of these classifications down in a little more detail.

I. CONVENTIONAL COOLANT

Also referred to as "traditional" coolant, feature corrosion inhibitors based on inorganic salts like borate, nitrate, and silicate. This particular corrosion inhibitor chemistry will protect coolant system metals such as copper, solder, brass, steel, cast iron, and aluminum against cavitation and corrosion. When used in the automotive sector, it is generally recommended for use in older model vehicles. Additionally, nitrite or nitrite/molybdate corrosion inhibitor components have been found to provide excellent wet sleeve liner cavitation protection when used in heavy-duty diesel applications.

For HD engines, traditional coolant can last:

- ▶ **UP TO 3,000 HOURS**
- ▶ **UP TO 300,000 KM (180,000 MILES)**

However, their corrosion inhibitors rapidly deplete in service, resulting in a limited lifespan to the coolant. When designed and used in heavy-duty diesel applications, traditional coolants require additional supplemental cooling additive scheduled service intervals to ensure satisfactory protection of their engine cooling system.

While these are no longer used as factory-fill in automobiles and light trucks, a limited number of HD diesel OEMs still factory-fill part of their product line with traditional coolants. When used for this application, these fluids are referred to as "fully formulated" coolant because they can still be used in automobiles, light, and HD diesel vehicles. Such fluid historically formed the majority of after-market coolant sales; however, they have recently been supplanted by newer coolant based on OAT or hybrid technology.

II. OAT COOLANT

OAT is an acronym for Organic Additive Technology, which describes the type of materials responsible for the corrosion protection it offers. OATs are Long Life Coolants (LLCs), based on minimally-depleting neutralized organic acids. This carboxylate technology provides superior protection to all components of the cooling system, including those made of materials like aluminum and light-weight steel alloys, which are commonly found in modern engines. Unlike traditional coolants, OAT coolants don't require regular additions of SCAs at scheduled service intervals, providing significant cost savings.

In a HD engine, HD Expert's Endurance coolant has a lifespan of:

- ▶ **UP TO EIGHT YEARS**
- ▶ **UP TO 1,600,000 KM (1,000,000 MILES)**

First generation OATs were specific to automotive applications. These were quickly followed by use in HD diesel applications, where the OAT was used (along with nitrite or nitrite and molybdate) to ensure adequate wet sleeve liner cavitation protection. In some heavy-duty diesel applications, you may see a reference to Coolant Extenders. These can be used with an OAT coolant to top-up certain additives after your coolant reaches its half-life, which is typically at around 480,000 km.

HD Expert's ProShield OAT inhibitors are known for their lower health and environmental toxicity compared to 2-ethylhexanoic acid (2-EHA) based coolants. As a result of work initiated by John Deere, there is now an industry specification for determining the liner cavitation properties of Engine Coolant. An ASTM Standard, D7583, is now available to validate the liner cavitation of any engine coolant – even those that do not contain nitrite or nitrite and molybdate. Recently, ASTM D15 modified ASTM D6210 to include this liner cavitation test. A review of ASTM D6210-10 will show that nitrite-free OAT engine coolants that pass ASTM D7583 are approved for use in HD diesel applications.

III. HYBRID COOLANT

Just like its name suggests, this coolant technology takes a "best of both worlds" approach by combining the benefits of traditional corrosion inhibitor technology with those of OAT corrosion inhibitor technology. Its inhibitors are based on a combination of inorganic salts (as found in traditional/conventional coolant) and some fully-neutralized organic acids (as found in OAT coolant)

As a result, hybrid technology provides HD engines with a lifespan of:

- ▶ **UP TO SIX YEARS**
- ▶ **UP TO 960,000 KM (600,000 MILES)**

This technology can have excellent coolant-to-coolant compatibility, making it suitable for top-up use with traditional or full OAT coolants. Additionally, it provides both excellent wet sleeve liner cavitation protection and high-temperature aluminum performance. Note that hybrid coolants are sometimes also referred to as "HOAT coolants." Their presence continues to expand in the North American engine coolant market, at both OEM factory-fill and the general engine coolant aftermarket.

CORROSION INHIBITOR TESTING

Even if you already know the general lifespan of your coolant, it is important to regularly check on the efficiency of its corrosion inhibitor package. If these important additives have prematurely depleted, you could be driving around and doing serious damage to your HD engine without even knowing it. Coolant can be more rapidly depleted by multiple factors, including:

- ▶ **BLOW-BY GASES**
- ▶ **IRREGULAR MAINTENANCE**
- ▶ **IMPROPER STORAGE**
- ▶ **ATYPICAL CONDITIONS**

Luckily, there are many affordable coolant test strips available on the market. Coolant test strips are small, chemically-treated pads attached to a plastic strip that allows you to immerse it in your engine's cooling system. The strips generally features a pH indicator, reserve alkalinity indicator, and a pad that will change color in response to the various concentrations in your antifreeze. Many strips also test for nitrite specifically. However, a coolant marked "nitrite-free" will not contain any to begin with. Follow instructions for each test to get as accurate a reading as possible without contaminating the coolant or injuring yourself – and always dispose of your coolant in accordance with local regulations.

CONCLUSION

Each of the coolant types we've mentioned fights corrosion in different ways, and is suitable for very different conditions. While all HD engines are similarly threatened by corrosion, be sure to choose your coolant solution carefully. What works for one vehicle may not work as well in another, which can lead to further engine corrosion. And even with the right coolant, faulty maintenance and irregular testing will eventually reduce its effectiveness.

Overall, the best practice is to always double-down on your research in advance. That way, you can select a coolant that matches both your resources and technical needs. This will ensure a successful, safe engine cooling system – as long as you test it regularly, so it stays that way.

HD Experts are the heavy-duty coolant professionals for all your most challenging coolant needs. Their sole focus is creating specialized coolant formulations for HD engines, resulting in superior protection, improved temperature control, and an extended service life. Discover what their solutions (including ProShield corrosion defence) can do for you today!