



**ISSUE 62 Nov/Dec/Jan 2008-2009**



# TECHNICAL TOPICS

## ANTIFREEZE FOR YOUR TRUCK by Robert Patton

In this issue we're going to cover another subject that causes confusion among the TDR faithful (although nowhere near the emotional reaction as our recent lube oil articles in Issues 54-58): the correct antifreeze for your truck. Issue 54's article by Andy Redmond gave you the Chrysler and ASTM specifications that you should use in your purchase decision. Yet, with the wide choice of products at the auto parts store, it puzzles the mind. How so?

In looking for a way to introduce the subject there were many titles that were considered: the straightforward, "Read Your Owner's Manual"; the condescending, "Your Perception is Reality"; the jovial, "Antifreeze and You"; the serious, "The Need for Coolant Additives"; the interactive, "A Coolant/Antifreeze Pop Quiz"; and the technical, "Specification Numbers and Antifreeze."

The decision—let's do, "13 Questions About Your Cooling System." The article covers more than just antifreeze, so read on.

**Q1** *I've often heard the term "cavitation erosion" in the same sentence as diesel engine. What is cavitation erosion?*

**A1** With a term like "cavitation erosion," you might think those affected would be found in the waiting room at your dentist's office. Not so. Cavitation erosion or liner pitting, if left unchecked, is a real issue with *some* diesel engines. Okay, I guess there is a parallel to your dental hygiene. A cavity is a cavity, and both types can drain money from your wallet.

To further clarify the issue, you may have noted that the cavitation erosion is an issue with *some* diesel engines. Which ones? All diesel engines with *wet* sleeves are subject to cavitation erosion or liner pitting if the cooling system is not properly maintained. The wet-sleeve design means the cylinder liner can be removed and replaced in the block. Although the cylinder liners are pressed into the block, wet cylinder liner design does not have the same structural rigidity as a cast block design. Under-concentration of coolant treatment additives will result in liner pitting and engine failure.

The Cummins B5.9 and 6.7 liter engines are a cast block design and do not have wet or removable sleeves.

To add further explanation to the liner pitting phenomenon, I'll quote from a Cummins Inc. Cooling System brochure. "Liner pitting is caused by vapor bubbles formed when the piston strikes the liner during engine operation. The energy generated during the combustion process and the side-to-side motion of the piston causes the liner to vibrate at a very high frequency. The liner moves away from the coolant fast enough to form vapor bubbles.

"The vapor bubbles collapse against the liner surface as the liner moves back into the coolant. The implosion of the vapor bubble against the liner surface produces a very high velocity jet of water. This water jet removes material from the liner surface. The jet of water acts on the liner surface with a pressure exceeding 15,000 psi. This process repeats again and again, resulting in liner pitting."

**Q2** *Is cavitation erosion or liner pitting a concern on my Turbo Diesel?*

**A2** No. Again, the Cummins B5.9 and 6.7 liter engines are a cast block design and liner pitting is not a concern.

**Q3** *How about my buddies with their Ford and GM diesels? Aren't both of those engines cast block designs?*

**A3** Yes, they are. My friends with the GM engine advise that their Owner's Manual does not mention the need to treat the cooling system with supplemental coolant additives (SCA). However, even though the Ford is a cast block design, the PowerStroke owners *must* use SCAs to prevent the cavitation erosion problem.

**Q4** *Okay, I understand that the Cummins B5.9 and 6.7 liter engines do not need supplemental coolant additives. But, I would like to learn more about SCAs so that I can inform some of my Ford friends. Tell me more about SCAs...*

**A4** How about an easy-to-understand analogy?

Do you wax your vehicles? Just like waxing is necessary for long lasting paint protection, SCAs form a protective coating on the engine's cylinder liners. Just like wax wears away, the SCAs have to be replenished in the engine's cooling system. There are easy-to-use test strips (remember high school chemistry?) that tell the owner how often/how much SCA to add to the cooling system.

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*No. Again, the Cummins B5.9 and 6.7 liter engines are a cast block design and liner pitting is not a concern.*

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**Q5** *In issue 54 TDR writer Andy Redmond gave us the specifications for coolant. Could you do a reprint?*

**A5** You bet. Here is the Issue 54, page 157, reprint:

**Coolant Data Chart For '89-'06 Trucks**

| Model Year  | Coolant type                        | Capacity   | Normal drain/refill                    | Specs   |
|-------------|-------------------------------------|--|--|---|
| 1989-1993   | Ethylene Glycol                     | 13-16.5 qts.<br>(Check your Owner's Manual.<br>The capacity varies by year<br>and transmission type) | Within 2-3 qts. of<br>system capacity. | (Dyed green)  |
| 1994-1998   | Ethylene Glycol                     | 6.5 gallons (26 qts.)  | 5-5.5 gallons                          | Low silicate antifreeze per<br>ASTM D-4985/GM6038m<br>ASTM D-3306<br>(Often dyed green)                                       |
| 1998.5-2002 | Ethylene Glycol                     | 6 gallons (24 qts.)  | 5-5.5 gallons                          | Low silicate antifreeze per<br>ASTM D-4985/GM 6038m<br>ASTM D-3306<br>(Often dyed green)                                      |
| 2003-2008*  | Ethylene Glycol<br>HOAT formulation | 7.3 gallons (29.5 qts.)  | 6.5 gallons                            | Mopar 5 year/100,000 mile life with<br>HOAT (Hybrid Organic Additive<br>Technology). MS-9769<br><br>(pink to orange in color) |

\*Some Turbo Diesels come from the factory with the green dyed ethylene glycol versus the orange "HOAT" coolant (2003-2005).

**Q6** Since 1989 the coolant type listed is ethylene glycol. How does ethylene glycol (EG) compare with propylene glycol (PG)?

**A6** Ethylene glycol and propylene glycol are clear liquids used in antifreeze and deicing solutions. Both are clear, colorless, slightly syrupy liquids at room temperature. Ethylene glycol is odorless, but has a sweet taste. Propylene glycol is practically odorless and tasteless.

Ethylene glycol is toxic. Eating or drinking ethylene glycol can result in death, while small amounts can result in nausea, convulsions, slurred speech, disorientation, and heart and kidney problems.

Ethylene glycol affects the body's chemistry by increasing the amount of acid, resulting in metabolic problems. Similar to ethylene glycol, propylene glycol increases the amount of acid in the body. However, larger amounts of propylene glycol are needed to cause this effect.<sup>1</sup>

**Q7** It seems that PG would be, literally, a safer product to use. Why is it not widely accepted?

**A7** Ethylene glycol (EG) has been in use since the 50s. The propylene glycol (PG) solutions were introduced in the early 70s. They were initially marketed as non-toxic. There was an industry uproar and court action forced the manufacturers of propylene-based antifreezes to relabel their products as low-toxicity.

In my discussions with Dave Embaugh at Valvoline/Zerex, I asked questions about these two glycol coolants. There is a 20-25% price premium for the propylene-based coolants. With the price premium for PG, it is a given that all new vehicles come from the factory with the less expensive ethylene glycol-based antifreeze. In the aftermarket, the EG fluids have a market share of 95%; the PG fluids have the remaining 5%. Embaugh notes that the two types of coolants should not be mixed. PG maker Sierra Antifreeze's web site recommends a cooling system flush before switching to their product.

**Q8** Okay, the Chrysler's recommendation up to year 2002 says ethylene glycol. Isn't that the traditional "green stuff" that has been around for years?

**A8** Yes, just be sure to use a low-silicate antifreeze per ASTM D-4985/GM6038M and ASTM D-3306.

**Q9** Why all of the fuss over low silicates?

**A9** The good old green stuff is known as inorganic additive technology (IAT). The IAT coolants have been around for generations. They contain silicates that form a protective barrier on everything in the cooling system, even rubber hoses.

Silicates plate-out quickly on metal engine parts; thus the silicates in a coolant solution can drop to less than 20 percent of the starting level in less than 10,000 miles. Another problem with silicates is that, under certain conditions, they can drop out of the solution and form minute deposits.

If this occurs between the shaft and seal of your water pump, the resulting abrasion will eventually cause a leak. In a cooling system that turns off coolant flow to the heater core when the heater is not in use, silicates can form a gummy deposit that, over the course of a summer season, might clog the core tubes.

So why even use silicates? Because they're really good at what they do, especially in iron block/aluminum head engines. That's why some manufacturers still specify using coolants with silicate corrosion inhibitors.<sup>2</sup>

**Q10** *So I understand that the green stuff (an ethylene glycol, EG, IAT, silicate formula) antifreezes need more frequent servicing as they plate-out as they provide a protective barrier to corrosion. How about Chrysler's recommendation for the '03-'08 cooling systems of a hybrid organic additive technology (HOAT) that is good for 5years/100,000 miles? What is HOAT?*

**A10** While there are some minor variations, there are three basic types of coolant available today: inorganic additive technology (IAT – typically dyed green), organic additive technology (OAT – typically dyed orange), and hybrid organic additive technology (HOAT – typically dyed yellow). To some extent, each will work in any cooling system, but each has been developed to meet car manufacturers' specific needs for warranty and/or maintenance intervals. Filling a vehicle that was designed for one type of coolant with another type can sometimes cause problems, and if you mix-and-match coolants the same corrosion protection as the initial factory fill shouldn't be expected.<sup>2</sup>

To understand Chrysler's recommendation of *hybrid* organic additive technology (HOAT), one must first understand the silicate-free OAT antifreeze. The newer OAT coolants work differently than the older silicate, ethylene glycol, IAT coolants (the green stuff). Aluminum and ferrous metals form a surface-layer of corrosion in the presence of moisture, even the little bit of moisture in the air. OAT coolants anneal this metal-oxide layer into a thin surface coating that protects against further corrosion. Inherent with their design, the OAT coolants last longer than the old green-stuff IAT coolants. Regardless, with either type of inhibitor, there must be enough in the coolant solution to occasionally re-establish the barrier as needed.

It took almost 20 years of OAT development to make a coolant that would effectively protect against corrosion without using silicates at all.

As a bridge between OAT and IAT there are the hybrid coolants (HOAT) that use both silicate and organic acid corrosion inhibitors. HOAT type coolants are the factory fill for many OEM vehicles.<sup>2</sup> Your '03-'08 Turbo Diesel uses HOAT.

**Q11** *How much of the coolant is actually additives?*

**A11** With all of the discussion about IAT, OAT and HOAT, you'll be surprised to know that the corrosion protection percentage of the mixture (matters not if it is EG or PG) is usually less than 4%, meaning the true "antifreeze" or glycol portion is 96%.

**Q12** *Is there a one-size-fits all coolant?*

**A12** To quote Dr. Paul Fritz, senior coolants technologist for ChevronTexaco Products Co., "Nothing bad will happen" when two brand-name coolants with different corrosion inhibitor technologies are mixed. By this he means that no sludge will form, there will be no damaging chemical reactions and the coolant will still carry heat and protect against freezing.

However, when adding an IAT to an OAT system, the recommended coolant change interval will degrade to that of the shorter-life coolant. Typically, when the mixture stays below 25 percent new coolant on top of 75 percent of the original coolant, the corrosion protection performance will remain that of the original coolant. But as the mix of coolant technologies deepens—that is, if a cooling system has a slow leak and it's continually topped off with a type of coolant that's different from what is already in there—eventually the original corrosion inhibitor will be replaced by the new corrosion inhibitor. This will determine the resulting mixture's overall performance. If someone continues to top off a five-year coolant with a two-year coolant, the resulting coolant mixture should now be changed every two years.

But you should not mix-and-match. According to Dr. David Turcotte of Valvoline Co., cooling systems are mechanically designed to work with specific types of coolant.

Filling a system with the wrong coolant could cause problems. In a 300-hour test of OAT coolant in a Ford engine designed for HOAT coolant, the water pump impellor and backing plate were seriously damaged by cavitation corrosion.

Turcotte and Fritz both said that it's not possible to have one product that meets the coolant requirements of all the different automakers. Because some OEMs require silicate-free coolant and others mandate the presence of silicate, "one size does not fit all."<sup>2</sup>

**Q13** *What coolant should I use?*

**A13** Looks like we've done a complete 360° walk around the block (cylinder block, that is). Please see the reprinted table that Andy Redmond provided in Issue 54. The short answer: Chrysler specification MSS-9769, HOAT coolant which is backward compatible to all years of the Turbo Diesel. That's right, use the yellow stuff after you drain the green stuff. And, thankfully we do not have to be concerned with cavitation erosion.

**Robert Patton**  
**TDR Staff**

<sup>1</sup> Agency for Toxic Substances and Disease Registry web site [www.atsdr.cdc.gov/tfacts96.html](http://www.atsdr.cdc.gov/tfacts96.html)

<sup>2</sup> Aftermarket Business, May 2005, Author Jacques Gordon