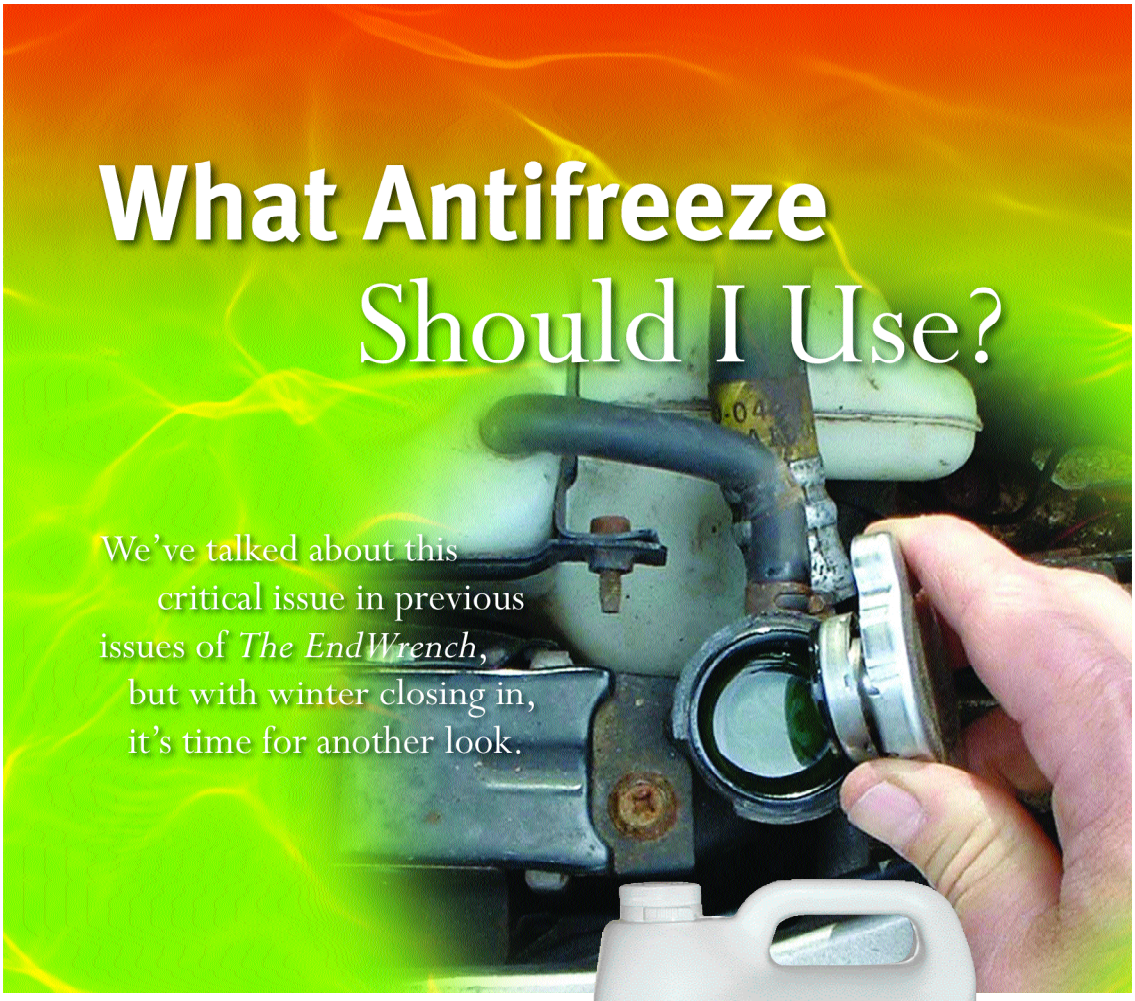
What Antifreeze Should I Use?

We've talked about this critical issue in previous issues of *The EndWrench*, but with winter closing in, it's time for another look.



What's in there, anyway? Colors and concentration readings will give you an idea, but you never really know unless you drain the system and refill it yourself.

It's not so simple anymore. Here's what Subaru recommends for its cars, and we'll tell you why in this article. Be forewarned there's a bit of chemistry involved in the explanation, but not to worry because we'll break it down into easy-to-understand language.

A Service Bulletin was issued by Subaru on 4/15/05, Number 09-42-05, applicable to all Subaru vehicles with the subject "Cautions Concerning Engine Coolant." The issuance of service bulletins is not taken lightly at Fuji Heavy Industries, so something must be going on. What's going on is that the wrong type of antifreeze is being added to cooling systems by people who are servicing Subaru vehicles and/or the owners of these vehicles.

This is interesting and at the same time discouraging since Subaru is very clear in all its publications, whether the owner's or repair manuals, that Genuine Subaru Long Life Coolant (P/N SOA868V9210) is to be used when servicing the cooling system. "Fine," you might be saying,

Instead of trying to find a near equivalent, then worrying that it might not have suitable properties, why not simply buy Genuine Subaru Long Life Coolant (P/N SOA868V9210) from your local dealer's parts department? Then you can be sure you're doing the best thing for your customers.

"Then what is an equivalent coolant that I can use?" Good question, and Subaru tells you that only a phosphate, non-amine coolant formula is acceptable. Actually, we've never seen a similar list of ingredients listed on the container of any other brand of antifreeze.

You might be familiar with the terms phosphate antifreeze and non-phosphate antifreeze. Those are pretty common terms. But what is non-amine? More on that in a bit, but let's keep talking about phosphate versus non-phosphate for a minute because that's what's critical – not the color of the antifreeze.

Christmas Colors?

How often have you heard the debate about green versus red antifreeze? Too often, we bet. While the color of the antifreeze might have some relevance, what's more important is that you read the label on the container to determine whether or not it contains phosphate. Of course, if you use Genuine Subaru Long Life Coolant there's never any problem.

Okay, let's roll up our sleeves and get down to the nitty gritty. We'll start off with a few definitions to get you started, and we'll not assume anything.

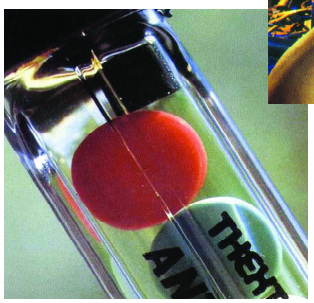
- **Antifreeze** – a water-based coolant used, in this instance, in automotive cooling systems. It has three jobs. First, it reduces the freezing point of the water to which it is added to a temperature somewhere below the lowest anticipated operating temperature of an automobile engine, typically -34 degrees Fahrenheit. Second, it raises the boiling point of the coolant, which is important when you consider the operating temperature of a typical engine and also when you remember how hot the weather was this past summer. And, third, it keeps corrosion inside the engine, the radiator, and the heater core from occurring.

The anti-corrosion part is especially important. One of its main causes is the presence of different metals in the cooling system. Aluminum, cast iron, steel, and solder are all electrochemically different from one another and when put into contact with each other through a fluid (actually, an electrolyte) will cause a small voltage to be produced, which, in turn, is just what's needed for corrosion to occur.

Ethylene glycol is the type of antifreeze used in most automotive applications. Propylene glycol is a non-toxic alternative, which is marketed as Sierra and a few other no-tox brands. Mostly, it's used in the food industry, in home and RV plumbing, and even in some foods and medicines. While there's nothing inherently bad about its use in motor vehicles, reading its concerntration requires a special hydrometer, or a refractometer. It has never achieved much market penetration.

Ethylene glycol – is a toxic chemical compound that is odorless, colorless, and syrupy with a sweet taste in its pure chemical form. It's been around since 1859, in the laboratory at least, and saw its first relevant commercial

While the coolant hydrometer has been used for almost a century ...



...it's simply nowhere near as accurate and fast as a refractometer. By the way, however you measure the concentration, don't go over 50/50, and it's foolish to use anything but distilled or deionized water (courtesy Leica).

application in WWI as an engine coolant, and, incredibly, as an ingredient in explosives. But it wasn't until 1937 when it was widely used in radiators as a coolant. Previously, plain alcohol had been all that was available to prevent cracked blocks, but it tended to boil off rapidly and caused extensive corrosion.

The aircraft industry was the first to benefit from ethylene glycol. It allowed the use of smaller radiators, thus reducing weight. Automotive application came quickly afterward.

Ethylene glycol likes to combine with water. If you're interested, its chemical makeup is HOCH2CH2OH. Its chief hazard is that it's poisonous when ingested. Animals are the major victims. Because of its sweetness, they tend to drink from puddles of coolant left on streets and driveways from leaky cooling systems. Recently, chemicals (Bitrex, for example) have been added to some brands of antifreeze to make them bitter to the taste, thus discouraging consumption by animals.

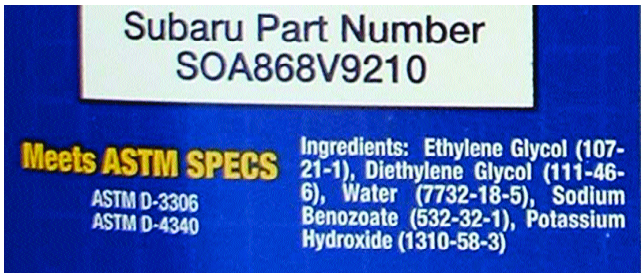
Phosphate – Phosphate is all around us. Its most common form is as phosphoric acid, and it's used in carbonated beverages (read the label on your soda), jams, jellies, cheeses and more. It gives a tart, slightly acidic flavor. But it's also used in detergents as a water softener that helps remove calcium and magnesium from "hard" water. Starting to get the picture?

Non-amine – Ahem . . . this one's interesting. To understand what this is, we need to first learn what an amine is. An amine is an organic compound (in other words, it comes from a living thing) that contains nitrogen. Chemically, an amine is a base (as opposed to being an acid), and is very strong chemically.

A non-amine is the opposite, basically an inorganic compound that is acidic. To keep things simple, it is something that would be present in antifreeze in the place of phosphate, yet designed to act chemically similar to a phosphate. For us this is a no-no.

What's interesting is that when you read the label on a container of Genuine Subaru Long Life Coolant, its ingredients are a bit different from what you would expect, or have probably ever seen elsewhere. For starters, phosphate is nowhere to be found on the label. Instead, you will find the ingredients to be ethylene glycol, diethylene glycol, water, sodium benzoate, and potassium hydroxide. What gives?

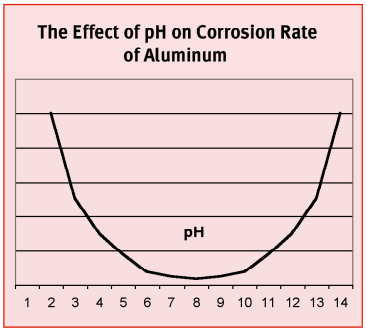
Quite simply, this is where non-amine comes into play through a trick of chemistry. Sodium benzoate and phosphoric acid (a derivative of phosphate) are virtually interchangeable. They do the same thing, but come to it via a different chemical makeup. In fact, chances are good that your can of soda has this ingredient in it instead of phosphoric acid.



The unique formula of Genuine Subaru Long Life Antifreeze provides the very best corrosion protection for the light alloys used in those boxer engines.

As far as potassium hydroxide, also known as potash, is concerned, its role is to help keep the coolant balanced by controlling pH. In case you forgot your high school chemistry, **pH** is the value assigned to a liquid that tells its acidity. A pH of 7 is considered neutral – neither an acid nor a base -- pure H2O is an example. A low pH number means the solution is an acid and a high pH number a base. Battery acid has a pH of less than 1.0, and cola a pH of 2.5; both are considered to be acidic. Hand soap has a pH of 9.0-10.0 and lye a pH number of 13.5, and both are considered bases.

Okay, that wasn't too bad, was it? So now that we know the type of antifreeze that Subaru vehicles require, we need to understand why. That's pretty simple — corrosion. But how does corrosion occur, and is there more than one type of corrosion to be concerned about?



As long as we are in a definition mode, let's define corrosion. **Corrosion** is the deterioration of a material due to a reaction in its environment, including those of the electrochemical variety, which is especially relevant here. **Electrochemical** means that the fluid acts as an electrolyte so that the assembly forms a cell and electrons will flow. In other words, where dissimilar metals are immersed in an electrolyte, voltage will be produced and metal migration will occur, which is called electrolysis.

Cavitation is another term that's important in cooling system analysis. It's defined as the growth and collapse of vapor bubbles as a result of local pressure changes in a liquid. Components, such as a water pump impeller, that are driven at a high velocity through a fluid are susceptible to cavitation, and this environmental disturbance promotes corrosion and

erosion (to distinguish it from corrosion, it is a wearing away due to physical abrasion).

What happens is bubbles form and rapidly burst, which creates a strong wave (from the pressure change) that causes damage to the material. This effect can strip corrosion protecting film from metal components as well as fatigue the metal to the point of failure.

Essentially, the big deal about using the right antifreeze in a vehicle is not its protection from freezing temperatures, which must be a given, but rather how it tackles the threat of corrosion in the cooling system. And that threat is determined by the composition of the materials used in the engine and its cooling system. Subaru uses all-aluminum engines, but traces of other metals, especially ferrous (that is, iron or steel) may contact the coolant at some point in the system.

In a nutshell, phosphate antifreeze protects aluminum engine components by reducing cavitation corrosion, interfering with the reaction with ferrous metals, and ensuring that the coolant mixture stays alkaline (a base on the pH scale). The Subaru antifreeze formula establishes a semi-permanent protective coating on metal surfaces even if the coolant level is allowed to fall.

Two service notes we've mentioned before bear repeating:

- Genuine Subaru antifreeze says "Long Life" right on the bottle, but that doesn't mean you should leave it in there seemingly forever. It simply refers to the fact that if the car's cooling system maintenance is neglected, there will be less damage from corrosion and clogging than would be the case with a less sophisticated formula.

- Fuji's engineers are more prudent than those of some other carmakers, and they want people to enjoy their Subaru vehicles for a long, long time without encountering expensive and inconvenient problems. So, they're sticking with the recommendation that the coolant be changed every two years or 30,000 miles. Sound wisdom in our opinion, and something you can easily justify to your customers.

There you have it, the nuts and bolts of antifreeze.