Radiator/Antifreeze Plugging Problem
in Gasoline Engines
April 2006

We were recently asked to investigate the problem of a radiator plugged with a white substance that was solid, semi-solid, or gelatinous in consistency depending on where it was removed from in the radiator.

<circumstances:< b="">The vehicle that this radiator came from had recently been serviced using a radiator flush product, followed by the addition of new coolant and a cooling system supplement.</circumstances:<>

At some point after this service the vehicle was returned to the service location with an overheating problem. It was determined that the radiator was plugged with a white foreign substance requiring the replacement of the radiator and antifreeze.

Our investigation centers on the source of the substance that restricted coolant flow in the radiator.

We proceeded with laboratory testing of the samples removed from the radiator. What we have found is consistent with what is known as "Silicate Drop Out".

Most antifreeze used in North America is Ethylene Glycol based. Corrosion inhibition for aluminum engine and cooling system components that are in contact with coolant (heads, intakes, radiator, e.g.) is generally provided by adding alkali metal silicates and silicone to the coolant.

These silicates under certain circumstances (coolant with a depleted additive package (worn out coolant), hard water (water mixed with coolant), high coolant temperature, over concentration of coolant (not enough water)) have a tendency towards "polymerization", which can cause silicate "dropout" or "precipitation" which can lead to gelation of the silicates in the coolant.

When this happens, the interior of the cooling system and engine are coated with a white gelatinous material that significantly reduces heat transfer and slows or even stops the circulation of coolant within the system. This reduction in heat transfer and restriction of coolant flow can then raise the temperature of the fluid to a point where this gelatinized precipitant can turn semi-solid or solid in the cooling system.

Conclusion: We conclude with a high level of certainty that this problem pre-existed the initial service. The problem is the result of "Silicate Drop Out", a condition where the silicates in the antifreeze precipitate or fall out of solution.

It is our opinion that this Silicate Drop Out problem is not the result of, or caused by using either the radiator flush or cooling system supplement products.

The problem requiring replacement of the radiator would have occurred with no service, with a service that did not include the flush or supplement products, or as happened with the use of those products. The most likely cause of this condition is the age of the coolant and the temperatures that this particular vehicle's cooling system was subjected to. The unknown mix concentration and the "hardness" of the mix water are also unknowns which may have caused or aggravated the condition.

Recommendations: Nearly all modern coolants used in vehicles sold in North America use silicates and silicones to inhibit corrosion of the aluminum components.

The normal testing process of checking the pH level of the coolant, while a good measure of most coolant conditions, will not show "Silicate Drop Out".

Because of this potential problem and the extreme heat load placed on engine coolant in today's vehicles, the coolant needs to be checked and replaced much more often than in the past.

Coolant should be tested annually, and replaced every two years regardless of mileage. In some conditions adding a coolant supplement every year is advised.

When coolant is replaced the system should be flushed using a high quality flush agent and the proper equipment by a trained technician.

Extra care should be taken to inspect the visible areas of the cooling systems such as in the filler neck, in the thermostat housing, in the surge tank, e.g. for buildup of any white material.

When the new coolant is installed the addition of a cooling system supplement will provide a much higher level of protection and extend the life of the coolant.

The mix concentration of water to coolant must be carefully monitored to assure it meets coolant manufactures recommendations.

The hardness of the water used to mix with the coolant should be checked and addressed if needed (purchasing pre-mixed coolant in bulk may prove to be a prudent solution).

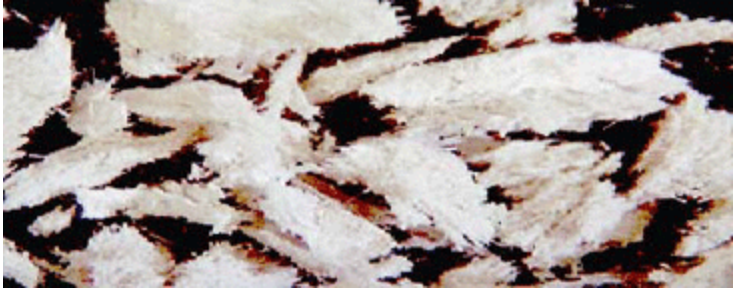
Explanation: We took samples of the white substance from the radiator for testing. We then obtained a sample of the generic antifreeze that was installed in the vehicle during the first service and we purchased a sample of the X branded antifreeze that the factory recommends.

These samples were combined in all possible combinations with the flush product and the cooling system supplement product in an attempt to recreate the problem. These samples were heated, cooled to -35°F, and pressurized during this testing.

We were unable to recreate this problem with either of the "new" coolants and with or without the flush and supplement products.

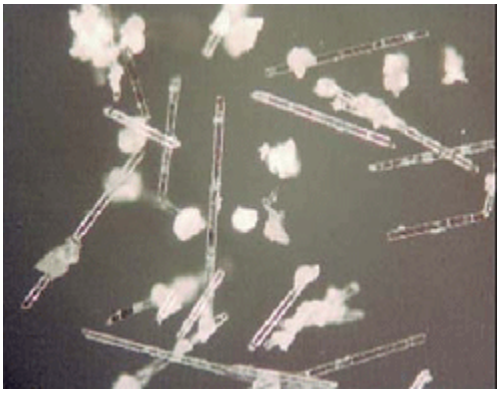
In our testing we looked at pH, glycol concentration, and metallic contamination in the fluid. The very low level of silicone found in the fluid supports the conclusion that the original coolant was "worn out" and silicate dropout had already occurred in this cooling system.

I have included some images of the sample material removed from the plugged radiator.



The first image shows the white material after is has been dried and shredded.

The above image shows the nearly pure silicate material that plugged the radiator.



The second image shows this material under a low power microscope.

The crystals shown above confirm the type of material as a silicate.

These findings together with our knowledge of the historical conditions of plugged radiators in this manufacturers vehicles, are the basis for our conclusions and recommendations.

Applies to:

Kool Well, Flush Well, Stop Well