Radiator Additives

By Robin Phipson
N.E.South African Jaguar Club

This article is written with the knowledge that it might possibly offend 95% of the-radiator additive salesmen amongst us. Nevertheless, judging by the overwhelming number of people that order X16 thermostats from me, and their queries on additives, overheating etc, it became apparent that this subject needs further airing in the hope that members will have a better understanding of cooling systems, and thereby will be able to maintain them better.

The first point to consider is where the heat goes when petrol burns in an engine. Here are the approximate figures: Crankshaft power 25%, exhaust gas 35%, cooling water 20%, radiation loss 20%.

In other words, we are worried about getting rid of 20% of the heat in the burning petrol, and that's a lot of energy. This heat has to be "moved" from the hot cylinder gases, which are at up to 1650 degrees Celsius, to the atmosphere, which is around, say 25 degrees Celsius. Considering that aluminium, as in the head and pistons, melts at 620 degrees Celsius and that cast iron in the cylinder walls melts at 1530 degrees Celsius, it can be seen how vitally important it is that heat is effectively removed from the combustion chamber.

But note, at this point, heat and temperature are not the same thing. Heat is the amount of energy which a substance possesses. Temperature is the "excitement level" at which that energy exists. As an analogy, a small weight dropped from a height can do just as much work as a large weight dropped from a small height, where weight would be equivalent to temperature.

The ability of metal, liquid or gas to transmit heat through it is its conductivity. A metal's ability to transfer heat to a liquid or a gas, or vice versa, is called convectivity. Thus, with a given amount of heat; the poorer the conductivity and/or connectivity, then a higher temperature is required to drive that heat through metal and liquid and finally to the atmosphere.

This would be like dropping a weight from a given height through, say syrup instead of air. The much less viscous air would permit the weight to do more work at the end. On the other hand, the weight falling through the syrup would have to be dropped from a much greater height to do the same amount of final work.

As a general rule, it can be said that metals are very good conductors of heat and that heat convects pretty easily from metals to clean, de-aerated water. Conversely, it is also generally true that non-metals such as paint, rust, scale, salt deposits, etc. are poor conductors of heat to water.

Further, Ford research found that nearly every radiator additive on the market whether anti-leak, anti-freeze, corrosion inhibitor, summer coolant or water pump lubricator, etc - increased cylinder wall temperature. They approached Ciba-Geigy and the final product was Motorcroft SXC 103, a corrosion inhibitor only which didn't increase cylinder wall temperature.

The other problem radiator additives with anti-freeze properties have, is that they cause leaks. Anti-freeze has incredible "creep-seep" properties. Usually with an older, even well looked after car, you add the stuff and soon find a green oozy seep coming out at various points, including the head gasket. What you can't see is the anti-freeze leaking from the water jacket into the combustion chambers and oil ways via the head gasket. Anti-freeze in oil ruins engines.

Also, most anti-freezes "require" a huge anti-freeze percentage. But the higher the percentage, the more harm. You only need the absolute minimum.

Summer coolants don't prevent overheating. While anti-freeze lowers the freezing point, summer coolants merely increase the boiling point. If an engine is going to overheat, it will. Just maybe it won't boil, but it will still overheat.

The worst additive is one which has "leak seal" properties for it increases metal and coolant temperatures as it deposits itself everywhere, literally sealing in the heat.

So, what advise should you follow? Always use Motorcraft SXC 103, two cans to start, and then one can - without draining - every four months.

Using Mntorcraft SXC 103 - two cans to start, and then one can, without draining every four months, the radiator water will stay permanently clear: and you know that metal temperatures have not gone up.

If you can't get SXC 103 (available from Ford and Motorcraf t dealers), use the Wynn's or Duckhams equivalent, but make sure it has no other properties except corrosion protection.

Use anti-freeze only if you have to and then use the absolute minimum. As soon as frosts are over, drain out the anti-freeze, flush and continue SXC 103 treatment. Never use leak seal-ants. Rather, fix the leak! This is the worst corrosion inhibitor inhibitor, don't believe a single word from the salesman - or the side of the can - unless independent scientific proof can be produced.

Unless it can be proven otherwise (scientifically), you are on good ground by assuming that all radiator additives either cause or encourage leaks, and/or cause rises in metal temperatures, and/or rises in cooling water temperature.

Use only geyser or boiled water in your Jaguar radiator with corrosion inhibitor of course! Some people advocate using only rainwater or distilled water or de-mineralised water. This is a fallacy and in the long term does more harm than good. The reason is rather complex. But, basically, a deposited thin layer of mineral salts in the water jacket covers the metal and protects it, to a certain degree, from corrosion. If you now add de-mineralised water, it tries to regain its equilibrium with the salts, and these deposited salts actually re-dissolve back into the water, exposing the metal surfaces, ready for corrosion. On the other hand, tap water already has it's share of minerals and does not remove salts from the water jacket as it doesn't want or need any. Also, distilled water absorbs oxygen more readily.

Next time you paint your radiator, think of what you are doing - locking the heat in! Rather, strip the old paint off first (old brake fluid sprayed into the core does a good job), and then spray on a very thin layer of black, preferably matt, paint. The matt ensures good radiation. Well that's about it. I hope I have made you think and reconsider some previous concepts.

Following this article's first appearance in South Africa, a number of people contacted me expressing incredulity and sometimes disbelief that most radiator additives do more harm than good, the following are some properties of the anti-freeze mixtures of various concentrations.

The figures below are for sea level and do not take the pressure cap on the radiator into account. The pressure cap increases the boiling point, and decreases the freezing point from these figures, thus reducing the necessity for anti-freeze.

It can be seen that anti-freeze reduces both the conductivity and specific heat. This means higher piston, cylinder wall and combustion chamber temperature in order to drive the heat to the radiator, which is the bad news. You will notice that the pure anti-freeze freezes at only minus 12 degrees Celsius. From 60% concentration onwards the freezing point actually starts increasing again.

	FREEZING POINT (°C)	BOILING POINT(°C)	THERMAL CONDUCTIVITY	SPECIFIC HEAT
Pure water	0	100	100	100
5% anti-freeze	-2	100.2	98	99
10% anti-freeze	-5	100.4	96	98
20% anti-freeze	-10	100.8	90	95
40% anti-freeze	-25	103.2	74	87
50% anti-freeze	-40	104.5	68	83
100% anti-freeze	-12	197	41	57

Now let's see how combustion heat gets from over 1000 degrees Celsius to 25 degrees Celsius in the atmosphere.

1. By conduction through the combustion gas itself;
2. By convection to the cylinder wall and Carbon layer on piston tops and cylinder head surfaces;
3. By conduction from the carbon layer to the metal engine;
4. Then, by conduction through the metal;
5. Next, conduction into the layer of rust, scale and salts on metal in the water jacket.

The heat then goes by convection into the rust, scale and salts layer in the radiator tubes and fins, then into the paint of the same, and finally by convection and some radiation, from the paint layer into the cooling air flowing into the radiator. Thus, the heat you desperately want to get rid of has to go through ten different heat transfer steps altogether before it's finally released into the atmosphere.

Now, anything extra which is added to these ten steps causes one, or both things to happen:

1. If you thicken the non-metallic layer in the water jacket, you will increase piston, cylinder and combustion chamber temperatures. You have the same amount of heat but more resistance to its flow. So the "driving" temperature must rise to get heat to flow.
2. If you thicken the non-metallic layer in or on the radiator tubes, by the same argument as above, the water temperature will go up and the water can then boil. Of course, the items in number one, above, will also get hotter as well.

The number two situation above is at least preferable to that of number one, as you know what's happening when the temperature gauge rises. In number one, however, you don't know. Pistons can be melting, but the cooling water isn't heating up above normal because, simply, the heat cannot get into the cooling water. So what's all this got to do with radiator additives?

Everything!

An ex-colleague of mine was an engineer at Ford's engine and cooling systems departments. You may recall that in the early 70's, Ford recommended that a can of Bar's Leaks be added to the cooling system on a regular basis - leaks or not. After they experienced cases of piston failures, research indicated that cylinder wall temperatures were going sky high when this stuff was added.

N.B The 2009 Motorcraft equivalent of SXC 103 is Ford part No R13C.