BTC Testing Advisory Group
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ITS NOT JUST ANTIFREEZE!

Is the liquid in your car's cooling circuit antifreeze or coolant? The answer is both and more. As a rule of thumb only about 28% of the thermal energy released by fuel combustion is converted into motion. About 7% is used to overcome friction in the engine, drive train, tyres etc. About 35% disappears out of the exhaust and the remaining 30% has to be removed by the coolant or the engine block would go into melt down. In addition, the multi-metal construction of the cooling circuit is very susceptible to corrosion and scale deposition at the operating temperatures commonly encountered. Data suggest up to 60% of engines failures can be attributed to cooling system failure. Clearly the fluid we know as antifreeze is multi-functional and critical to the continuous satisfactory performance of the engine. The requirements of a modern coolant/antifreeze may be summarised as:

- Corrosion Prevention
- Freeze Protection
- Compatibility with Hard Water
- Compatibility with Plastics and Elastomers
- Excellent Heat Transfer
- Prevents Scale Build Up
- Stability at High Temperature
- Low Foaming

Since around 1930 the necessary freeze protection and heat transfer has been provided by mixtures of water and ethylene glycol. This is available in large quantities from the petrochemical industry and has the added advantage of raising the boiling point of the mixture. More recently propylene glycol has been introduced as a less hazardous alternative to ethylene glycol although its increased cost and resistance from engine manufacturers has limited its uptake.

The important recent technical advances have been in the field of corrosion inhibition, hard water compatibility and scale deposition control as engine design has changed to improve fuel efficiencies, lower emissions and to reduce weight and costs. The resultant, increased severity of the operating conditions places an even greater demand on the cooling system.
The coolant/antifreeze used at first fill is OEM approved. Subsequent service top ups or change outs should use product meeting the OEM's specification requirement to ensure the vehicle warranty is not compromised. Beyond the warranty period, it is still advised to follow the vehicle manufacturer's

recommendation, however the coolant/antifreeze used should at least meet minimum specifications such as BS 6580 (1992) and/or ASTM D 3306. These are national standards that provide a basic level of performance for light duty applications. The concentrate is diluted with water prior to use and to ensure adequate cooling system protection it is recommended that a concentration between 40% and 50% v/v (by volume) is maintained with an absolute minimum of 35% v/v (by volume) being acceptable in older vehicles. Suitable hydrometers and refractometers are commercially available for checking concentrations.

More recently, globalisation and consolidation of automotive brands and design has led manufacturers to try and rationalise the coolant/antifreeze composition to reduce potential technical issues and limit their supplier base. This, together with a drive to develop longer life coolants, has led to the introduction of organic acid technology (OAT). (This is sometimes referred to as red antifreeze. However as nowadays OAT coolants are available on the market in various colours this description can be misleading). The corrosion inhibitors in OAT products deplete much more slowly in service than traditional corrosion inhibitors and lead to claims of service lifetimes of 5 years or over 100,000 miles. Although generally accepted (and approved) by the majority of the European, Japanese and North American automotive manufacturers question marks concerning its compatibility with older style products and some specific (but isolated) performance issues mean the OEM and service markets are dominated by OAT and also hybrid OAT. The latter contains the slowly depleting organic acids and triazoles but also contains a selection of traditional corrosion inhibitors such as silicate and nitrite. The silicates are generally stabilised and used at lower concentrations than in older styled products. This has significantly reduced the tendency to form gel in the presence of hard water or under extreme conditions of use and reduces its rate of depletion. Hybrid OAT products are claimed to have similar lifetimes to OAT products.

In spite of this attempt by the OEM's and antifreeze manufacturers to raise the quality and increase the lifetimes of their products a significant percentage of the service market on older vehicles which have exceeded their warranty period is still dominated by traditional technologies with 20,000 mile or 2 year service cycles. These coolants are cheaper than the longer life technologies and although they do not achieve the same corrosion protection performance at the higher temperatures generated in modern engine coolant systems they should at least meet recognised national standards e.g. BS 6580 (1992) and/or ASTM D3306. These traditional technology coolants are used extensively in light duty applications such as passenger and smaller commercial vehicles that have exceeded their warranty periods and have shorter service cycles. It is likely this scenario will continue until the disparity in pricing is reduced and/or the purchaser is convinced of the benefits associated with the modern technologies.

The move to longer life antifreeze/coolant is easier to justify in heavy-duty diesel (HDD) engines where the mileage is much higher and the cost of having a vehicle off the road can more than compensate for the higher price. Both OAT and Hybrid OAT products are approved by HDD OEMs, although in some cases the former are modified by the addition of nitrite and/or molybdate to protect against pitting of the wet sleeve cylinder liners. Traditional North American HDD antifreeze/coolant is treated with a supplemental coolant additive (SCA) before use and at regular intervals during its lifetime. Indeed some engine cooling systems are fitted with a filter canister containing solid corrosion inhibitors that dissolve slowly to act as a top up as the inhibitors deplete. This can lead to excessive solids build up in the cooling circuit and reduced cooling efficiency. The longer life products are known as fully formulated antifreeze/coolant and do not require an initial SCA treatment. Because of the slower depletion rates of their inhibitors they can run for much longer periods before requiring topping up. A new generation of SCA's has been developed for use in conjunction with OAT and hybrid OAT products and total lifetimes of 1 million miles have been reported for on road vehicles and 16,000 hours for stationary engines.

Although tremendous progress has been made in improving the performance of modern day antifreeze/coolants there is still one factor that can still reduce their effectiveness – the quality of the water used for dilution! Hard ions such as calcium and magnesium that cause furring of kettle heater elements for example are present in tap water in hard water areas of the UK. These can also lead to deposits and scale build up in the engine cooling system. A map of water quality can be found on the Drinking Water Inspectorate web site, http://www.dwi.gov.uk/pubs/hardness. If you are in one of the heavily hatched areas or, if in doubt, it is advisable to use distilled or deionised water.

BTC Testing Advisory Group is an Industry Association originally established in 1963 as the British Technical Council of the Motor and Petroleum Industries. It has various technical committees that look at different subjects related to the internal combustion engine and the associated laboratory-testing environment. The Engine Coolants Technical Committee represents the coolant industry, including manufacturers, distributors and equipment suppliers. For more about BTC visit their Web Site at http://www.btctag.org
If you are interested in more detail, as well as the technical aspects of engine coolant, please visit the BTC Web Site at http://www.btctag.org/downloads.asp for more information.