RECO-COOL

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USE OF WATER-BASED COOLANTS IN TEMPERATE AND TROPICAL CLIMATES

There has been growing consideration of the use of water-based corrosion inhibitor products as coolants in countries where the ambient temperature never falls below Zero.

Most coolants are blended with a percentage of Mono-Ethylene Glycol, otherwise known as MEG (typically 50% in the products which are prediluted, or "ready to use"), which is a requirement through the specifications and recommendations from equipment manufacturers. This advice predominantly comes from the excellent performance and effect that the MEG and water mixture has on Freezing Point. A 50% solution of water and MEG will exhibit a typical freezing point of -37°C. This allows for functional operation of the product in most severe winter conditions.

There is growing use of performance products in warmer climate countries, where performance of Freezing Point is not a requirement, as ambient temperatures may never fall below Zero.

Debate has here shifted to the criterion of "anti-boil", otherwise known as boilover protection, where MEG again provides a performance enhancement. A 50% solution of MEG and water will have a Boiling Point of 105.8°C, which is 5.8°C higher than the boiling point of pure water. This increase in boiling point is often cited as a reason in hot climates to insist on using MEG based coolants.

PRESSURISED SYSTEMS

The modern automotive cooling system is a pressurized system, and with good maintenance practices, most properly functioning systems commonly have a cap with a pressure release set to approximately 15psi. This means that the cooling system fluid is also under this same pressure of 15psi. At this level, the boiling point of pure water increases to about 125°C (and 50% water/MEG mixture will increase to approximately 129°C). This indicates that it is clearly as critical (if not more) to properly maintain the radiator system and radiator cap, as this will increase the boilover protection by up to 25°C.

EFFECTIVE HEAT TRANSFER

The primary function of the cooling system fluid is the removal of the heat (energy) away from the engine. The ability of a fluid to remove heat is governed by two fundamental fluid physical properties:- "Specific Heat Capacity", and "Dynamic Viscosity".

The Specific Heat of a fluid is that amount of heat/energy required to raise one gram of the substance by one degree. In terms of cooling fluids, the higher the number the better, as

this means that the fluid itself can absorb more energy before the fluid itself gets hot. (At a molecular level, this means that the atoms run freer). The specific heats of both water and MEG (and mixtures of them) are indeed different, and they are also different over a temperature range. Not surprisingly, water is the singularly most effective cooling fluid known to mankind – its performance in this regard has been acknowledged for centuries and is primary to why and how we cool off our own body. The specific heat of MEG is lower than water, which means that it cannot absorb as much energy as readily.

The Dynamic Viscosity is simply a measure of how "runny" the fluid is. Again, the lower the number indicates that the fluid is "runnier" at the same temperature, and therefore able to flow quicker, moving heat away faster.

Specific Heat and Dynamic Viscosity of Water/MEG mixtures
* Source: The Engineering Toolbox

Fluid Type	Specific Heat (C_p) $J.g^{-1}.K^{-1}$ at 90°C	Dynamic Viscosity (μ) at 90°C
100% Water	4.18	0.4
33% MEG in WATER	3.88 (7% loss)	1.8
50% MEG in WATER	3.62 (13% loss)	2.8
100% MEG	2.88 (31% loss)	14.0

At temperatures typically of those operating temperatures found in automotive engines – that the fluid loses approximately 13% of its cooling capacity when blended as a 50% MEG in water solution (compared to pure water), which is partly due to the fact that the fluid is also seven times more viscous. Put in another way, the pump needs to circulate the fluid 13-16% faster as a blended glycol product compared to pure water to achieve the same cooling effect.

BOILOVER VERSUS SPECIFIC HEAT

In theory, this means that a waterbased product will exhibit improved cooling efficiency (allowing the motor to run cooler), however will have a lower boiling point and therefore may suffer more evaporative losses, when compared to a 50% water/MEG mixture.

It should be noted that modern coolant/antifreeze formulations contain more sophisticated ingredients than just water and MEG, of course. Most reputable modern coolants contain a series of qualified performance corrosion inhibitor compounds. Other functional additives are also included in the formulations, such as dyes, bitterants and antifoaming agents. These materials will also affect the specific heat and dynamic viscosity of the blended fluids.

GLYCOL OXIDATION

Under conditions of extreme temperature, MEG will undergo an oxidation reaction, which can generate a number of corrosive carboxylic acid derivatives (glycolic, oxalic, formic and carbonic). The rate of this oxidation reaction doubles with every increase of 10°C. The presence of water in the coolant will quench this reaction up to approximately 60% MEG.