FROM ANTIFREEZE FLUIDS AND ENGINE COOLANTS TO THERMAL MANAGEMENT FLUIDS

Our experienced engineer, Hans Petereyns gives an in-depth explanation of the role of an engine coolant in maintaining the thermal balance of an engine.

The whole story

The tremendous change in engine design, especially with Euro V and Euro VI vehicles and their reliance on additional equipment, requires highly advanced technical products, able to protect the engine and the cooling systems. In fact the engine coolant has a strong impact because it is in contact with several modules in the vehicle, with different metals, and needs to deal with higher temperatures and increased heat transfer. Today's engine coolants play a vital role in the contribution to fuel consumption reduction, a major condition for meeting environmental requirements in terms of reducing harmful emissions and carbon footprint. In addition, the use of an incorrect fluid can have dramatic consequences for the vehicle and generate high repair or replacement costs.

History

In the past people talked about antifreeze, because the major issue consisted in the protection of the engine from freezing. The reason is very simple: if the liquid starts freezing the volume expands, and the engine might suffer significant consequences.

In the 1950s salt was added to water, to prevent the liquid from freezing. As this increased corrosion the next step was to use alcohol, such as methanol and ethanol. These liquids lowered the freezing point andincreased the boiling point, but still did not protect the engine from corrosion. Given that methanol is a toxic and flammable product using higher levels was deemed inappropriate with respect to safety. As a result, methanol and ethanol were replaced by another alcohol i.e. mono ethylene glycol or MEG in short. A synonym for mono ethylene glycol is ethane diol. The non-hazardous alternative for mono ethylene glycol is mono propylene glycol (MPG) also known as propane diol. The mixture of MEG with water or MPG with water was still not offering corrosion protection. This was the point where companies started to introduce additives to coolants to help prevent the metals in the cooling system from corroding.

Prevention from freezing and boiling as well as providing corrosion protection are basic requirements. But in fact one of the most important requirements for an engine coolant is the ability to cope with heat transfer.

How does it work and evolve?

When an engine burns fuel, only a portion of that energy is converted into motion. While some of the energy is used for propulsion, another portion (heat) is fed through the exhaust system and a final share (also heat) has to be removed by the engine coolant. In older engines each portion represents around 33%, which means that the coolant has to take away 33% of the energy that becomes available when burning fuel. For a heavy-duty truck engine this corresponds to enough energy to heat 5 houses in very cold conditions.

Now with the new Euro V and Euro VI engine designs, the amount of heat generated that has to be taken away by the engine coolant is closer to 40% for Euro V truck engines and 40-45% for Euro VI truck engines.

Different flows of engine coolant need to redirect the heat into the system including a major part of the heat which normally escapes through the exhaust.

This is managed by applying several additional modules which are now connected into the coolant system and which adds further complexity to the cooling system. That's why today we talk about thermal management fluid instead of coolant or antifreeze fluids.

Extra modules and Thermal Management Fluids play a crucial role in the reduction of fuel consumption

Exhaust Gas Recirulation (EGR), an intelligent waterpump and the Waste Heat Recovery module (WHR) have been introduced on recent engine designs such as Euro V and/or Euro VI. The purpose of these extra modules in the system is to recover lost energy (heat) in order to bring it back into the system, which is beneficial for the overall efficiency of the engine. Studies have indicated that by adding these modules to the system, fuel consumption is decreased considerably.

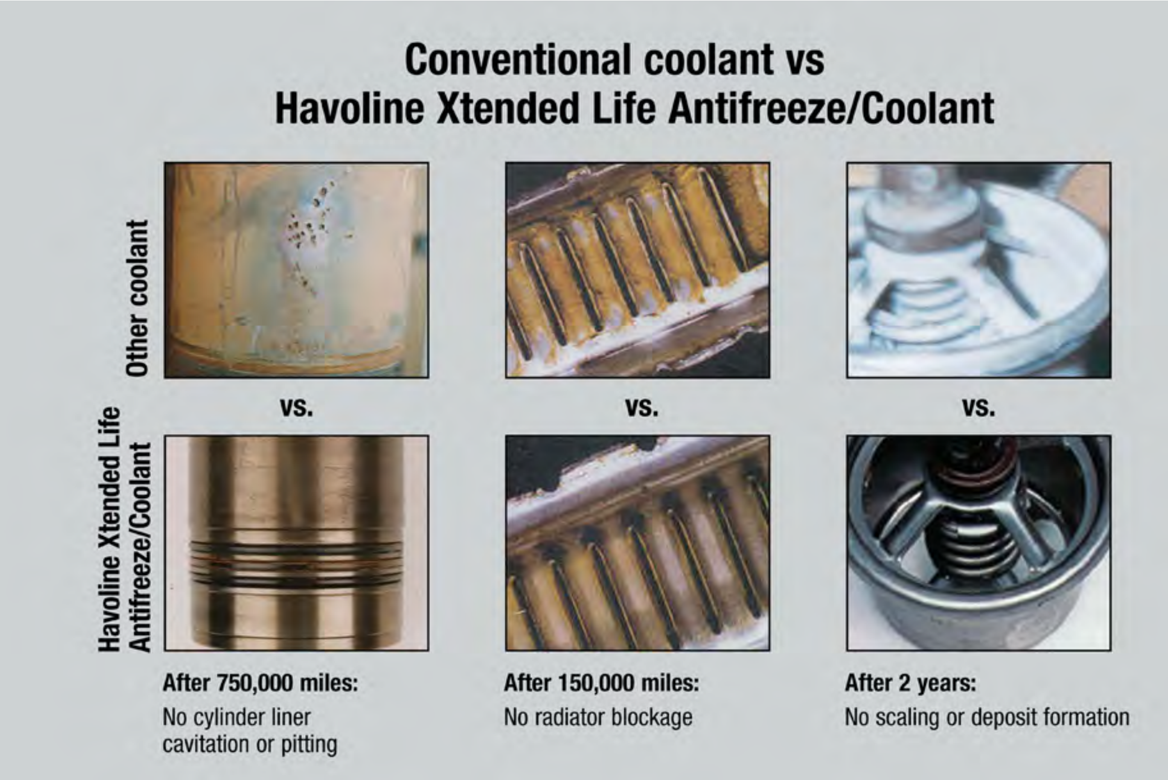
Lower fuel consumption is compulsory to meet environmental requirements. Less fuel consumption reduces emissions of carbon dioxide, particulate matters and NOx, as a lower volume of fuel is burnt.

Cooling is therefore playing an important role in reducing fuel consumption. This is done through the additional modules which are incorporated in the engine and coolant systems. The EGR module is one of these. The intelligent water pump also plays an important role in fuel consumption reduction, as the pump only rotates at the speed which is necessary at the time. So the water pump does not consume energy for rotation if it is not required.

The biggest potential to reduce fuel consumption is through WHR. This module is using part of the lost heat that would normally escape to the exhaust pipe. The heat is recycled in the WHR module via a working fluid which when it is heated up is vaporized. As it is turning from liquid to vapor, the volume of the fluid expands and heat is converted into motion. In order for the working fluid to evaporate heat is required. That heat is brought into the system by means of the engine coolant. The vapor then needs to be condensed to go back into the liquid state. This phase transfer is enabled by an additional loop of engine coolant.

It is obvious that the coolant is playing an important role in the WHR process that is providing heat and cooling as and when required. And again this shows the vital role that an engine coolant is playing in bringing down fuel consumption and emissions.

Since all the additional heat streams are regulated by the engine coolant, the amount of heat that has to be taken away has increased up to 40%.



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Thermal Management Fluid technology

Because a lot of heat is entering the system, there are additional requirements for the thermal management fluid. That means other chemical reactions (accelerated corrosion, thermal breakdown of the base fluid glycol or any reactions) might take place because of the high temperatures. Therefore, a robust and well performing coolant is required to cope with these very high heat inputs at the interface of extended and different material surfaces. This coolant needs to manage the different heat flows very well. It has to maintain the thermal balance of the engine, hence the reference to Thermal Management Fluid (TMF).

Generally, a Thermal Management Fluid contains a mixture of glycol (50%) and water (45%) which define the physical properties such as freezing and boiling protection, viscosity, heat exchange properties, etc. The additives contained in the TMF are responsible for protecting material from issues such as corrosion.

The difficulty in producing a high performance TMF is in developing a product with the optimal combination of high quality glycol, water and additives. The high temperatures and high flow speeds present a real challenge in maintaining the stability of the formulation.

Metal, an additional constraint

There are two major evolutions in terms of metals used in the cooling system. Firstly, in order to reduce fuel consumption, lighter materials are used to lower the overall weight. Aluminum is increasingly used in car engines, cooling systems and heat exchangers, but it is more susceptible to corrosion which means that corrosion inhibitors are required.

Secondly more metal is used overall. An increasing number of small heat exchangers are necessary in modern cars for applications such as personal temperature regulation in the car interior. This means that the same volume of coolants/thermal management fluids now comes in contact with more and differing metals.

Vintage coolants have come to the end of their usefulness as they are no longer able to cope with these requirements.

Higher temperatures, an additional constraint

Higher temperatures can cause glycol to thermally degrade, breaking down into acid and increasing the risk of corrosion in the cooling system.

This means that the coolant/thermal management fluid needs to be stable at high temperatures, to limit the breakdown of glycol to acid, which is where additives play an important role. Corrosion metals themselves do catalyse the glycol breakdown reaction, which means that in order to reduce the release of metals, proper corrosion protection at these high temperatures is very important.

Havoline Xtended Life Antifreeze/Coolant for passenger cars or Delo XLC AntiFreeze/Coolant for commercial vehicles as well as HDAX ELC Premixed 50/50 for stationary Gas engine coolant systems are able to comply with all these requirements

This generation of Chevron coolants provide stability and have a positive effect on the thermal breakdown of glycol.

It is crucial to use the right coolant containing the right additives, the right combination and ratios and the right concentration.

Different coolant classes exist on the market, from standard to highly sophisticated products.

The technology Chevron uses is called Organic Additives Technology (OAT) which Chevron has pioneered since the 1990's. This technology refers to the corrosion inhibitors that are used. With OAT technology different inhibitors are combined in one unique package which do protect all the different metals comprising modern engines. The inhibitors used in Chevron products provide an extended life for engine coolant because they are resistant to high temperatures and are not consumed during service even when providing corrosion protection.

An engine coolant that suits all engines does not exist

A universal coolant does not exist and indeed the trend is moving towards more and more custom made TMFs. Before receiving approval by an OEM, for each product, Chevron runs an approval programme, consisting of laboratory tests, bench tests, and then finally, fleet tests. Only after this last stage of the OEM approval programme, which typically takes between 2 to 5 years to be completed, does a supplier get product approval.

Each product starts with lab testing, using OEM specifications as the basis. All OEMs have different requirements, in terms of stability, contamination, and regarding whether certain additives can be used or not. As a result, we see more and more OEM specific products.

This also explains why it is extremely important to choose the right coolant for each car or truck. An inappropriate coolant might lead to problems, such as not resisting high temperatures, leading to corrosion. The consequence can be the total breakdown of the engine. On a large scale, such as for fleets, it might quickly become a very expensive issue.

Chevron Thermal Management Fluids/ engine coolants product range

Chevron produces and sells a whole range of engine coolants/thermal management fluids based on OAT technology, covering a long list of applications.

Havoline Xtended Life Antifreeze/Coolants and Delo XLC Antifreeze/Coolant which cover OEM requirements and are based on Chevron OAT Technology.

Havoline Xtended Life Antifreeze/Coolant and Delo XLC Antifreeze/Coolant produced by Chevron are one of the most universal coolants on the market. They are available in several formats: Concentrate, Premixed 40/60 and premixed 50/50.

As one of the most universal coolants on the market, these products meets a long list of OEM requirements.

Check our PDS on our e-Guide for the latest specifications: http://chvguide.novacomportal.com/eu/