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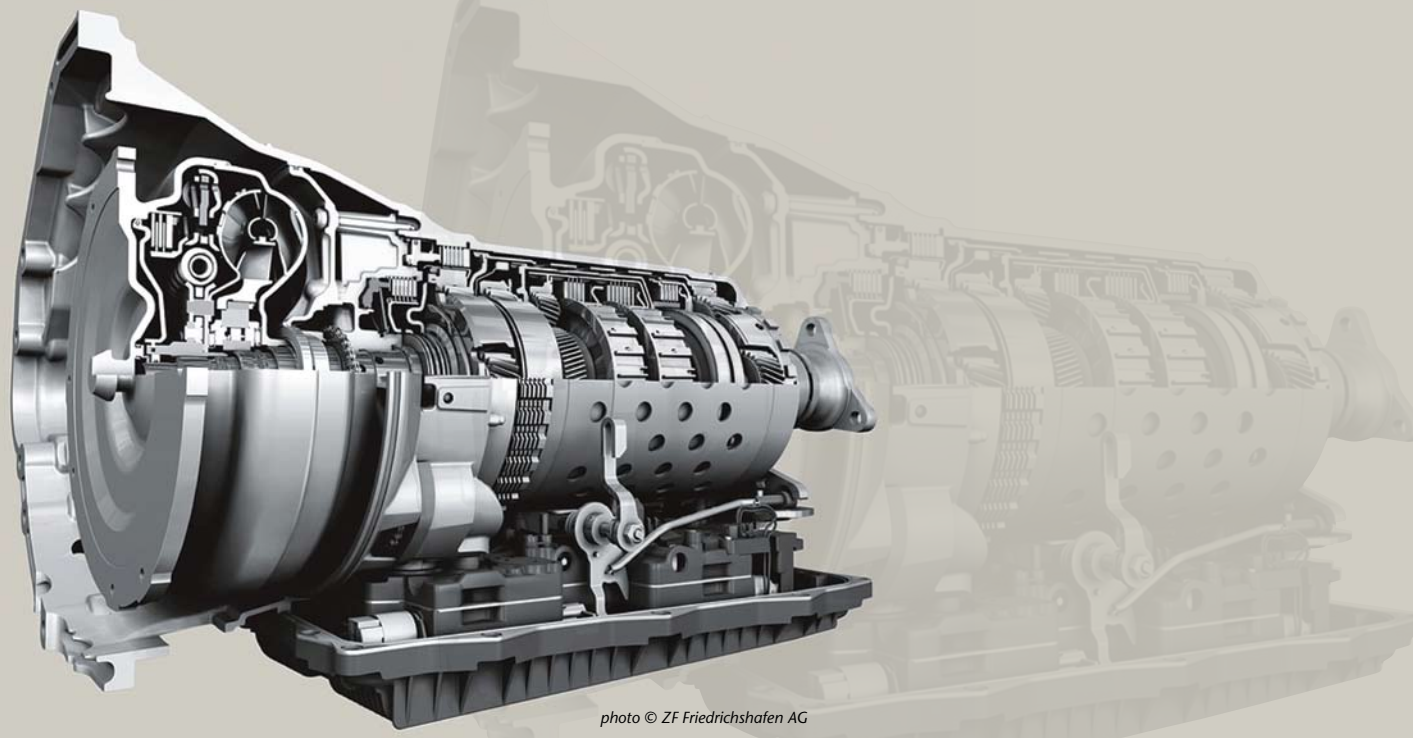
Transmission fluid evolution

The quest for fuel economy performance drives the use of low viscosity fluids



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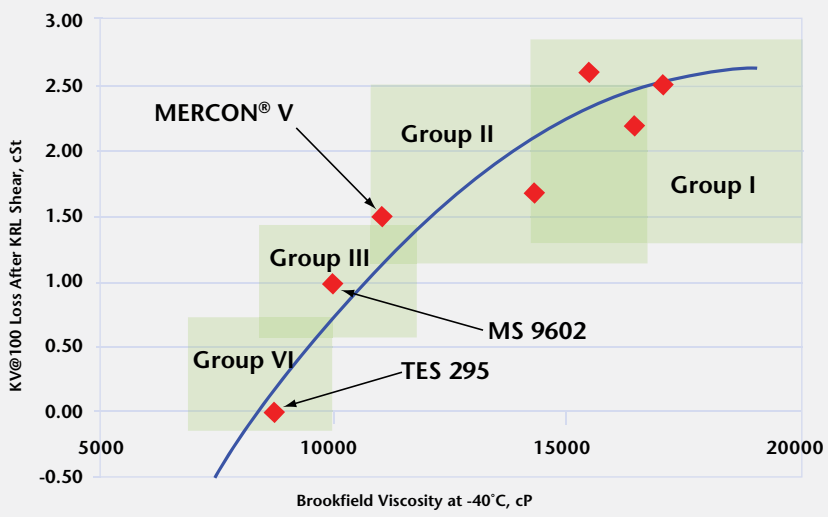
Automatic transmission fluids are increasingly expected to contribute to vehicle fuel economy performance. Joe Noles, Infineum PTF Global Technical Advisor, takes a look at the biggest trend in the market – the evolution of low viscosity fluids.

Transmission fluid performance is determined by the choice of lubricant base stock and the combination of additives used in the formulation. The lubricant base stock employed sets the fluid's fundamental low temperature capabilities and resistance to oxidation. Over the last two decades, transmission fluid specifications issued by the major transmission builders have required significant improvements in low temperature fluidity and oxidative stability. The practical impact of this evolution was that API Group I base stocks, used most widely throughout the 1990s, were no longer capable of producing many of the next generation transmission fluids and had to be replaced by API Group II, Group III and/or synthetic base fluids. Recently issued and proposed specifications are continuing this trend of limiting the number of base stocks capable of producing suitable transmission fluids. Driven by the desire for transmissions with increased fuel efficiency, OEMs have now begun specifying low viscosity transmission fluids that can only be formulated using API Group III and/or synthetic base fluids.

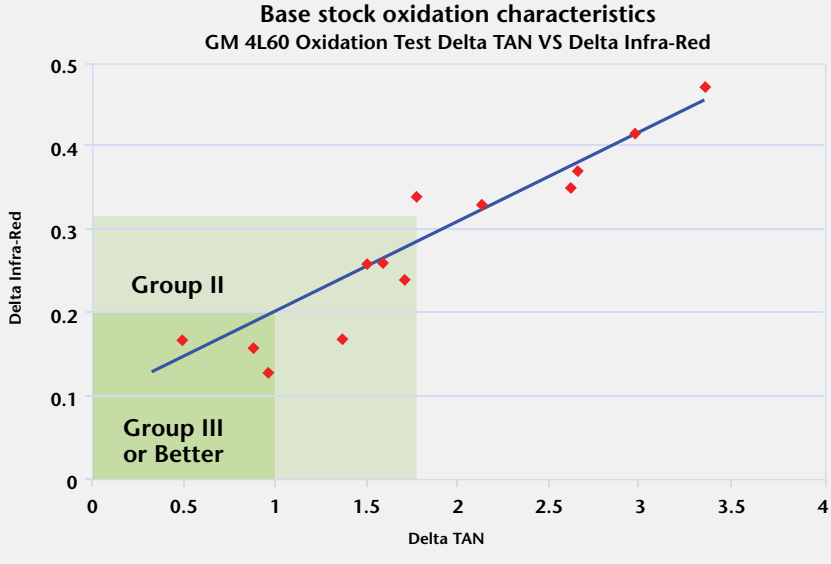
Low temperature fluidity

Looking back, the first transmission fluid trend to impact the choice of base stock was the demand for improved low temperature performance and shear stability. Low temperature requirements for transmissions fluids are most often specified by Brookfield Viscosity (BV) at -40°C in units of centipoises (cP). BV requirements have been steadily reduced to allow transmission OEMs to gain better cold start performance.

The first significant step change came when General Motors introduced DEXRON®-IIE in 1990. They upgraded the low temperature performance requirement of DEXRON®-II ATF from a maximum BV of 50,000 cP to 20,000 cP. However, since that time, fluids meeting 20,000 cP maximum have been at the high end of the spectrum, with recently introduced transmission fluids moving below 10,000 cP.



Relationship between low temperature viscosity and shear stability



How pass/fail limits in GM 4L60 Oxidation Test impact base oil selection

Meeting lower BV limits requires the use of base stocks with inherently better low temperature characteristics. This can be achieved by either using lower viscosity base stocks or by using more viscous, but more highly refined base stocks. The choice ultimately depends on the fluid's shear stability requirement. Less shear stable fluids, such as DEXRON®-III/ MERCON® fluids introduced in the early 1990s were commonly based on lower viscosity Group I base stocks and normal treat rates of higher molecular weight viscosity modifiers. By comparison, more shear stable fluids, such as those subsequently introduced by Ford, and Chrysler in the late 1990s needed to be formulated with more viscous Group II or Group III base stocks and low treat rates of low molecular weight viscosity modifiers. Looking at this relationship between low temperature viscosity and shear stability graphically shows how the trend of increased shear stability and improved low temperature performance has increased base fluid requirements significantly.

Oxidation resistance

Reduced sump volumes and higher temperatures prompted increased demands for improved oxidation stability in order to extend drain intervals and improve friction durability. In 2004 GM's move to DEXRON®-IIIH was a primary factor in the demise of the use of Group I base stocks in transmission formulations – forcing the use of Group II as an absolute minimum.

The combination of increases in both infra-red and acid number (TAN) also impacted the selection of base stocks used in DEXRON® formulations. While the regions in the graph are not absolute and could be composed of mixtures of base stocks it serves to illustrate the trend imposed on base stocks by oxidation limits.

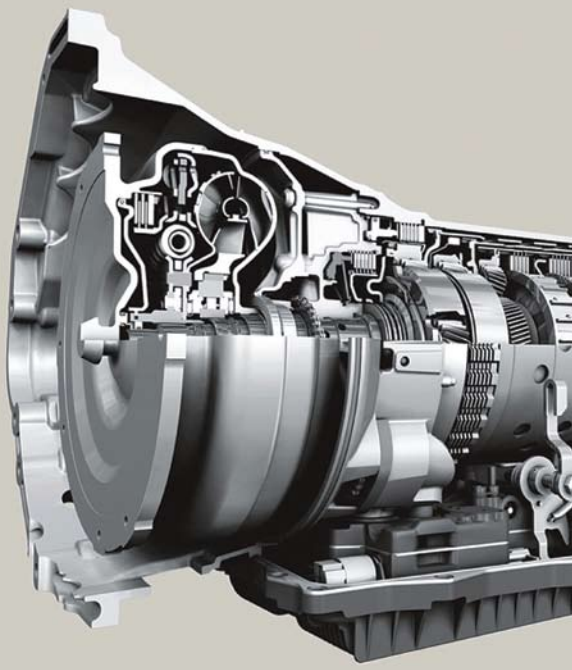
Fuel economy improvement

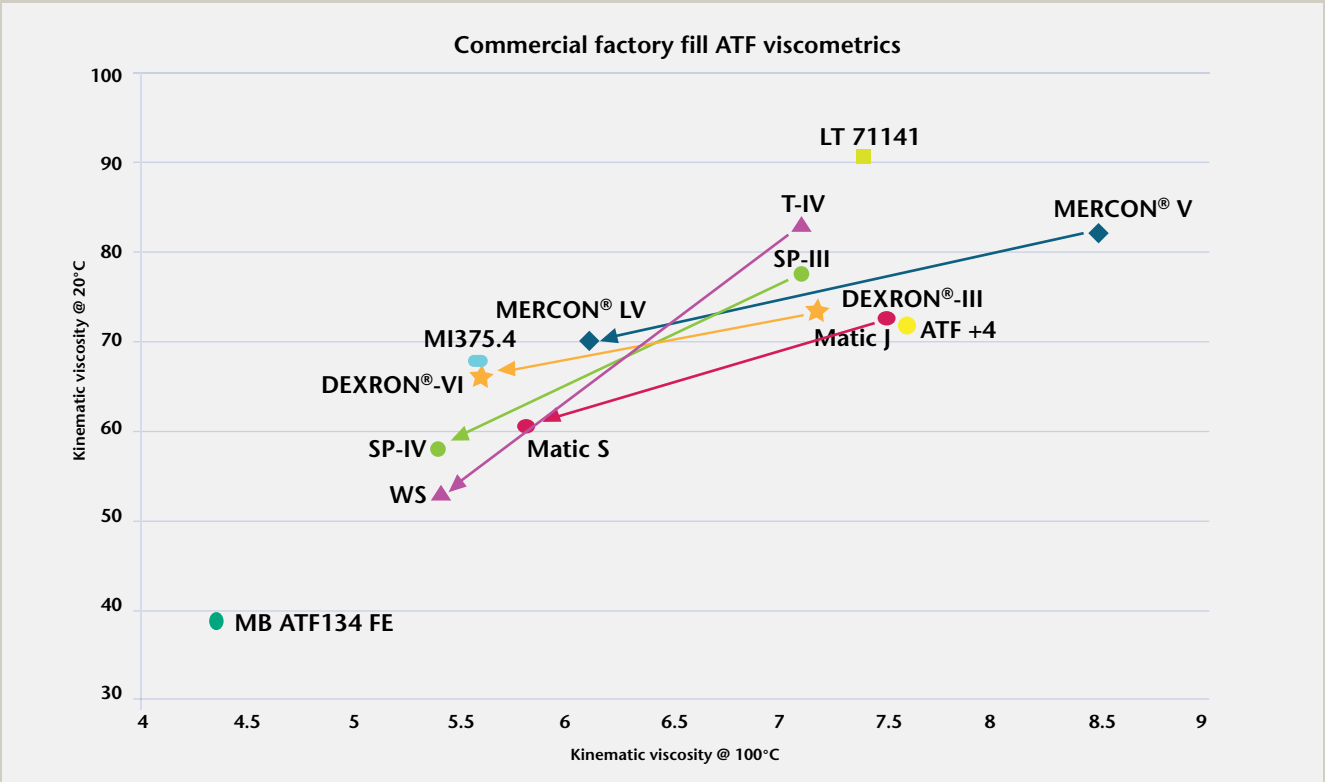
So how is the latest OEM trend for fuel economy improvement affecting base stock choice?

As CO_2 emissions limits get tougher, CAFE penalties bite harder and consumer demands for fuel efficiency increase, improving fuel economy has become the key driving force for OEMs. Transmissions are now increasingly expected to play their part. This has led OEMs to introduce new transmission designs including continuously variable and dual clutch transmissions and to increase the number of gears in their conventional stepped automatic transmissions – with some announcing plans for nine-speed transmissions in the near future.

No matter what the transmission design, fluids will contribute to fuel economy performance by minimizing viscous drag, pumping and churning losses. The new formulation trend is for lower viscosity fluids (lower KV100, KV40 and KV20) so that viscosities are low over a wide range of operating conditions. Before the emphasis on fuel economy, ATFs were typically formulated with a KV100 of more than 7 cSt. The introduction of ZF's six-speed transmission fluid, M1375, really started the low viscosity trend with KV100 dropping to 5.5 cSt. The quest for fuel economy improvements will continue to drive down the viscosity of transmission fluids even further. Mercedes for example has just introduced its new ATF134 FE fluid with the lowest KV100 to date of around 4.3 cSt, It is likely that the demand for fluids with viscosities this low will increase – making the use of Group III base stocks or polyalphaolephins essential for transmission formulations. Bearing in mind that transmission fluids must still deliver the level of protection required by OEMs over the lifetime of their vehicles, the question that remains is just how low can fluid viscosity go in the future?

In an upcoming issue of *Insight* we will take a closer look at the emerging demand for low viscosity transmission fluids in the service-fill market.





The formulation trend is for lower viscosity fluids over a wide range of operating conditions

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