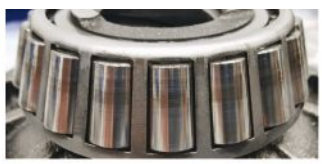
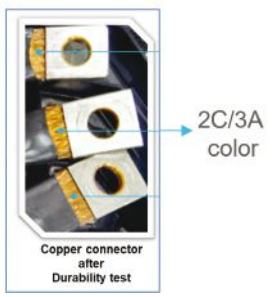
Spelling out the need for ETF durability

Electrified transmission fluid plays a vital role in reliability and must evolve to meet changing performance demands





Above: The excellent condition of end-of-test components, after the equivalent of 1,000,000km of running

When designing an electrified transmission fluid (ETF), just as surely as D comes before E, durability must precede efficiency. The world's most efficient electric vehicle offers little value if it has broken down and is in a workshop – unless you're looking to save energy by not driving it. Afton's recent collaboration with an OEM involved durability testing equivalent to 1,000,000km of use, and also revealed a new failure mode in high-speed e-axles. Solving the durability challenge emphasizes the role of additives in making high-efficiency, low-viscosity ETFs viable.

As e-axles get smaller and lighter yet more powerful, e-motors can spin at over 20,000rpm – nearly four times faster than those produced a decade ago. Developing fluids to enable this evolving hardware means overcoming multiple obstacles to deliver durability.

Durability is tripartite, encompassing mechanical components, electrical systems and the fluid itself. To deliver durability, another priority must also be met: C for compatibility. However, ensuring compatibility with seals, electromagnetic wire and insulation materials can constrain the choice of chemistries that provide essential wear protection.

Before compatibility comes another priority: B for base oil. The electrical, thermal and friction properties of a finished fluid, its viscometrics and its oxidation resistance are all influenced by the base oil. Afton has previously highlighted the excellent balance of friction and thermal properties that linear synthetic oils offer, although these can limit the options for performance additives.

PROTECTION PRIORITIES

Afton recommends early testing for mechanical protection during ETF development. Screener tests, from FZG failure load stage and Vickers vane pump to FE8 bearing wear and pitting, can deliver valuable insights into the performance of fresh and aged fluid. Even greater value comes from rig tests that use real hardware, under conditions that simulate a lifetime of use.

In a recent OEM collaboration, Afton conducted e-axle ETF tests equivalent in severity to driving 1,000,000km. Interestingly, this revealed a new e-axle failure mode when e-motor speeds exceed 20,000rpm. Manifesting as a sudden rise in fluid temperature then a drop in oil pressure, it results in heavy gear scuffing.

Afton initially devised a test procedure and rig to reproduce the phenomenon reliably, before its complex tribological and thermodynamic causes could be identified and resolved. ETF aeration was the culprit, occurring at e-motor speeds above 20,000rpm. The finished fluid needed to tackle high-speed foaming on top of priorities B-E, all of which rely on one thing: A for additives.

PROOF OF PERFORMANCE

Candidate ETF testing demonstrated that Afton's additive solution could deliver the durability required. It also demonstrated an overall efficiency gain of 1.5% versus the reference oil, and with little fluid oxidation, in a low-friction formulation with a low viscosity of just 3cSt at 100°C.

End-of-test inspection images show gears and bearings in great condition after the equivalent of 1,000,000km of use, and exposed copper connectors remain shiny, indicating impressive wear protection with excellent compatibility.

Despite the continuing increase in e-axle power density, developing ETF and hardware in parallel enables innovative additive platforms and base oils to be tailored for compatibility and durability, helping to realize a lifetime of efficiency gains for OEMs.

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