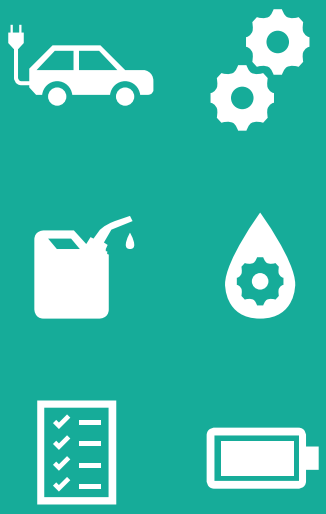
Fluids for next generation EV drivetrains

Ester base oils and additives for next-generation electric vehicle gearboxes, transmissions and e-axles

Cargill®

Fluids for electric vehicles - overview



- The automotive market is rapidly changing and interest in vehicle electrification is growing as countries enact new emissions legislation and move to ban new sales of internal combustion engine (ICE) vehicles
- Standard automatic transmission fluids (ATFs) are not optimised for electric vehicles (EVs), and further development of fluids is needed to meet the requirements of EV drivetrains.
- Lubricant standards are still being developed for EVs and there are many varied technologies and designs for their drivetrains.
- EV transmissions are subject to high torque at low speeds, electrical fields, high voltages and greater localised heat loads which requires novel fluid solutions.
- Fluids must have specific performance requirements including low electrical conductivity, low viscosity, low traction as well as protecting against wear and good thermal heat transfer properties.

Our products for EVs

Priolube™ EF Low viscosity Group V ester base oils

Formulate lubricants with a low coefficient of traction. Compatible with Group III, IV and ester base oils, suitable for formulating high efficiency fluids for transmission, gearbox and motors.

Parameter		Priolube™ EF 3446	Priolube™ EF 3221	Priolube™ EF 7010
Kinematic viscosity at 40 °C	cSt	6.1	7.7	9.6
Pour point	°C	≤ -40	-81	-35
NOACK volatility at 200°C	%	9.6	6	2
Biodegradability (OECD 301B / OECD 301F)		Readily biodegradable (301B)	Readily biodegradable (301B)	Readily biodegradable (301F)

Perfad™ traction reducing co-base fluids

Patented technology to reduce traction and wear in a Group III, IV or V based formulations, while thickening and increasing viscosity index. Suitable for replacing PAO 100 and standard high viscosity esters

Parameter		Perfad™ 3006	Perfad™ NG 2500
Kinematic viscosity at 40 °C	cSt	6400	2900
Flash point	°C	269	>250
Biobased content (ASTM D6866)	%	77.5%	95.3%

20% Priolube™ EF 7010 reduces traction even in very harsh conditions

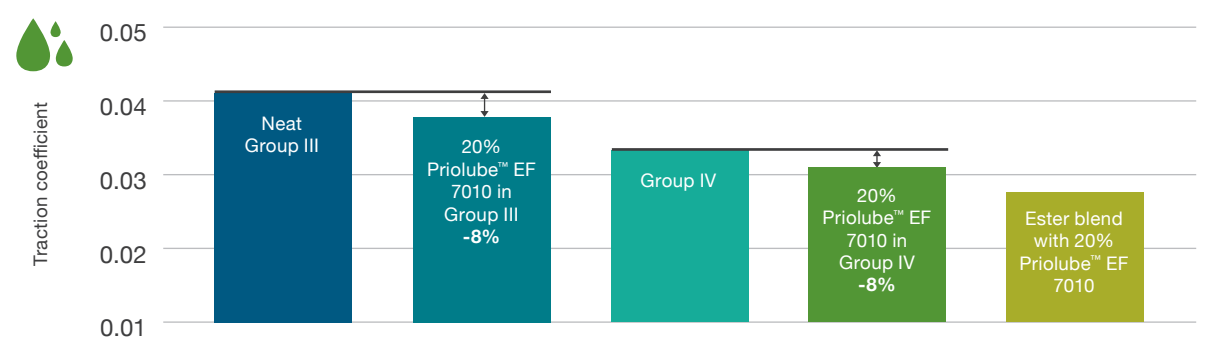


Figure 1 Adding 20% of Priolube™ EF 7010 reduces traction by 8% vs. an untreated group III or IV base oil. All tested at a KV40 of 4.5 cSt.

Parameter	Value
Speed	0.2 m/s
Temperature	40 °C
Load	25 N
SRR	50%

Compared to a neat Group III or Group IV base oil, Priolube™ EF 7010 has:

- Significantly lower NOACK volatility
- Higher breakdown voltage
- Significantly increased oxidation stability
- No adverse impacts on copper wire insulation materials and elastomer seals

Perfad™ reduces traction vs. a PAO 100 thickened formulation

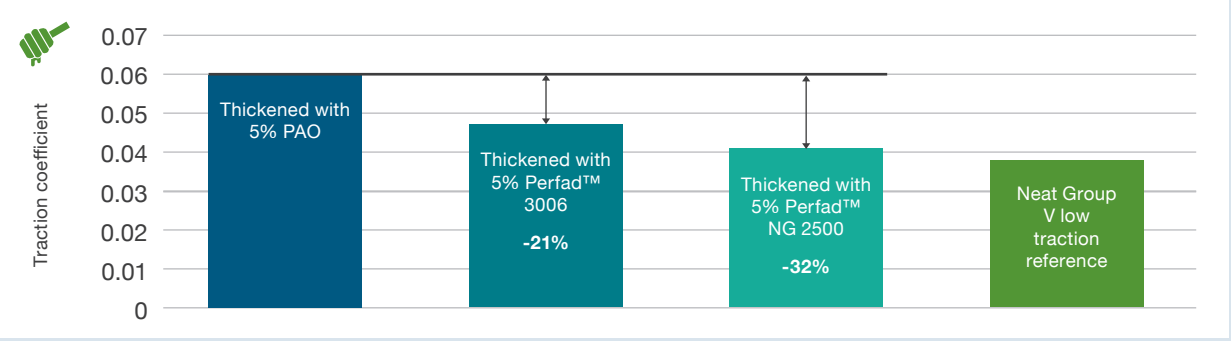


Figure 2 Adding 5% Perfad 3006 or Perfad NG 2500 offers up to 32% reduction in traction coefficient vs. a PAO100 thickened formulation in group III. All tested at a KV40 of 26 cSt

We used an oxidatively stable polyol ester solubiliser to ensure complete solubility of the additives

Parameter	Value
Speed	0.1 m/s
Temperature	60 °C
Load	60N
SRR	40%
KV40	26 cSt

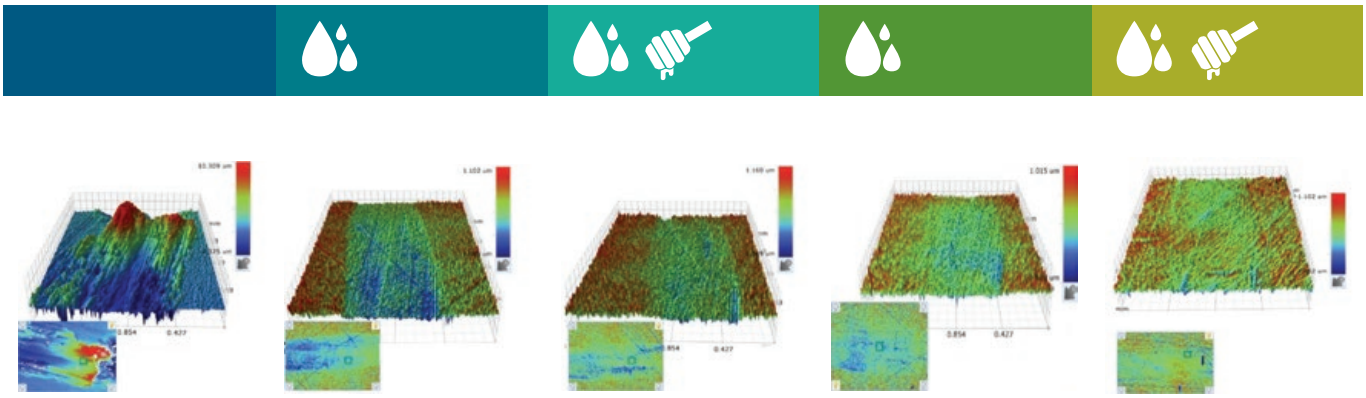
In Group III and Group IV base oils, the addition of 5% Perfad 3006 or Perfad NG 2500:

- Reduces traction coefficient by up to 32% vs. a PAO100 thickened formulation
- Improves pressure viscosity coefficient of fluid, increasing film strength and wear performance
- Improves viscosity index
- Maintains viscosity in the KRL shear loss test (20 hours, 40°C)

Formulating with both 20% Priolube™ EF 7010 (low viscosity base oil) and 5% Perfad NG 2500 (traction reducing co-base fluid) in Group IV:

- Reduces traction further compared to just the addition of Priolube™ EF 7010
- Reduces wear even further vs. 20% Priolube™ EF 7010 only
- Using the same additive package, Priolube™ EF 7010 and Perfad NG 2500 improves FZG A10/16.6R/90 results by 2 load stages in a Group IV formulation

Visualising wear reduction in the FZG on SRV gear contact mimic test



Group III Failed at 78 minutes	20% Priolube™ EF 7010 in Group III	20% Priolube™ EF 7010 + 5% Perfad NG 2500 in Group III	20% Priolube™ EF 7010 in Group IV	20% Priolube™ EF 7010 + 5% Perfad NG 2500 in Group IV

Other application areas:

We are developing a portfolio of products for electric vehicle applications, including:

High viscosity thickeners: Shear stable thickening power for wear protection in EV gearboxes, transmissions and e-axles

Low viscosity dielectric coolants for immersion cooled EV batteries and drivetrains

This document is a short overview of a larger dataset.

Please contact us for further information.

Energy Technologies

About us

The Energy Technologies business in Cargill Bioindustrial creates, makes and sells specialty chemicals and additives for the global energy market. Working in close collaboration with our customers, we apply sustainable concepts and deep scientific expertise so that together we can efficiently power the world of tomorrow.

At our core, we are experts in synthetic ester and polyalkylene glycol chemistries, taking products from lab scale through to full manufacturing. Investing in the development of new chemistries allows us to support our customers in meeting new industry challenges.

For those who dare to imagine a brighter future, we establish long lasting relationships and create bespoke industry solutions through our integrated research & development and global manufacturing capabilities. Being both global and local, you have direct access to our network of technical experts. We look forward to talking to you.

Further information

Cargill Bioindustrial sales and distribution are coordinated through an extensive worldwide network of technical and commercial experts. For further information or guidance please contact us:

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