



Whitepaper

Hydro Lubricants for Gears.

The future of gear lubrication is based on water

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Water is a visionary but yet obvious raw material. As a functional component in speciality lubricants, it can reduce friction to such an extent that superlubricity comes into reach. This offers unprecedented opportunities for instance:

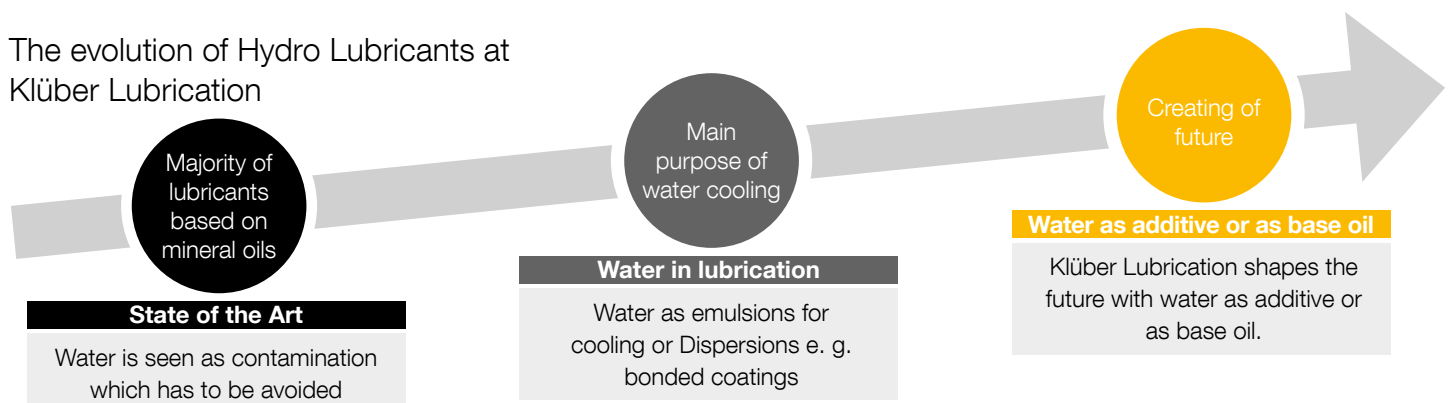
- **Lower friction and lower energy consumption than conventional lubricants**
- **Electrical resistivity as an important aspect for E-Mobility**

Executive Summary

Conventional lubricants based on mineral oils show limitations in various scenarios. At the same time, industrial operators' expectations towards innovative specialty lubricants are increasing. This includes elongating of component life, reducing emissions and reaching higher energy efficiency. This is where the innovative Hydro Lubricants technology plays a significant role: they unfold their innovative potential by using water either as a base oil or as an

additive. Thus, offering great potential to deliver high performance. Among the main advantages of Hydro Lubricants is their high thermal and electric conductivity, resistance towards water intrusion, low friction values and good load carrying and cooling capacity. The overall advantages of Hydro Lubricants are introduced in Klüber Lubrication's "Whitepaper Hydro Lubricants".

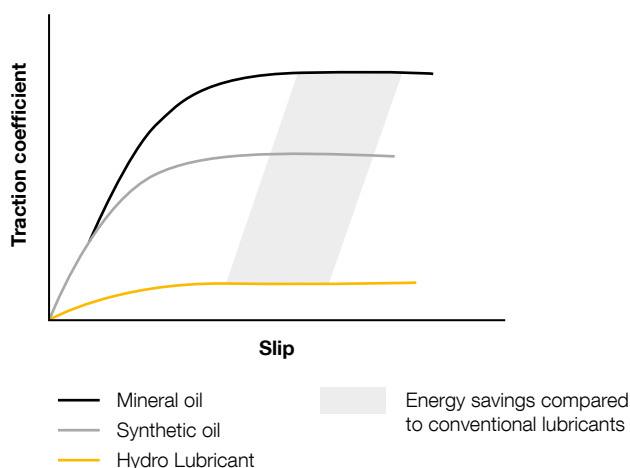
The evolution of Hydro Lubricants at Klüber Lubrication



Friction measurements

This paper focuses on our Hydro Lubricant product Klübersustain GW 0-460, a gear lubricant in the ISO VG 460. The specific performance of Klübersustain GW 0-460 is evident when compared to a conventional polyglycol (PG) based on synthetic gear lubricant. In the following, read about the friction behavior, the load carrying capacity and the electrical resistivity of Hydro Lubricants. Friction measurements were made on steel/steel contact using a ball-on-disc tribometer (EHD2, PCS Instruments) at a realistic test temperature of 60°C and a mean speed ensuring EHD full film condition (2.5 m/s). It is evident from the figure below that the Hydro Lubricant exhibits extremely low friction compared to the PG gear oil that is known for its low friction among conventional gear oils.

Friction reduction of Hydro Lubricants



Load carrying capacity

The load carrying capacity was evaluated by a modified scuffing test according to ISO 14635-1. The Hydro Lubricant was tested at a reduced starting temperature of 30 °C (FZG A/8.3/30) instead of 90 °C. In this test, elevated surface temperatures due to high surface pressures and sliding velocities cause a local welding of the tooth flanks of pinion and wheel. A higher failure load stage from this test is an indicative measure of high relative scuffing load capacity of gear lubricants. The tested Hydro Lubricant reached a failure load stage greater than 12. This result clearly indicates that the Hydro Lubricant provides a good tooth flank surface protection even at high temperatures in the gear mesh. The excellent FZG results qualify our Hydro Lubricant for the use in gear applications.

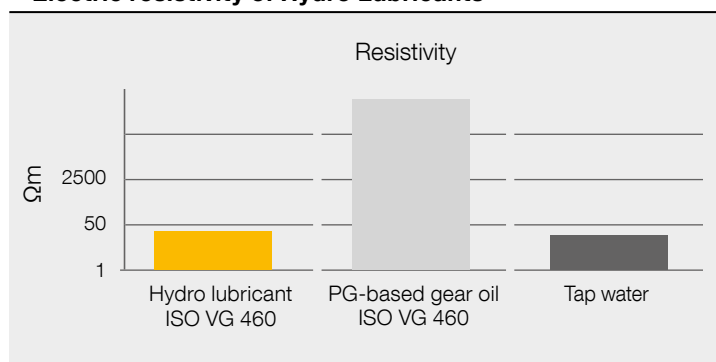
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Electrical resistivity

Another important character of lubricants that contain a significant amount of water is their low resistivity. As shown below, the ISO VG 460 Hydro Lubricant shows almost the same value as tap water and is much lower compared to conventional PG gear oil.

Electric resistivity of Hydro Lubricants



This behavior is particularly beneficial in systems where electric discharge (ED) is a problem, such as those found in small frame size electric motors. It is well known that bearings used in variable speed electric motors experience fluting; a damage commonly found on the surface of bearing raceways caused by electric arcs that pass through the lubricant. The resulting electric discharge could potentially degrade the lubricants by high local temperature rise. One way to reduce the risk and severity of damage caused by ED is to use lubricants with high electrical conductivity. The excellent electrical conductivity of the presented Hydro Lubricant compared to conventional oils clearly indicates that it could potentially reduce the damage caused by electric discharge.

Cooperation with partners from different industry segments

Klüber Lubrication is currently cooperating with a variety of partners from universities and different gear manufactures (OEM), in order to develop a wide range of Hydro Lubricants for applications like gears, bearings and industrial chains.