Whitepaper

The next generation of axlebox bearing greases

More safety combined with longer service life

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The axleboxes of a train are components with high relevance for safety, as they constitute the interface between the vehicle and the rail. They have to support the train's weight also at high speeds, and are expected to ensure smooth, comfortable travelling.

Besides the wheels, it's the wheelset shaft and its bearings that are very much at the focus of measures for optimisation and maintenance. The grease used is tasked with a very specific job: It has to separate the friction bodies, i.e. the raceways and the rollers of the bearing, to ensure low-wear operation.

Besides the **aspect of safety**, the reduction of the **Total Cost of Ownership** (TCO) constitutes currently one of the biggest challenges for the operators of freight cars and passenger trains as well as for the manufacturers of rail vehicles and their components. These costs are closely linked to the **service life** of axlebox bearings and **maintenance intervals** as well as bearing **efficiency**.

This Whitepaper provides an outlook on how a new generation of axlebox bearing greases improves **safety** and **service life** as well as **efficiency**.

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Longer bearing life thanks to advanced, application-specific lubricants

In the rail sector, fixed maintenance intervals determine how long lubricants in axlebox bearings can be used. These intervals may be based on either a certain timespan or a certain mileage travelled. In most cases the lubricant is replaced because its ageing during the time in use means it no longer provides sufficient lubricity under the tough requirements of the application.

Ageing of a lubricant is caused by the following factors: thermal ageing due to oxidation, mechanical ageing due to loads, shearing forces as well as lubricant loss. The ageing resistance of a lubricant can be optimised by dealing with three of its ingredients: additives, thickener and base oil.

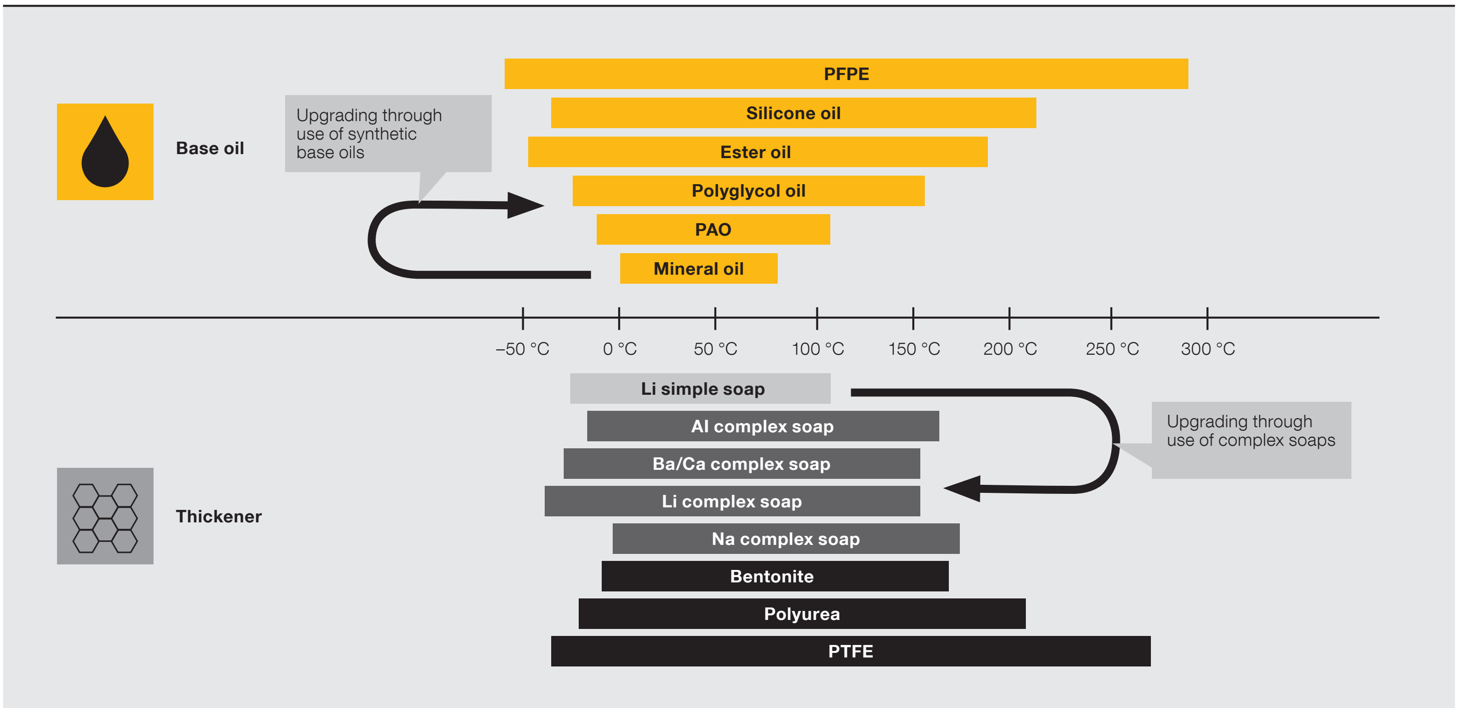
By adding antioxidants, thermal ageing can be slowed down considerably. Such additives prevent the chemical oxidation of the base oil. Furthermore, extreme-pressure (EP) and antiwear (AW) additives increase the mechanical load-bearing capacity of the lubricant.

When looking at the base oils used for lubricants, the main differentiation is that between mineral oils and synthetic oils. Synthetic base oils have less volatile components than mineral oils and are more resistant to ageing because of their chemical structure. This benefit comes to bear especially as operating temperatures rise. Short-term temperature peaks as occur when the brakes of a train are put on also affect synthetic oils less than mineral oils.

The type of thickener can also be selected with a view to making the lubricant more resistant to ageing. Complex-soap thickeners, for example, show greater oil retention, especially at elevated temperatures or mechanical stresses. This means an optimal oil quality is present at the friction point for a longer time, with less dependence on temperature or loads. Especially with cylinder and tapered roller bearings, which are often used in these applications, sufficient oil supply to the tribological contact is of major importance.

For the use of axlebox bearings, the application of a lubricant with good resistance to ageing means a constant lubricating effect and more safety throughout the maintenance interval, and often beyond.

Service temperature ranges of individual lubricant constituents

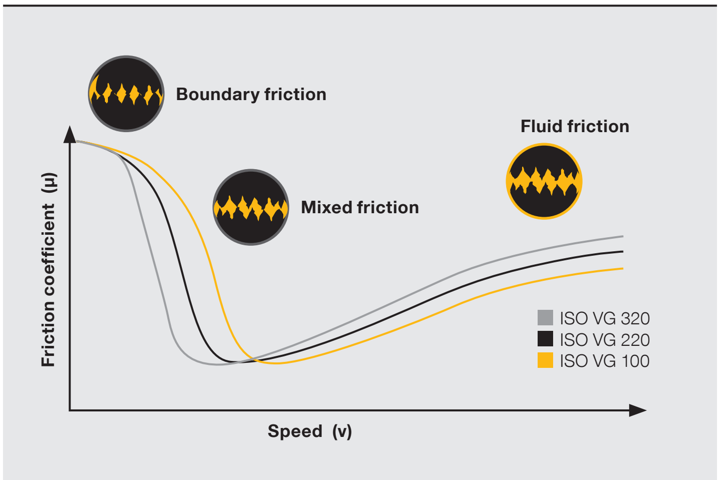


Higher efficiency due to optimised friction behaviour

Efficient utilisation of the tractive force is decisive for the optimised operation of axlebox bearings in rail vehicles and a reduction of costs. The focus here is primarily on the friction as it influences performance, wear and service life of the axlebox bearings.

To start with, it is important to determine the general friction condition the axlebox bearing operates in at varying speeds. These can be boundary friction, mixed friction, and fluid friction. Boundary friction occurs at very low rotational speeds, especially during moving off or stopping. Boundary friction means that contact between the friction bodies' surfaces is very intense, so friction and wear are at a maximum. Mixed friction is the range between boundary friction and fluid friction. There is still some direct contact, but separation by a lubricant film sets in, which greatly reduces friction. As the speed increases, the base oil viscosity leads to the formation of a lubricant film with hydrodynamic load-bearing capacity, enabling full separation of the friction bodies. The graphic representation of the friction coefficient as it changes with speed is referred to as the Stribeck curve, named after the German scientist Richard Stribeck. When operating in the fluid friction mode, the lubricant's internal friction increases with rising speed to a degree that is largely determined by the base oil viscosity.

Friction behaviour curve with different viscosities



While a higher base oil viscosity will normally lead to higher internal friction at high speeds, it provides more favourable friction behaviour under boundary and mixed friction conditions at low to medium speeds. It makes therefore sense to select a viscosity that matches the individual application. In freight cars, for example, a higher viscosity is of advantage to get the wheel bearing out of the boundary friction range sooner.

Other components impacting a lubricant's friction behaviour are additives. Surface-active EP and AW additives can reduce friction considerably. Component surfaces are acted on in a way to obtain a more favourable degree of friction. What is decisive here is the interplay between base oil and additives. They must be optimal matches to ensure maximum effect.

More safety with advanced grease concepts

Damage to axlebox bearings can have unfathomable consequences for passenger or freight trains. In this context, the **wear behaviour, shear stability**, and the **load-bearing capacity** of a lubricant are of vital importance. The focus is very much on preventing the generation of what is called „hot boxes“ as they cause rapid ageing of the lubricant.

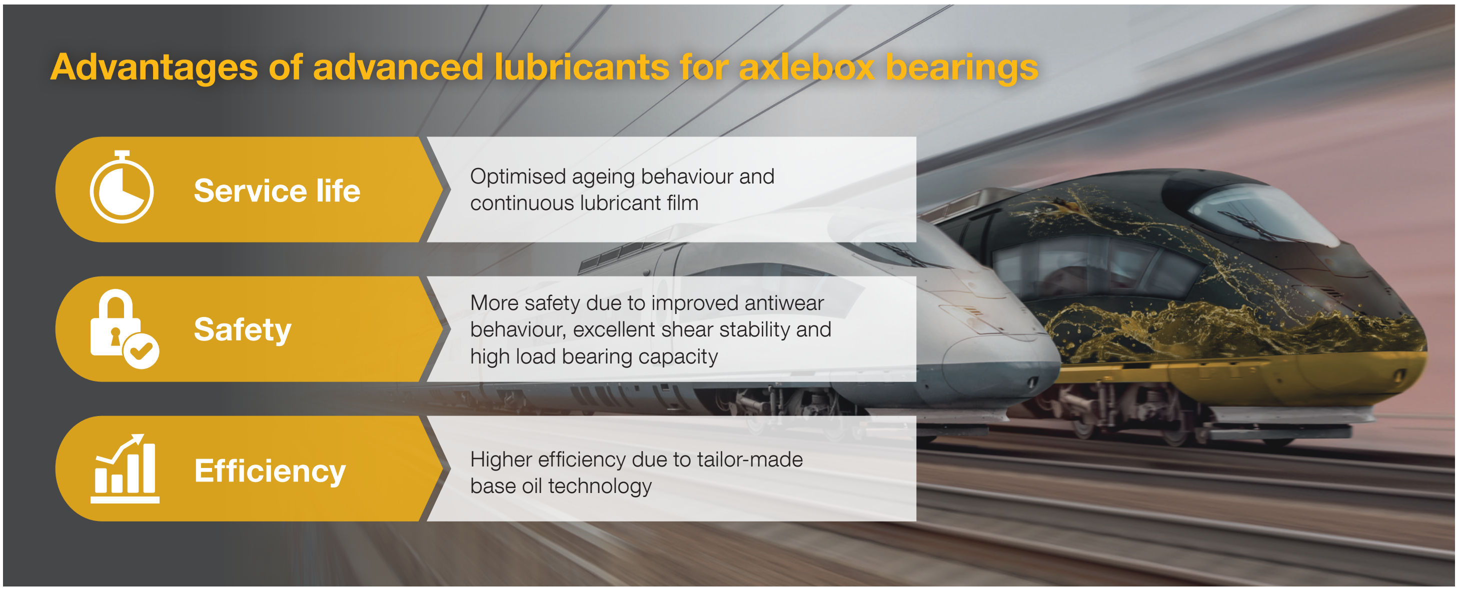
When a load-bearing lubricant film builds up at an early stage, the friction bodies, i.e. bearing rollers and raceways, are separated from one another, leading to much less **abrasion** and hence longer bearing life. With specially selected antiwear additives, significantly lower friction coefficients can be attained. The wear behaviour can be assessed on the basis of FAG-FE8 testing.

A grease‘s **shear stability** describes its resistance to mechanical stress and is a measure of its general stability. Loss of viscosity and consistency due to mechanical stress in axlebox bearing greases must not lead to too much oil bleeding from the grease and leakage from the bearing. It must be ensured there is always enough grease in the bearing. For this purpose, Klüber Lubrication uses selected fully synthetic base oils and thickeners meeting these requirements, enabling the lubricant to be used for longer.

Especially in freight cars, a grease‘s **load bearing capacity** is an important characteristic describing its pressure absorption capacity in the axlebox bearing. Axle loads may be as high as 25 tonnes acting on both the bearing and the lubricant. To attain a lubricant film of sufficient thickness, the stability of the thickener as well as the selection of an adequate base oil viscosity are of utmost importance. Klüber Lubrication meets conflicting requirements by offering two different lubricating greases - one especially for trains travelling at higher speeds and with lower loads such as high-speed and other passenger trains, and another for trains travelling at lower speeds and with high loads such as freight trains.

All benefits at a glance

- Improved ageing behaviour and constant lubricity due to advanced base oil and thickener concepts
- More safety in operation due to optimised wear behaviour, very good shear stability and application-specific grease
- Increased axlebox bearing efficiency due to base oil viscosities matching different requirements



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