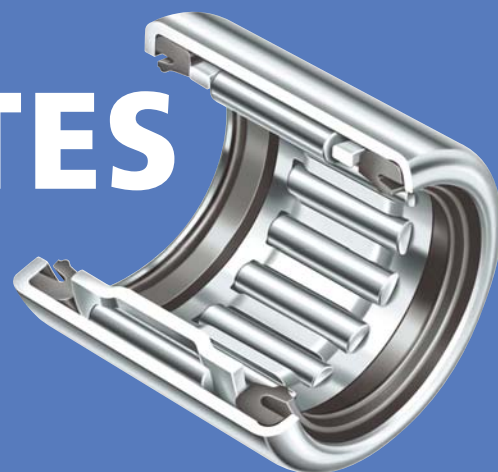




PASTES AND GREASE PASTES

WITH ACTIVE-REACTION
WHITE SOLID LUBRICANTS



SYNERGETIC - PRACTICAL - EFFECTIVE



PASTES AND GREASE PASTES

with active-reaction white solid lubricants

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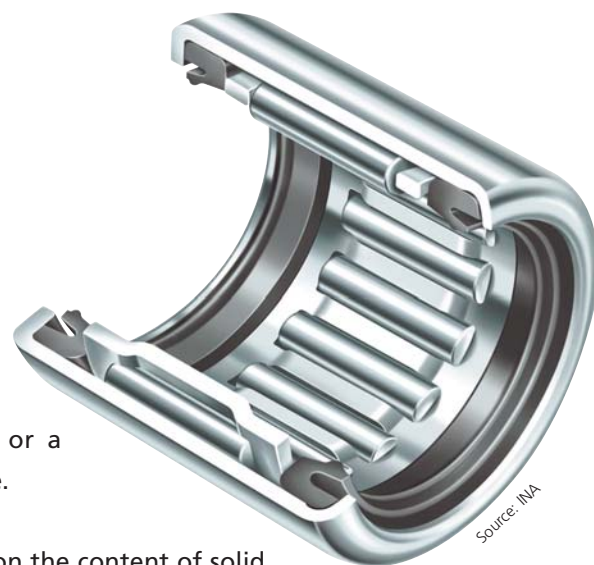
■ INTRODUCTION

In extreme applications where extremely stringent demands are made on lubricants, pastes and grease pastes from the gleitmo range are often the only solution, and in many cases cannot be replaced by other products. In particular where there are high surface pressures and low sliding speeds, or in the presence of oscillating movements or extremely high temperatures, the unique characteristics of pastes and grease pastes can demonstrate their excellent performance.

Pastes and grease pastes are a mixture of a base oil or grease with solid lubricants and additives. The solid lubricants can also take on the function of thickeners. Their main purpose is rather to lend properties to the product

that could not be achieved with an oil or a grease alone.

Depending on the content of solid lubricants, we speak of pastes, grease pastes or greases. If the content is 40% or more, we consider the product to be a paste, and with a content of 10 to 40%, a grease paste. If a product contains less than 10% of solid lubricants, we refer to the product as a grease.



TYPES AND CHARACTERISTICS

of pastes and grease pastes

■ EXAMPLES OF PASTES:

The classification of pastes and grease pastes, and also their possible applications, are very complex. Up to the present day, no unified standard has been issued with regard to these lubricants.

Because of different ways to classify pastes and grease pastes, according to specific parameters, overlaps also frequently occur. Possible criteria for differentiation can be, for example, the colour (black or white pastes), or the

composition or main constituent (copper pastes, MoS₂ pastes). A further possibility is to differentiate according to the application (hot thread paste, parting paste). Within this, a copper paste is always also a hot thread paste and an MoS₂ paste is a black paste etc.

The following table lists some of the different terms referring to pastes and shows the characteristics and applications associated with these.

Designation	Properties	Application
Assembly pastes	High pressure resistance, good lubrication, low friction coefficients, no stick-slip	All types of assembly work (pressing in and out)
Hot thread pastes	Good separating property in the thread at extreme temperatures, as far as possible without harmful interaction with the screw material	High-temperature screw connections
Copper pastes	Separation in high temperature applications, extremely high pressure resistance, limited lubrication	Use as high-temperature parting pastes
Metal pastes	Resistant to high temperature, often not metalurgically safe	Use as high-temperature parting pastes
PTFE-pastes (containing polytetrafluorethylene)	Contain PTFE as solid lubricant, good lubrication effect at medium loads, good chemical resistance, temperature up to +280°C possible in association with PFPE base oils	Steel-plastic lubrication, elastomers, also in food production and food processing
PFPE-pastes (containing perfluoropoly-ether base fluid)	Perfluorinated base oil, good chemical and thermal resistance, low affinity with surfaces, often used with PTFE as thickener or solid lubricant	Oxygen technology, chemical industry
Silicone pastes	Physiologically safe, plastic compatible	Drinking water fittings, lubrication of plastics
Black pastes	Contain MoS ₂ or graphite, pressure resistant, low friction coefficients	Use as assembly pastes
White pastes	Depending on composition, good lubrication or separation characteristics, in some cases very high resistance to temperature	Use as assembly pastes, for highly-loaded components, anti stick-slip, for stainless steel screws
	gleitmo pastes and grease pastes with active-reaction white solid lubricants play a special role.	For avoidance of tribocorrosion (fretting corrosion), caused by vibrations and small adjustment movements.

STRUCTURE AND FUNCTION

of active-reaction white solid lubricants

■ WHITE IS NOT ALWAYS WHITE

The term “white paste” includes a large number of different products. The characteristics differ greatly depending on the composition of the paste or grease paste (Fig. 1). The only common feature is the pale colour, which can nevertheless range from white to beige/brown through the addition of different base oils, solid lubricants or additives.

■ DEFINITION

By “**active-reaction white solid lubricants**” are meant various inorganic compounds in the form of smooth, soft powders, which do not have an abrasive effect. These are able to form tribochemical reactive layers under certain conditions of use. Selected combinations of these solid lubricants, as are used in the **gleitmo pastes and grease pastes**, also demonstrate a **synergetic effect**, which accelerates and intensifies the formation of these reactive layers, achieving excellent wear protection characteristics, even under difficult operating conditions. PTFE and waxes are not included in this group, as they cannot form reactive layers.

■ FRICTION CONDITIONS (Fig. 2)

In the area of very low relative speeds or when starting up machines, the shaft and bearing shell are not yet separated by the lubricant (boundary friction). As velocities increase, a lubricating film forms between the surfaces, which increasingly separates the components from one another (mixed friction). The roughness peaks are still in contact with each other, so that wear continues to occur. Only when relatively high velocities are attained a lubricant film can be generated in which the two surfaces are fully separated from each other (hydrodynamics). In the hydrodynamic friction regime no wear of the friction part-

Fig. 1: BASIC COMPOSITION OF GREASES, GREASE PASTES AND PASTES

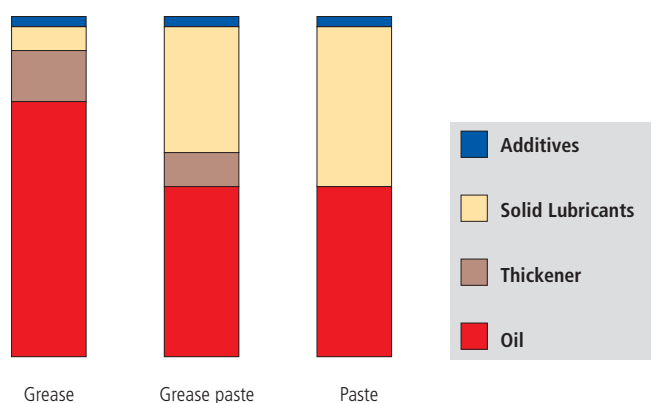
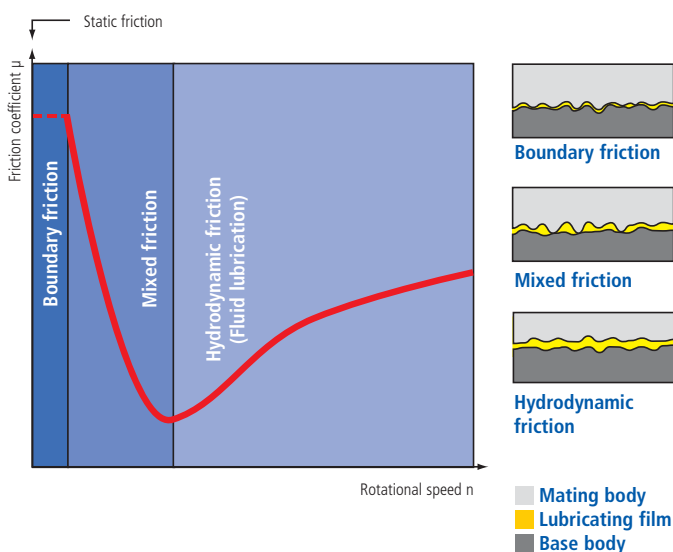


Fig. 2: STRIBECK DIAGRAM: MODEL OF FRICTION CONDITIONS

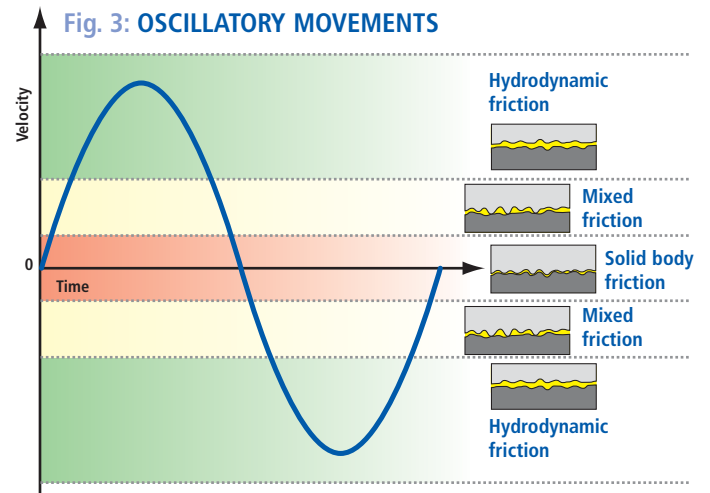


ners takes place. This ideal state is only achieved in a few machine elements, e.g. in sliding bearings of turbines. However, in many applications the most common form of friction is mixed friction. Here in particular, gleitmo pastes and grease pastes with active-reaction white solid lubricants demonstrate their excellent effectiveness as compared with conventional products.



■ OSCILLATORY MOVEMENTS

Many machine elements are subject to vibrations. In addition, there are cases where oscillatory movements take place as a normal part of the function. The characteristics of these movements are that during each individual cycle of movement, the velocity rises from zero to its maximum value, and then falls back to zero again, to rise again in the opposite direction before passing through zero again (Fig. 3). Related to the Stribeck diagram (p. 4, Fig. 2) this means that the friction condition changes continuously between static or boundary friction and mixed or even hydrodynamic friction. This places extreme demands on the performance capacity of the lubricant.



Under these conditions, traditional lubricating greases are not able to form a protective lubricating film with sufficient load resistance.

■ SRV TEST METHOD (OSZILLATION, FRICTION AND WEAR-TEST)

The performance data for lubricants which are intended for use in applications where friction is associated with oscillatory movements are determined with the SRV test machine. Here, the test specimen (ball or cylinder on plate) move oscillatory in a straight line. The test specimen, which are wetted with lubricant, are subject to mechanical loading with a vertical force, a specified frequency, a predetermined vibration displacement and

a specified temperature. Typical values are, for example, 50Hz / 500μm / 300N / +50°C. The friction coefficient μ is determined by measurement of the friction force. The volume and depth of wear on the plate are also measured. The test data gathered by these means show the actual performance of the lubricant.

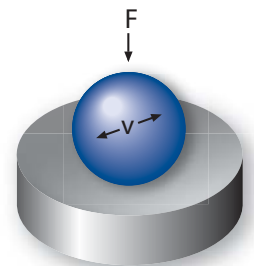
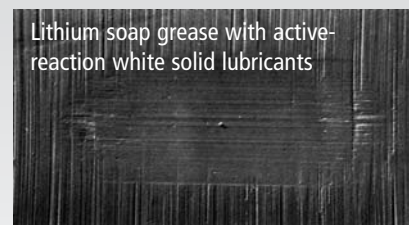
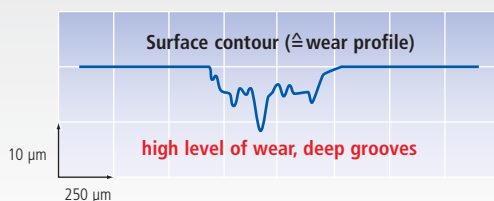
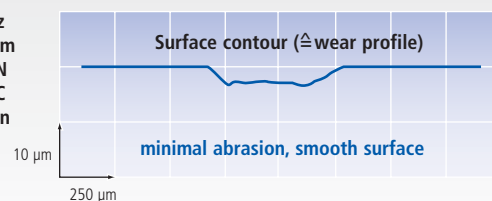


Fig. 4:
SRV-TEST

Surfaces of test bodies after an hour of testing



$f=50\text{Hz}$
 $A=500\mu\text{m}$
 $F=300\text{N}$
 $T=50^\circ\text{C}$
 $t=60\text{min}$



ADDITIVES

THE RIGHT COMBINATION IS VITAL

Certain white solid lubricants react tribochemically with metallic boundary surfaces in the presence of sufficiently high excited states. These occur, for example, with oscillatory movements, i.e. if the metal bodies which are in contact with each other perform low-amplitude oscillations.

This results in the formation of thin adhesive layers on the contact surfaces which reduce friction and wear, improve running in and considerably prolong the lifetime of machine elements. The particular synergy effect of the combination of different white solid lubricants in gleitmo pastes and grease pastes facilitates an optimal protective layer, both for steel-steel material pairings and for other metal pairings with copper or aluminium alloys. In many applications, this tribochemical effect of the active-reaction white solid lubricants is much more effective than the mostly mechanical-physical functioning of lubricants containing MoS₂ or graphite (Fig. 5).

Fig. 6 shows the results of five comparable tests with $p \cdot v = 1200 \text{ N/mm}^2 \cdot \text{mm/s}$ ($p \cdot v \triangleq$ product of surface pressure and velocity) and an angle of 30°. Tests 4 and 5, where a gleitmo grease paste with active-reaction white solid lubricants was used, was stopped after 500 h with the joint bearings fully intact. The lifetime of the joint bearings was increased between 6 and 10 times by using a gleitmo grease paste with active-reaction white solid lubricants as against a grease containing MoS₂. The joint bearings lubricated with the grease containing MoS₂ only achieved a maximum lifetime of 80 operating hours.



Fig. 5: SOLID ADDITIVES

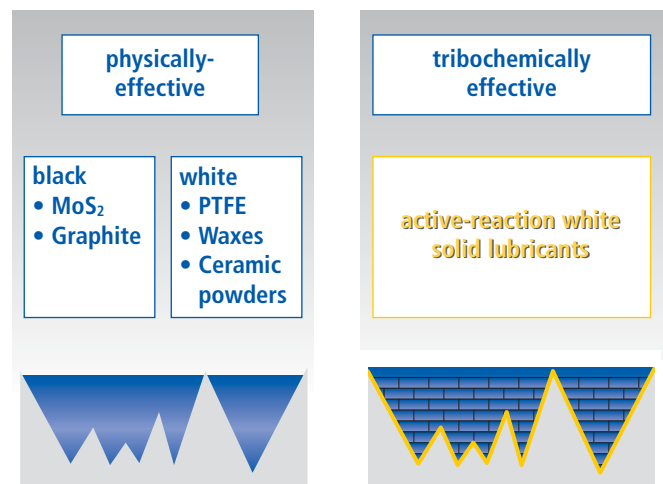
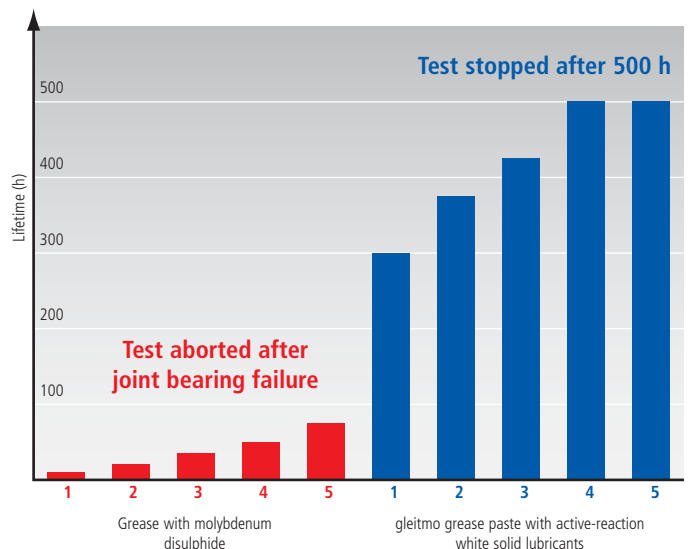


Fig. 6: TILTING BEARING TEST



TYPICAL FIELDS OF APPLICATION

and application examples



“White” gleitmo pastes and grease pastes are designed for use on components and machine elements that are subject to the following stresses: oscillatory movements/vibrations or heavy loads/slow movements.

As the friction partners are not completely separated from one another in the case of boundary or mixed friction, very high wear occurs and therefore the affected components and machine elements fail very early.

The desired hydrodynamic state cannot be achieved in many applications, since the relative velocities under the

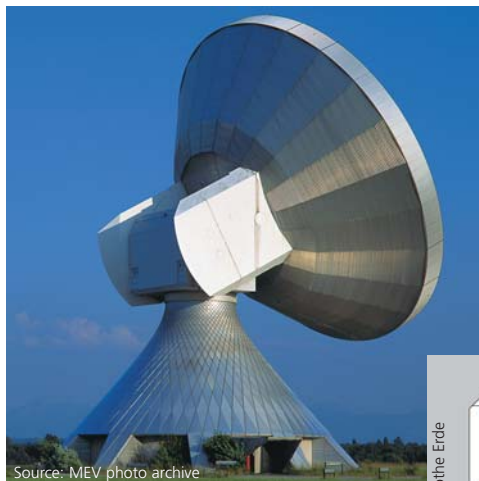


defined loading conditions are insufficient to separate the friction partners from each other. Mixed and boundary friction also occur in the presence of very rapid oscillatory movements, as no relative speed occurs between the surfaces at the reversal points and therefore the friction partners touch one another (see page 5, fig. 3).



TYPICAL FIELDS OF APPLICATION

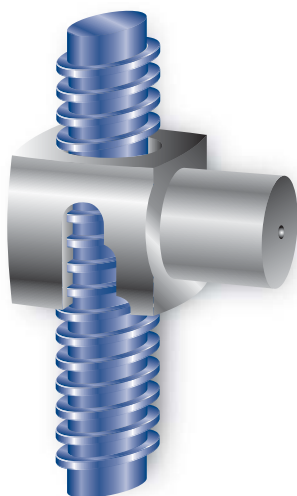
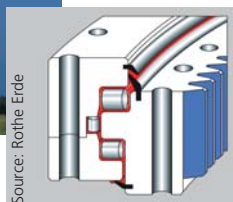
and application examples



LUBRICATION OF THE MAIN BEARING OF A RADIOTELESCOPE

In this case, the entire turn table of the tower (bearing and gearing) and also the gearing of the altitude adjustment mechanism are lubricated automatically. Active-reaction white solid lubricants reliably protect these large machine elements.

gleitmo® 585 K



LUBRICATION OF SPINDLES IN HEAVY-DUTY LIFTING ELEMENTS

Optimum wear protection and best-possible compatibility with the materials used. Active-reaction white solid lubricants prevent stick-slip, even with unfavourable material pairings.



gleitmo® WSP 5040



LUBRICATION OF CURVED TEETH COUPLINGS

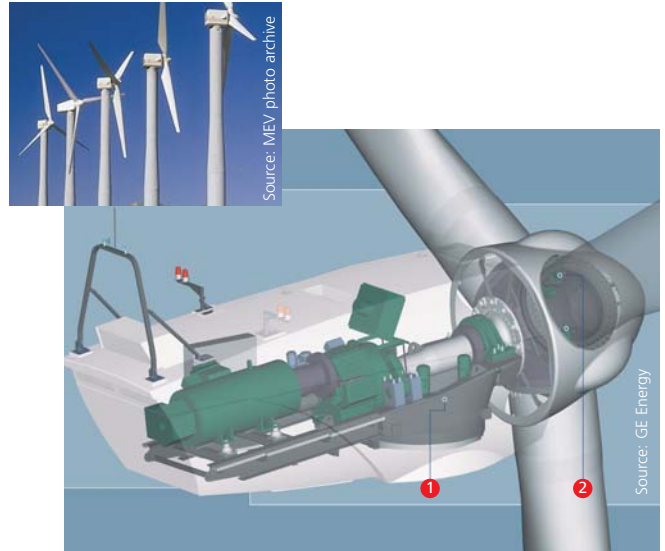
Constant sliding movements demand effective lubrication of the gear teeth when the coupling is subject to fluctuating loads. Active-reaction white solid lubricants ensure safe operation.

gleitmo® 805 K

LUBRICATION OF TOWER BEARING (1 AZIMUTH BEARING) AND BLADE PITCH CONTROL (2 PITCH BEARING) OF A WIND POWER PLANT

Constantly fluctuating forces and vibrations place these expensive components at risk. Active-reaction white solid lubricants prolong the lifetime of the large-diameter bearings, as they prevent the unwelcome ripples in the raceways, even under small adjustment movements.

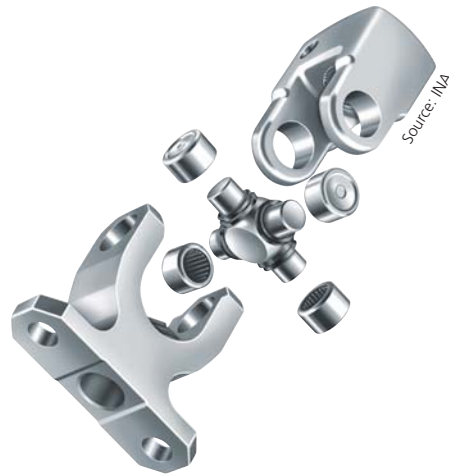
gleitmo® 585 K



LUBRICATION OF CARDAN JOINTS

No rolling movements as in a bearing, but more-or-less even rotation with overlaid swivelling motion. There is no real alternative to active-reaction white solid lubricants for protection against wear in such applications.

gleitmo® 585 M



INCREMENTAL LAUNCHING FOR THE CONSTRUCTION OF BRIDGES MADE OF PRE-STRESSED CONCRETE

The concrete elements produced on site are pushed along by means of special hydraulic lifting and shifting units (small picture). Active-reaction white solid lubricants reduce friction and wear.



gleitmo® 805

TRIBOCORROSION

Causes and effects

■ DEFINITION

Undesirable changes occur to mating surfaces of ferrous materials because of frictional corrosion. In practice, this form of wear is often found in machine elements which are joined by means of frictional and positive connections.

If the amplitude of the oscillatory movement is very small ($< 500 \mu\text{m}$), this form of wear is referred to as tribocorrosion or fretting corrosion. It is not necessary that com-

ponents are deliberately moved against one another for fretting corrosion to occur.

In fact it often already develops through transmission of vibrations e.g. in the case of bearing seats or shaft-hub connections. This is also true for components with uniform motion, but which experience numerous start/stop movements (e.g. linear guides and spindles).

TRIBOCORROSION HAS DIFFERENT CAUSES AND EFFECTS:

Cause	Effect
Adhesion	Formation and separation of adhesive connections at the atomic level in the case of highly-stressed friction pairings (cold welding)
Abrasion	Removal of material through scoring or grooving when touching the roughness peaks of the friction partners
Surface disruption	Material fatigue with crack formation near to the surfaces of the friction partners through high tribological fluctuating loads (material may break off)
Tribochemical reaction	Formation of chemical reaction products through high level of mechanical excitation of boundary surfaces and/or the intermediate material

TYPICAL APPEARANCE OF TRIBOCORROSION



Joint bearings



Clamping sleeve



Needle bearings

■ MEASURES FOR THE AVOIDANCE OF TRIBOCORROSION

Both design-related and tribological measures can be employed in order to prevent the occurrence of tribocorrosion:

- Use of special coatings
- Reduction of machine vibrations
- Reduction of high bending forces
- Avoidance of large metal surfaces which act upon one another

- Use of gleitmo pastes and grease pastes with active-reaction white solid lubricants



This measure is still available when all the above measures cannot or can no longer be applied. Active-reaction white solid lubricants offer effective protection even here.

RESEARCH RESULTS

■ SPINDLE LUBRICATION

The superior lubrication performance offered by active-reaction white solid lubricants is impressively demonstrated in the following test: a steel spindle is cyclically rotated by two turns. In this process, it moves inside a steel nut, which is attached to a tension spring. The nut and spindle are therefore in permanent tension. One cycle consists of two rotations to the right and two rotations to the left.

In the case of this unfavourable material pairing, the surface pressure is decisive. The requirements for the lubricant are very severe, as the design of the spindle does not allow deposit of lubricant. The lubricant film must provide the entire lubrication effect for the duration of the loading.

A multi-purpose lithium soap grease frequently used in such applications fails after a few cycles. The MoS₂ paste which was tested achieved 35,000 cycles. However, in contrast the test with the white grease paste was only stopped after 500,000 cycles, but with the spindle fully intact.

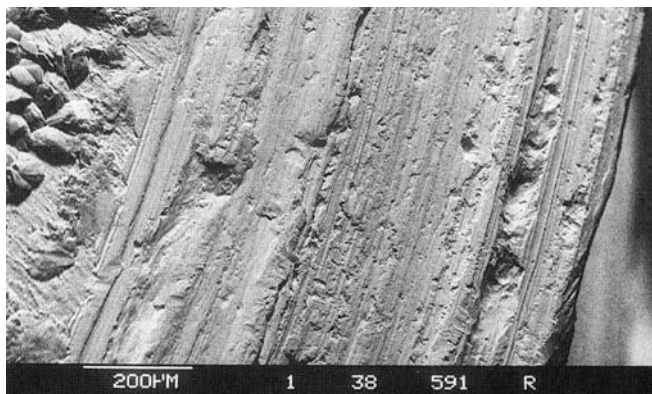
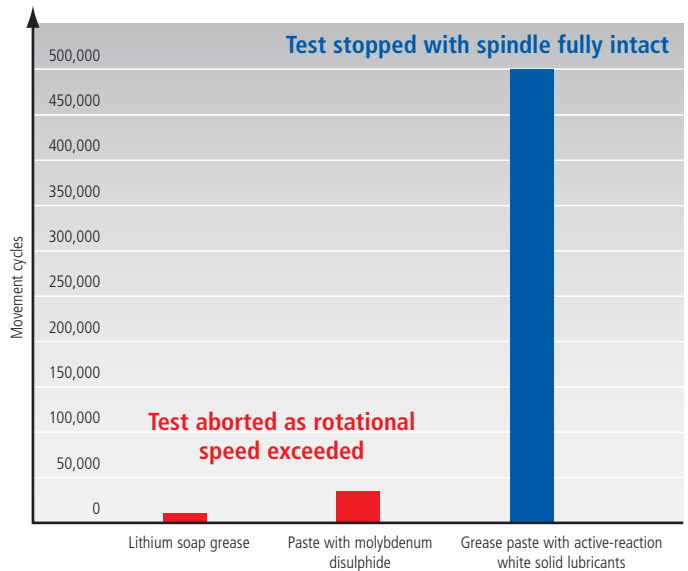


Fig. 8: Lubrication with MoS₂ paste. Spindle surface after 35,000 motion cycles. Test aborted, as power consumption of motor too high (torque exceeded).

Fig. 7: COMPARATIVE SPINDLE LUBRICATION TEST



- Steel-steel material pairing
- Sliding speed 8.5 mm/s
- Motion cycle: 2 rotations right, 2 rotations left
- Switch-off criterion: increase in rotational torque with stick-slip effect

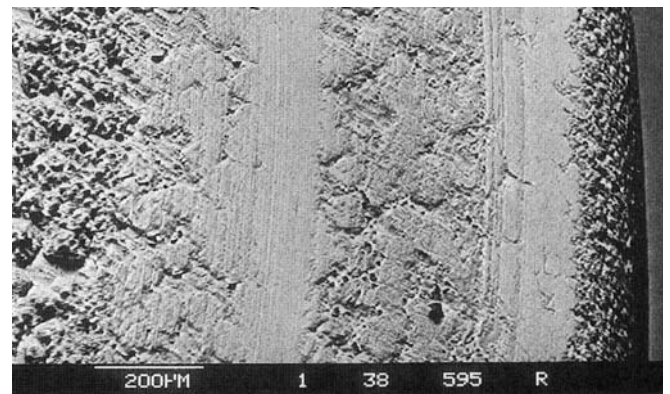


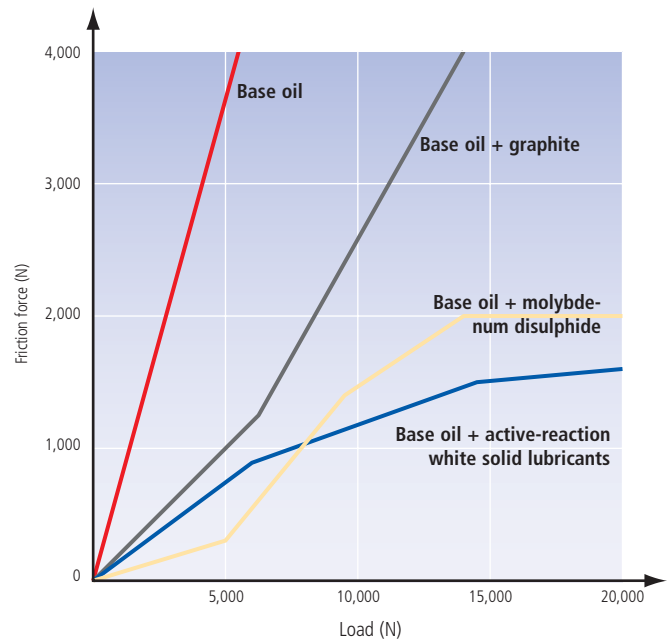
Fig. 9: Lubrication with a grease paste which contains active-reaction white solid lubricants. Spindle surface after 500,000 motion cycles. Test stopped with spindle fully intact.

RESEARCH RESULTS

JOINT BEARING LUBRICATION

Fig. 10 shows the results from tests performed on a joint bearing test rig. The friction force is shown depending on the loading. All joint bearings are lubricated with base oil. On the one hand untreated, and on the other alloyed with graphite, MoS₂ and active-reaction white solid lubricants. The friction force was kept at a significantly lower level through the addition of active-reaction white solid lubricants than with the graphite or MoS₂ additive. The benefits which can be achieved by using active-reaction white solid lubricants are particularly clear in the case of joint bearings. Hydrodynamic conditions do not come into play and protection against wear is generally due to the inclusion of the white solid lubricants.

Fig. 10: RESULTS FROM TESTS ON THE JOINT BEARING TEST RIG

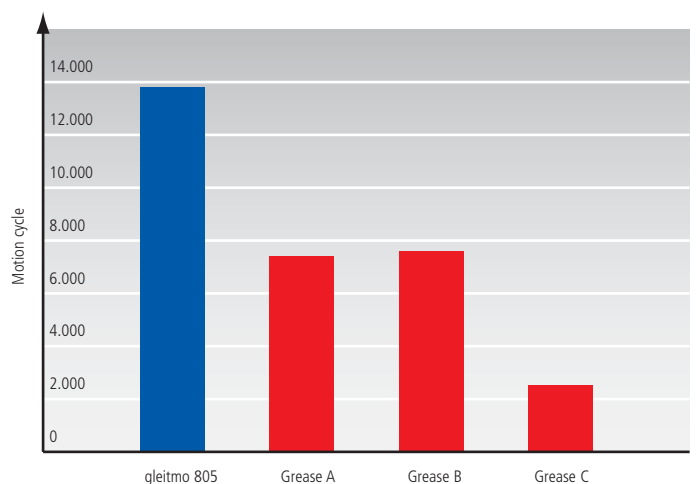


Lifetime of joint bearings lubricated with oils containing different additives

Fig. 11 shows gleitmo 805 in direct comparison with different greases in a joint bearing test. With a loading of 50 N/mm² and the material pairing steel/steel and also a

swivelling angle of +/- 10°, gleitmo 805 shows its obvious superiority over other greases which were tested, achieving double the number of cycles. The other greases were stated to be particularly suitable before the test by the respective manufacturers.

Fig. 11: JOINT BEARING TEST AT EXTREME LOADING WITH SMALL SWIVELLING ANGLE



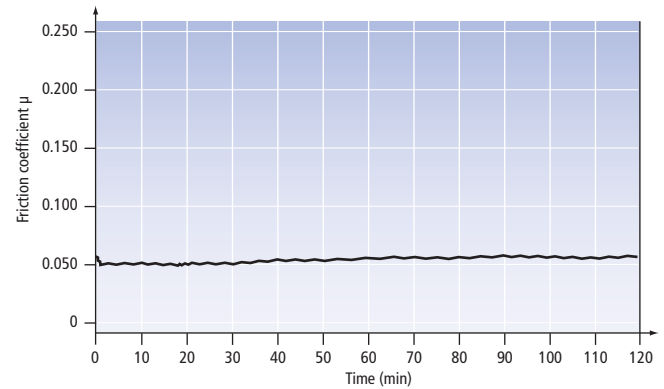
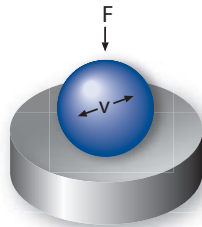
- $p=50 \text{ N/mm}^2$
- Material pairing: steel/steel
- Swivelling angle: +/- 10°
- $f=54 \text{ min}^{-1}$

TYPICAL TEST METHODS

for pastes and grease pastes

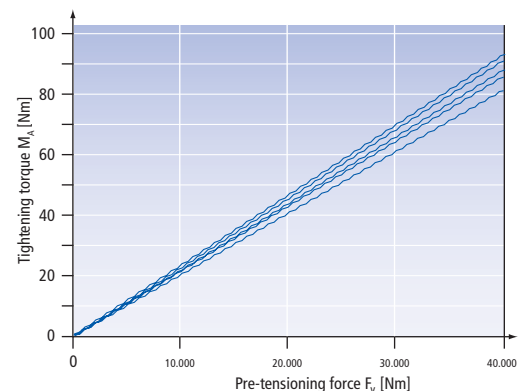
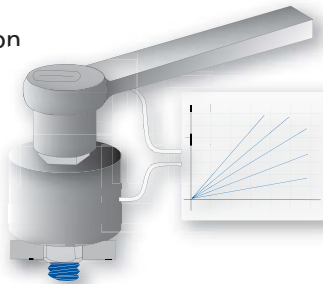
SRV TEST METHOD

- DIN 51834-8
- Oscillating test body on plate (lubricated)
- Contact geometry: point (alternatively flat surface or line)
- Test criteria: coefficient of friction, wear
- Lifetime test at high sliding speeds and variable surface pressures, temperatures, amplitudes and frequencies



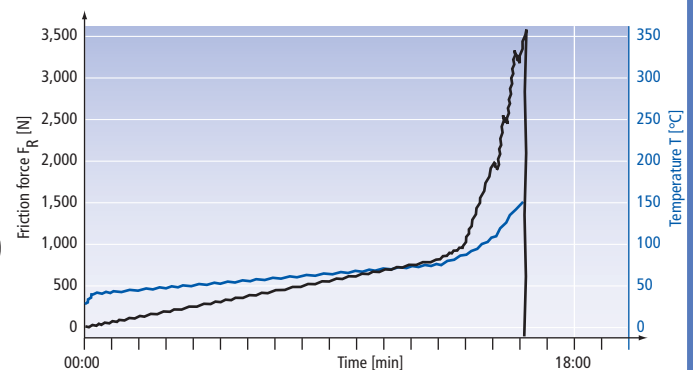
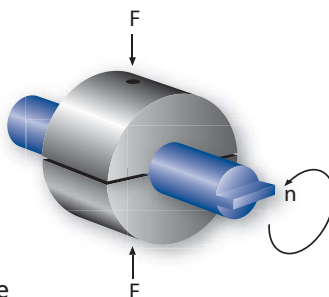
SCREW TEST

- DIN EN ISO 16047 (DIN 946)
- Determination of coefficients of friction on bolted connections
- Contact geometry: flat surface (thread and bolt head)
- Test criteria: coefficient of friction, pre-tensioning force
- Measurement of thread friction, head friction and overall coefficient of friction



ALMEN-WIELAND TEST METHOD

- LLS¹⁾ 060
- Rotating shaft (lubricated) fixed in two bearing shells
- Contact geometry: flat surface
- Test criteria: seizing load, coefficient of friction
- Measurement with low sliding speeds and high surface pressure



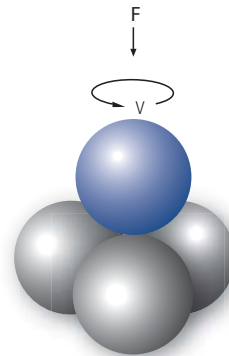
1) LLS: LUBRITECH Laboratory Specification

TYPICAL TEST METHODS

for pastes and grease pastes

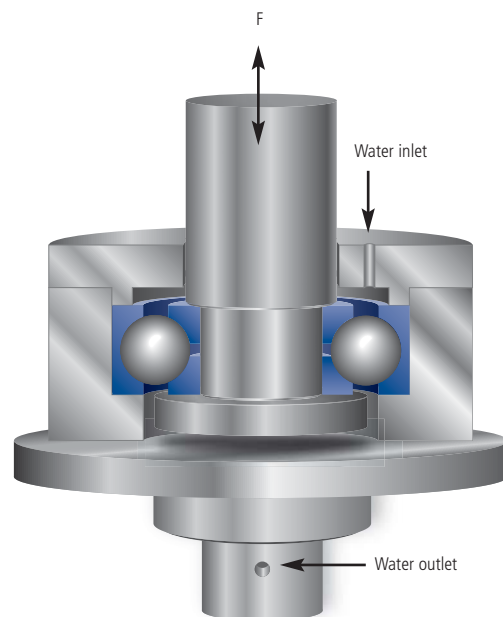
FOUR-BALL TEST METHOD

- DIN 51350 (1-5)
 - Rotating ball on three fixed balls
 - Contact geometry: point
 - Test criteria: four-ball welding load, wear
 - Step-by-step increase of test force up to welding of the balls
- or
- Constant test force over a specified period of time (1h or 1min), measurement of wear scar



IME-RE RIPPLING TEST METHOD

- Test developed by IME Aachen (Institute for Machine Elements and Machine Design at the Technical University of Aachen) and the bearing manufacturer Rothe Erde GmbH, Dortmund
- Oscillating axial force on a four-point bearing with outer and inner ring fixed against each other
- Contact geometry: point
- Test criteria: wear depth (ripple depth) and corrosion protection
- Lifetime test with high axial loads with influence of salt water



SELECTION GUIDE

Pastes and grease pastes

FIELDS OF APPLICATION

Item no.	0154	0156	0157	0112	0158	0170	0115	0173	0171	0222	0174	1726	0215	0370	0377	0169
	gleitmo 577 A	gleitmo 577 C	gleitmo 582	gleitmo 585 M	gleitmo 585 K	gleitmo 800	gleitmo 805	gleitmo 805 K	gleitmo 810	gleitmo 815	gleitmo 820	gleitmo 825	gleitmo 830	gleitmo WSP 5000	gleitmo WSP 5040	CHEMPLEX 746
Min. operating temp. [°C] ▶	-40	-40	-15	-25	-45	-25	-20	-45	-25	-45	-20	-30	-25	-20	-20	-40
Max. operating temp. [°C] ▶	180	180	120	120	130	100	110	110	80	110	1150	1150	100	140	1200	175
NLGI grade ▶	1	00	-	2	2	2	2	2	2	2	1-2	1	2	2	2	1-2
Annular springs ▶																
Assembly ▶																
Ball screw spindles ▶																
Bending ▶																
Cardan shafts ▶																
Chains ▶																
Chucks ▶																
Crimping ▶																
Curved teeth coupling ▶																
Fretting corrosion ▶																
Gear couplings ▶																
Hinges ▶																
HT paste ▶																
O-rings ▶																
Pillar guides ▶																
Plain bearings ▶																
Press fitting ▶																
Press forging ▶																
Roller bearings ▶																
Running-in lubrication ▶																
Seals ▶																
Shock absorbers ▶																
Threaded joints ▶																
Threaded spindles ▶																
Tilting bearings ▶																

Lubrication Technology



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