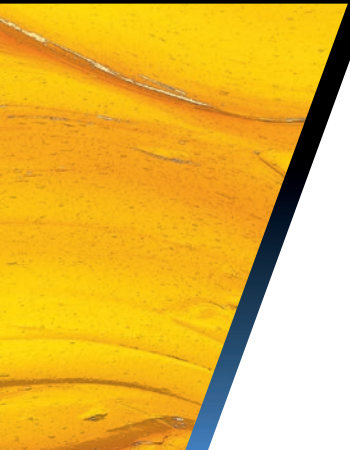


your global specialist

Perfect fit for each life
stage of a gear.

Lubrication solutions for mineral and cement processing



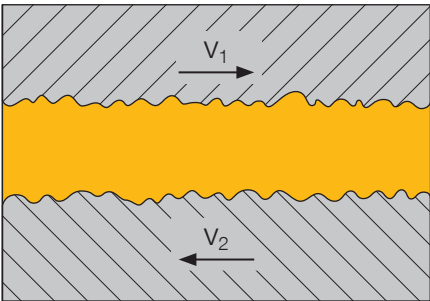
How open gear lubricants work

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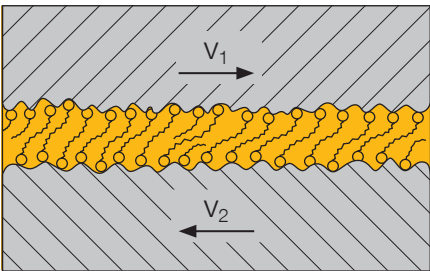
Lubrication mechanism: base oil with additives

Excessive wear and flank damage can be avoided if the intermeshing tooth surfaces are completely separated by a lubricant film. This, however, is almost impossible in large gear drives due to the low peripheral speed, the very high flank pressure and the relatively high flank roughness. Furthermore, since pinion and gear rim are supported separately and are aligned during assembly, their axes are often not perfectly parallel, which makes the operating conditions even more severe. As a consequence, large gear drives operate mostly under mixed friction conditions.

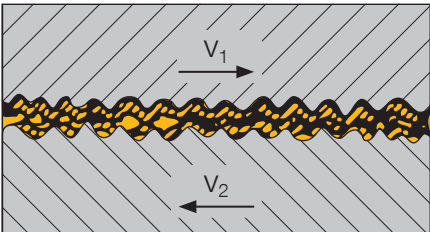
To lubricate large gear drives reliably and protect them against damage, the lubricants applied must be highly adhesive, and their physical and chemical properties must be such that they form protective layers on the tooth flanks under the prevailing operating conditions. These protective layers largely prevent direct metal-to-metal contact and hence minimize friction. To create lubricants that have this effect, special types of base oil are selected that have the right viscosity. The lubricants also contain EP (extreme pressure) additives and possibly the right amount and type of solid lubricants.



Hydrodynamic lubrication



Lubrication by physically adsorbed layers



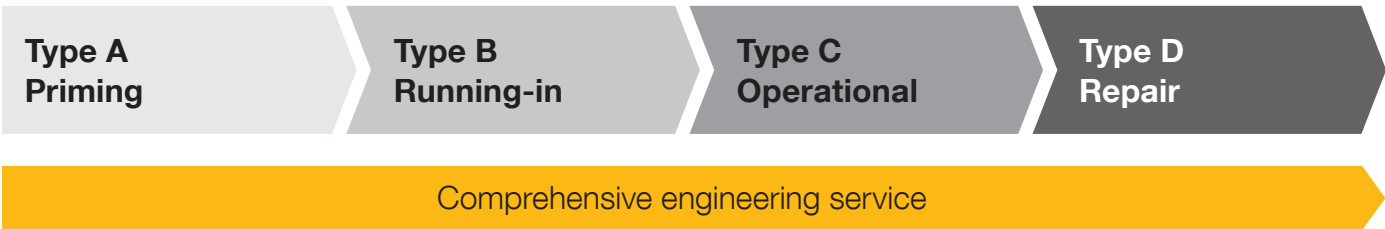
Lubrication by chemical reaction layers

A-B-C-D system lubrication for open gears

Increased efficiency, productivity and reliability

Large girth gear drives have proven effective in plant engineering for many decades and continue to be the type of drive most commonly found in ore and cement processing, coal fired power plants, fertilizer plants, chemical factories, sugar refineries, waste incineration and composting plants. The reliability and operational safety of the drives, and in consequence their lubrication, is of utmost importance.

Functional reliability and damage-free operation of large gear drives highly depend on correct lubrication. To ensure optimum lubrication at all life stages, Klüber Lubrication has developed a systematic lubrication method for large gear drives which has been known for many years under the name of A-B-C-D system lubrication.



Comprehensive gear care throughout its lifetime

Outstanding gear protection starts long before the actual first revolution and accompanies the gear set over its entire life span. Therefore Klüber Lubrication offers a four-step process.

Priming lubricants protect the tooth flanks from damage during storage and initial alignment of the gears. Lubricants can be applied manually by brush or spatula.

Running-in lubricants are applied to new gears or after repair lubrication. They improve the surface condition and the contact pattern and reduce the possibility of gear damage in subsequent stages.

Operational lubricants provide excellent gear protection at very low consumption rates and are approved by all major gear OEMs.

Repair lubricants re-condition the tooth flank surface; they remove asperities, scratches and scorings to improve the contact pattern. Even plastic deformation, up to a certain level, can be smoothened.

Coping with influencing parameters
Our operational lubricants keep up wear protection with the latest additives and high-viscosity base oil technology.

Service
Klüber Lubrication offers a comprehensive engineering service to its customers during every life stage of a gear.

Gear greases containing solid lubricant <ul style="list-style-type: none">High solid lubricant contentSoap-thickened and based on mineral or semi-synthetic oilWell proven performance for more than 40 years	High-viscosity fluids <ul style="list-style-type: none">Transparent colorUltra-high-viscosity base oilsExtremely adhesive
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Priming, running-in and repair lubricants are available for both lubricant technologies.

Product selection guide

With the experience of thousands of open gear sets lubricated around the world over more than 40 years, our experts will assist you during the product selection process and provide you with the right solution. We offer a complete selection for large, low to medium-speed and high-torque open gears. All our products are available worldwide in the same quality and packaging sizes.

Product line	Specialty lubricant	Color space	Application method and temperature range					
			Automatic lubrication				Manual lubrication	
			Spray lubrication	Immersion lubrication	Circulation lubrication	Transfer lubrication	Brush, spatula	Compressed air spray gun
A	Klüberplex AG 11-462	White	-	-	-	-		-
	GRAFLOSCON A-G 1 ULTRA	Black	-	-	-	-		-
B	Klüberfluid B-F 1 Ultra	Black	○	0 to 100 °C	10 to 80 °C	10 to 80 °C	○	
	Klüberfluid B-F 2 Ultra	Yellow	-5 to 100 °C	0 to 100 °C	-10 to 100 °C	-10 to 100 °C	○	○
	GRAFLOSCON B-SG 00 ULTRA	Black	-15 to 90 °C	-	-	-	○	
C	Klüberfluid C-F 1 Ultra	Black	○	-15 to 60 °C	5 to 60 °C	5 to 60 °C	○	○
	Klüberfluid C-F 2 Ultra	Black	○	5 to 100 °C	15 to 80 °C	15 to 80 °C	○	○
	Klüberfluid C-F 3 Ultra	Brown	15 to 120 °C	15 to 120 °C	15 to 80 °C	15 to 80 °C	○	
	Klüberfluid C-F 3 S Ultra	Brown	0 to 80 °C	○	○	○	○	
	Klüberfluid C-F 3 M Ultra	Brown	25 to 100 °C	25 to 100 °C	○	25 to 100 °C	○	
	Klüberfluid C-F 4 Ultra	Brown	0 to 80 °C	0 to 110 °C	0 to 80 °C	0 to 80 °C	○	○
	Klüberfluid C-F 5 Ultra	Yellow	-5 to 80 °C	-5 to 110 °C	-5 to 80 °C	-5 to 80 °C	○	○
	Klüberfluid C-F 7 Ultra	Yellow	15 to 120 °C	-5 to 120 °C	-5 to 120 °C	-5 to 120 °C	○	○
	Klüberfluid C-F 8 Ultra	Brown	10 to 80 °C	10 to 120 °C	10 to 80 °C	10 to 80 °C	○	○
	Klüberfluid C-PG 17 Ultra	Green	10 to 120 °C	-	-	-	○	○
	Klübersynth OA 98-15000	Beige	15 to 120 °C	15 to 120 °C	15 to 80 °C	○	○	○
	Klübersustain LG 39-700 N	Beige	-30 to 100 °C	○	-	○	○	○
	GRAFLOSCON C-SG 00 LT	Black	-40 to 90 °C	-	-	-40 to 90 °C	○	
	GRAFLOSCON C-SG 0 ULTRA	Black	0 to 90 °C	-	-	0 to 90 °C	○	
	GRAFLOSCON C-SG 1000 ULTRA	Black	5 to 100 °C	-	-	5 to 100 °C	○	
	GRAFLOSCON C-SG 2000 ULTRA	Black	15 to 120 °C	-	-	15 to 120 °C	○	
D	Klüberfluid D-F 1 Ultra	Green	-	-	-	-		
	GRAFLOSCON D-SG 00 ULTRA	Black	-	-	-	-		

■ = preferred application method and application temperature range

○ = possible application method

- = application method not possible

Type A – Priming lubricants

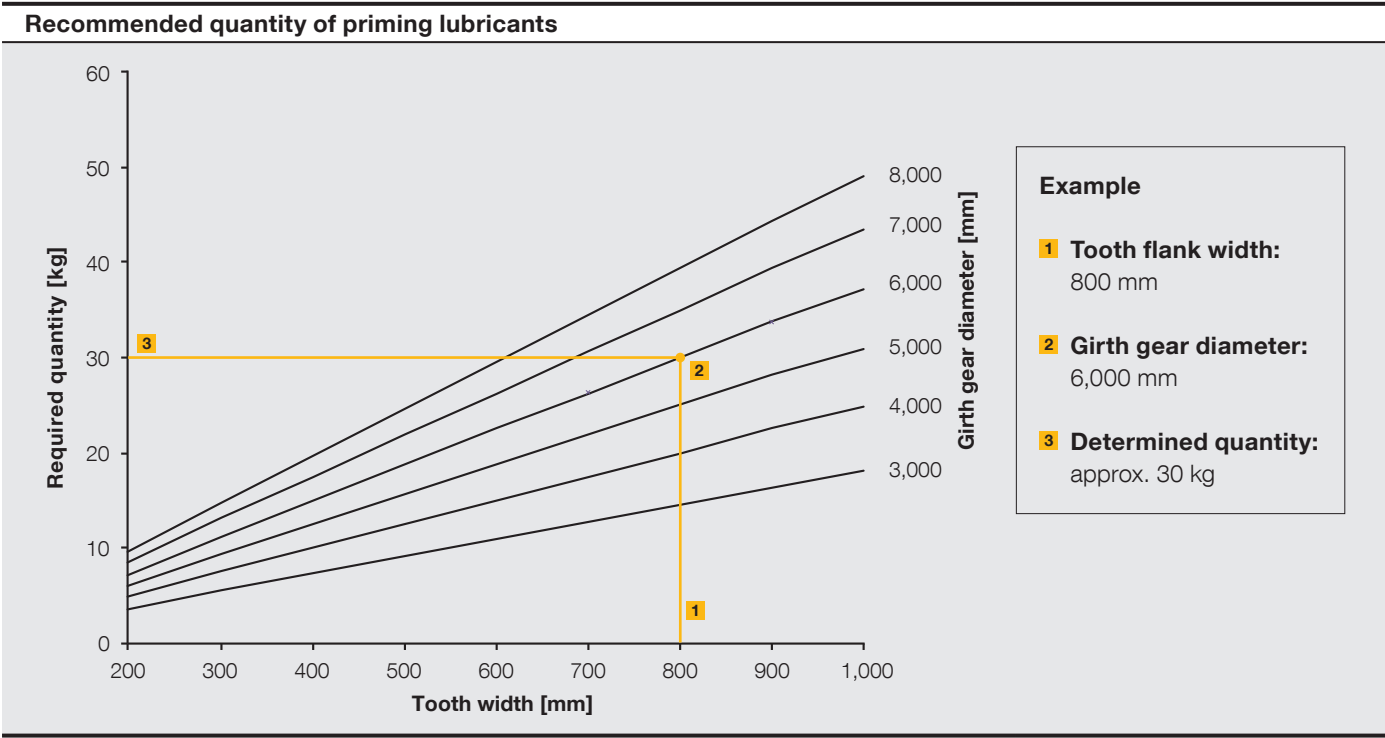
Klüberplex AG 11-462 and GRAFLOSCON A-G 1 ULTRA

Gear protection starts even before the gears are installed, i.e. during transportation and storage, and then continues during assembly and the first gear rotations. Our priming lubricants support the open gear in the first life stage that may be decisive for a long and carefree lifetime.

Priming lubricants are products containing a high percentage of additives and are applied prior to the initial operation of gear drives. They may be used in all spur or helical girth gear drives, irrespective of the subsequent lubrication method used.

- The main tasks of priming lubricants are:
- They protect teeth against corrosion until the drive is operational for the first time.
 - During assembly and alignment, they lubricate and protect against initial damage due to overloading.
 - They serve as a contrast lubricant for a first impression of the dynamic contact pattern.

Priming lubricants are usually applied manually by spatula or brush.



Type B – Running-in lubricants

Klüberfluid B-F 1 Ultra, Klüberfluid B-F 2 Ultra and GRAFLOSCON B-SG 00 ULTRA

Running-in products are used for the running-in of new gear drives to smoothen rough surfaces and improve the contact pattern of the tooth flanks. Due to their special additives, they cause a controlled, minimum amount of chemical wear.

Running-in products are safe to use since they only remove material in the high spots of the tooth profile in order to reduce the surface roughness. Reducing the surface roughness leads to higher pitting resistance and a more uniform contact pattern.

Specific consumption quantities for running-in lubrication

Type of installation/ drive	Specific consumption quantity [g/cm*/op.hrs.]
Rotary drum drives (e.g. cooling units)	4
Single-pinion kiln drives	5
Single-pinion mill drives	6
Large single-pinion mill drives and double-pinion kiln drives	7
Double-pinion mill drives	8
* width of tooth flanks	

Benefits:

- Short application time of 500–600 hours with spray lubrication
- Wide operational temperature range
- Longer service interval through smoothened tooth flank surfaces
- All application methods possible for Klüberfluid B-F 1 Ultra, Klüberfluid B-F 2 Ultra

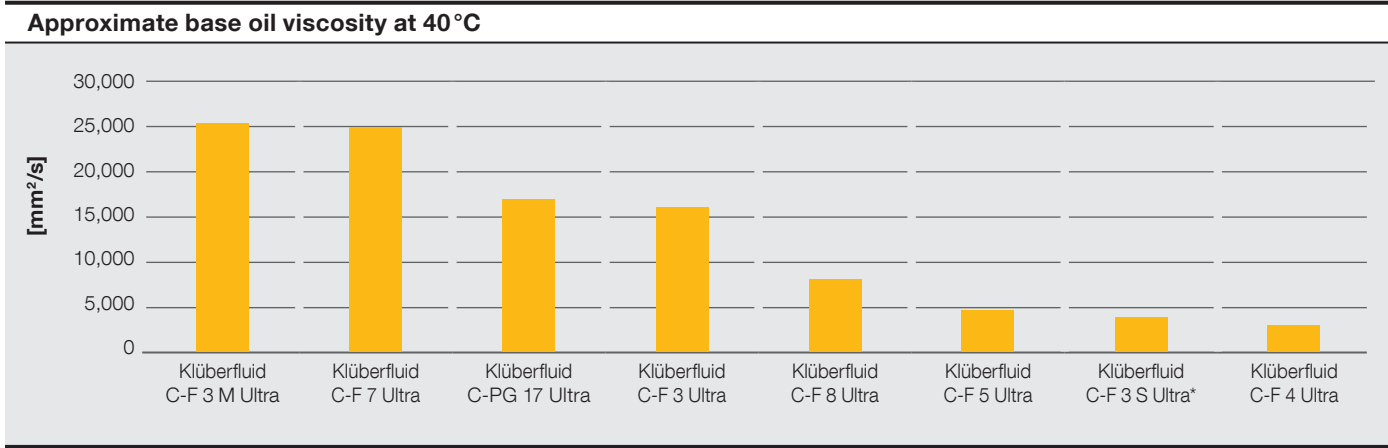


Type C – High-viscosity fluids

Leading-edge technology

Over 20 years ago, Klüber Lubrication invented a range of transparent open gear lubricants to meet the demands of large girth gear drives. The transparent formulation adds on to our black product portfolio range.

With a wide range of available viscosities, the Klüberfluid C-F series can be used in spray, circulation, and immersion systems in all climates.



Our product portfolio of high-viscosity fluids

Ambient climate	Speciality lubricant	Approx. base oil viscosity		Characteristics	Benefits
		at 40 °C [mm²/s]	at 100 °C [mm²/s]		
Warm	Klüberfluid C-F 3 M Ultra	25,500	750	For extremely heavily loaded gears	<ul style="list-style-type: none">- Cost reduction due to reduced consumption- Easy lubricant detection via UV indicator- Mainly OEM-tested and approved- Excellent wear protection for long gear service life- No build-ups- Outstanding FZG results- High adhesion- High load carrying capacity- Reduced vibrations and tooth flank temperature- Ability to inspect flank surfaces while in operation- No need to clean the gears for inspection on down days- Energy savings through low friction values
Warm	Klüberfluid C-F 7 Ultra	25,000	1,000	Fully synthetic lubricant meets old standard ANSI/AGMA 9005-E02 Annex D-2	
Moderate	Klüberfluid C-PG 17 Ultra	17,000	2,700	Highest base oil viscosity at 100 °C available on the market. Excellent pumpability without the use of diluent/solvent	
Moderate	Klüberfluid C-F 3 Ultra	16,500	500	Balanced base oil viscosity for high film thickness and sprayability	
Moderate	Klüberfluid C-F 8 Ultra	8,000	320	Excellent low temperature performance	
Cold	Klüberfluid C-F 5 Ultra	4,900	350	Fully synthetic lubricant meets old standard ANSI/AGMA 9005-E02 Annex D-2	
Cold	Klüberfluid C-F 3 S Ultra	4,000*	202.5	Excellent low-temperature sprayability due to use of diluent	
Cold	Klüberfluid C-F 4 Ultra	3,100	165	Improved low-temperature sprayability without use of diluent	

* = with diluent

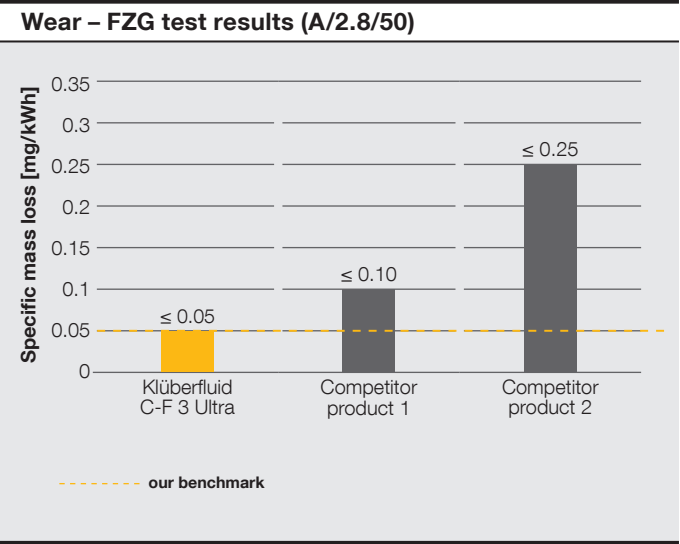
Protection and low consumption

Low consumption in combination with the best gear protection on the market is our aim. Modern high-viscosity fluids offer both. For example a double-pinion mill gear drive with 850 mm width can be operated with as little as around 3 kg of lubricant per day.

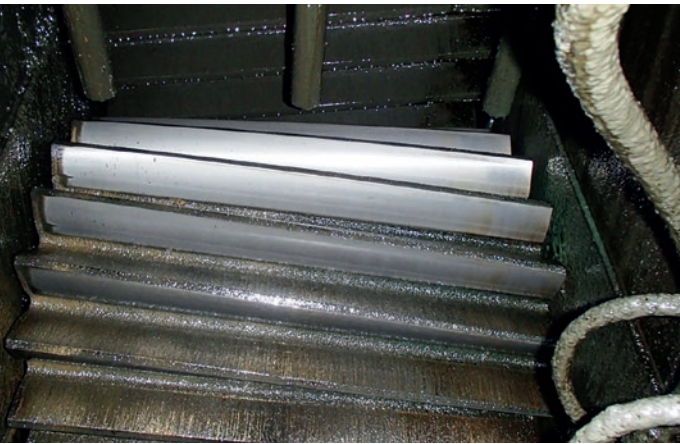
- The indicated specific consumption quantities are based on the following assumptions:
- No major damage to the tooth flanks
 - Sufficient contact pattern
 - Thorough and regular inspection and maintenance of the gear drive and the spray system
 - Normal operating conditions
 - Good spray pattern

The lubricant temperature must be set to allow unimpeded pumping and spraying. This depends on the type of lubrication system used.

The Klüberfluid C-F series has been tested and approved by major OEMs of mills, kilns, dryers, etc. and meets the viscosity requirements outlined in AGMA 6014-B15 Annex D.



Klüberfluid sets the benchmark for wear protection of open gears.



Pinion/girth gear with Klüberfluid C-F 3 Ultra: inspection and documentation easy with strobe light or high-resolution digital camera while running

Type C – Gear greases containing solid lubricant

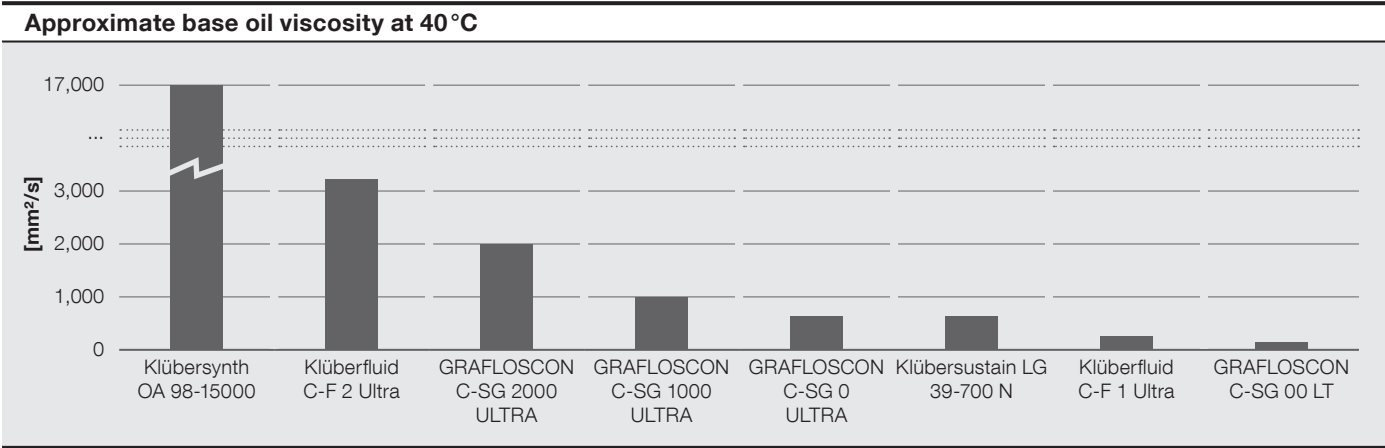
Type C – Comparison of lubricant technologies



Well-proven performance for decades

These open gear lubricants are based on soaps and mineral or semi-synthetic base oils. Klüber Lubrication offers a broad range of these lubricants in order to match the customer requirements in different environments around the world. Gear greases containing solid lubricant offer the customer operating safety that has been

proven by decades of experience. Furthermore these lubricants are the first choice if cost efficiency is a target. Another advantage of these lubricants is to visualize the contact pattern easily by the contrast to the gear material.



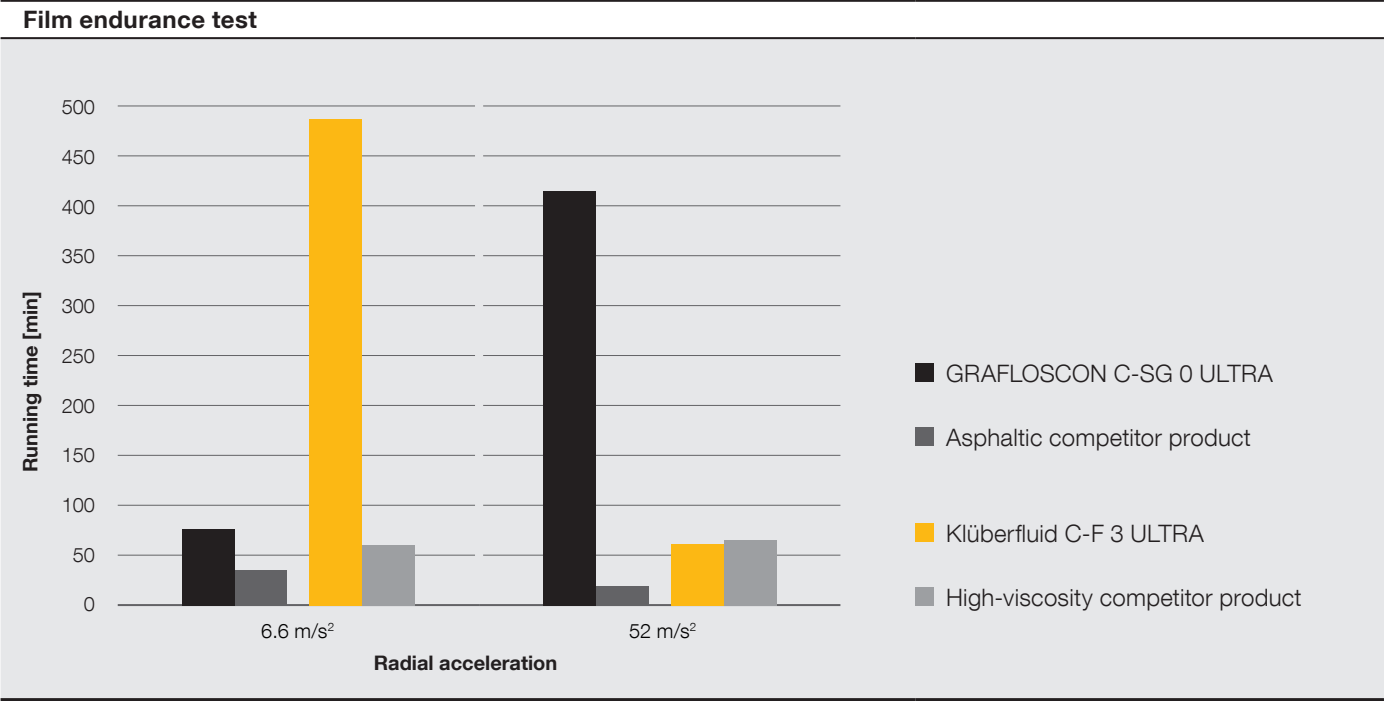
Our product portfolio of gear greases containing solid lubricant

Ambient climate	Speciality lubricant	Approx. base oil viscosity at 40 °C [mm²/s]	Base oil type	Key benefits and facts
Moderate	Klübersynth OA 98-15000	17,000	Mineral	– High-viscosity base oil with integrated white solid lubricants for reduced risk of gear failures
Warm	Klüberfluid C-F 2 Ultra	3,200	Mineral	– Suitable for normal to elevated operating temperatures
Warm	GRAFLOSCON C-SG 2000 ULTRA	2,000	Mineral/ synth. HC oil	– Especially suitable for application under hot climatic conditions – Prevents wear even at high loads – Better viscosity temperature behavior due to semi synthetic base oil enhances operation over a wide temperature range
Moderate	GRAFLOSCON C-SG 1000 ULTRA	1,000	Mineral	– Prevents wear even at high loads – Recommended by leading OEMs like FLSmidth, ThyssenKrupp, KHD, Ferry Captain, Cemtec, Hoffmann Engineering, etc. and used by leading global players
Moderate	GRAFLOSCON C-SG 0 ULTRA	680	Mineral	– Recommended by leading OEMs like FLSmidth, ThyssenKrupp, KHD, Ferry Captain, Cemtec, Hoffmann Engineering, etc. and used by leading global players
Cold	Klübersustain LG 39-700 N	680	Ester	– Biodegradability with 90 % renewable raw materials – Excellent low-temperature pumpability – Excellent FZG results for scuffing and wear protection
Cold	Klüberfluid C-F 1 Ultra	250	Mineral	– Suitable for low operating temperatures down to –15 °C
Extreme cold	GRAFLOSCON C-SG 00 LT	130	Mineral/ synth. HC oil	– Highly efficient and reliable operation even at low service temperatures – Excellent pumpability at low temperatures with good adhesion at high temperatures

Specific consumption quantities for operational lubricants

Type of installation/ drive	Specific consumption quantity [g/cm³/op.hrs.]	
	Gear greases containing solid lubricant	High-viscosity fluids
Rotary drum drives (e.g. cooling units)	1.0 to 1.5	0.5 to 0.8
Single-pinion kiln drives	1.5 to 2.0	0.8 to 1.0
Single-pinion mill drives	2.0 to 2.5	1.0 to 1.3
Large single-pinion mill drives and double-pinion kiln drives	2.5 to 3.0	1.3 to 1.5
Double-pinion mill drives	3.0 to 3.5	1.5 to 1.8

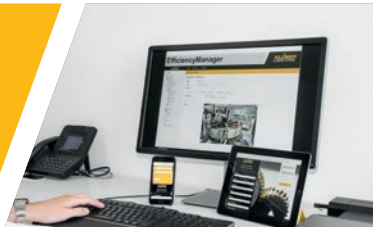
* width of tooth flanks



Estimation of emergency lubrication behavior by film endurance test at a FZG back-to-back test rig. After initial lubrication the gears are tested at a constant speed/radial acceleration and load until a failure occurs. The radial acceleration of 6.6 m/s² is typical of a kiln whereas 52 m/s² is the acceleration of a mill drive.

Type D – Repair lubricants

Comprehensive engineering service



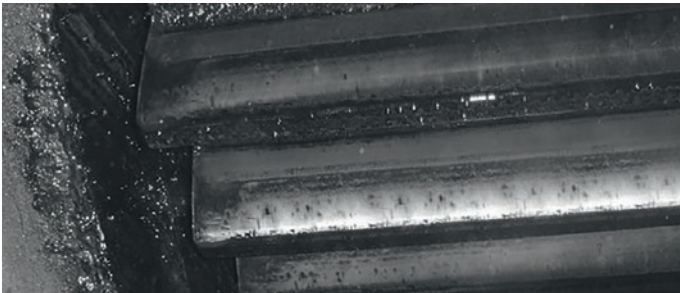
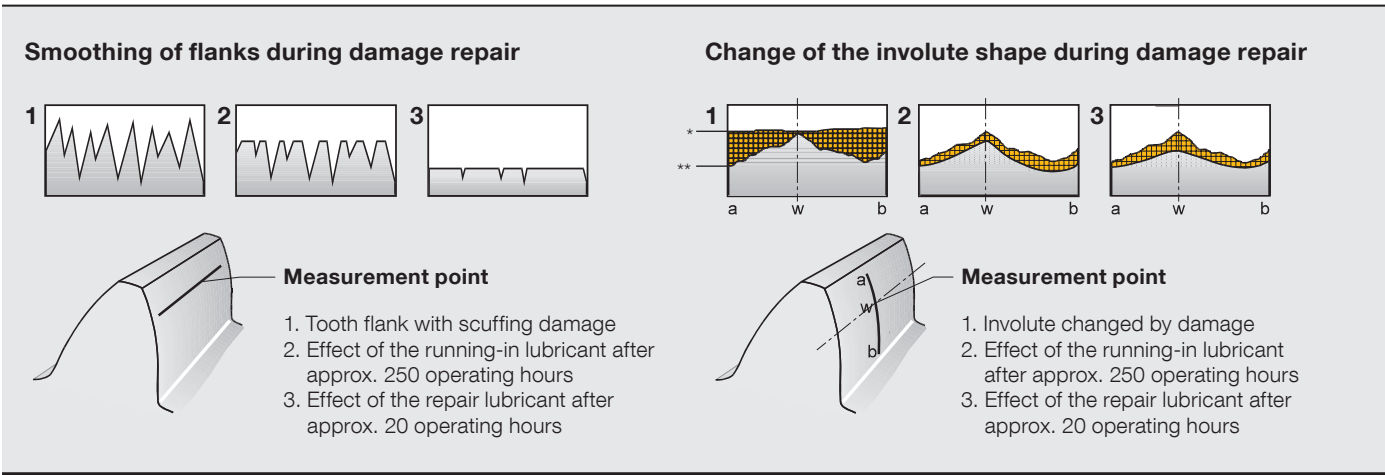
Prolong your gear service time with Klüberfluid D-F 1 Ultra and GRAFLOSCON D-SG 00 ULTRA

Flank surfaces often become damaged for a variety of reasons, which can lead to an inadequate contact pattern. To prevent breakdowns, the gear is often repaired by means of mechanical treatment, which might even make the situation worse. With the cost of downtime increasing and lead times of new gears in excess of several months, Klüber Lubrication has a solution to repair the gear while remaining in operation under full load. The repair lubricants are applied by one of our service engineers while the gear is in operation. These compounds are adapted

chemically and physically to subject metallic surfaces to mechanical, chemical, and corrosive wear. The material is worn off incrementally and evenly at the contact points as the product is being applied in addition to the operational or running-in lubricant. Scuffing, scratches, pittings, plastic deformation, and scoring can be reduced, which causes an improved contact pattern and avoids peak loads. This can extend the lifetime of the gear system. We recommend that repair lubricants be only applied by trained Klüber Lubrication service engineers.

Klüber Lubrication offers its customers a comprehensive engineering service. Nothing is better than having an extra pair of eyes inspecting your open gear frequently. Our open gear experts are available around the globe in almost every major mining and cement producing country. Our engineering services are comprised of three stages.

Effects of repair lubricants for open gears



Tooth flanks before repair lubrication



Tooth flanks after repair lubrication

Inspection	Technical documentation/ recommendation	Repairs and optimization
<ul style="list-style-type: none">– Vibration measurements on the pinion bearings– Tooth flank temperature readings while the drive is operating via laser gun or thermal imager– Inspection of the pitch circle alignment– Inspection of the central lubrication system and spray pattern– Silicone rubber impressions of the tooth flank surfaces– Visual inspection of the tooth flanks by means of stroboscope while the drive is operating– Assessment of the tooth flanks' condition and load distribution– Used lubricant analysis in sump and immersion systems to achieve maximum lubricant lifetime	<ul style="list-style-type: none">– Detailed reporting through inspection reports– Photo-documentation of the tooth flank surfaces and the spray pattern– Technical recommendation of corrections and improvements to prolong the gear's lifetime– Gear damage and root cause analysis– Central lubrication system optimization recommendation– Close cooperation with the OEM	<ul style="list-style-type: none">– Repair of tooth flank damage with our unique Klüberfluid D-F 1 Ultra and GRAFLOSCON D-SG 00 ULTRA– Repairs and optimization of the central lubrication system, e.g. spray pattern, spray time and lubricant consumption– Mechanical tooth flank treatment if significant damage has occurred

Your benefits:

- Repair lubrication, improvement of tooth flank condition
- Gear is repaired without down time as it is performed during full operation of the gear
- Lower tooth flank temperatures and more even temperature distribution
- Improved tooth flank contact pattern and smoother tooth flanks
- Reduced vibrations
- Extended gear lifetime

Notes

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Klüber Lubrication – your global specialist

Innovative tribological solutions are our passion. Through personal contact and consultation, we help our customers to be successful worldwide, in all industries and markets. With our ambitious technical concepts and experienced, competent staff we have been fulfilling increasingly demanding requirements by manufacturing efficient high-performance lubricants for more than 85 years.

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