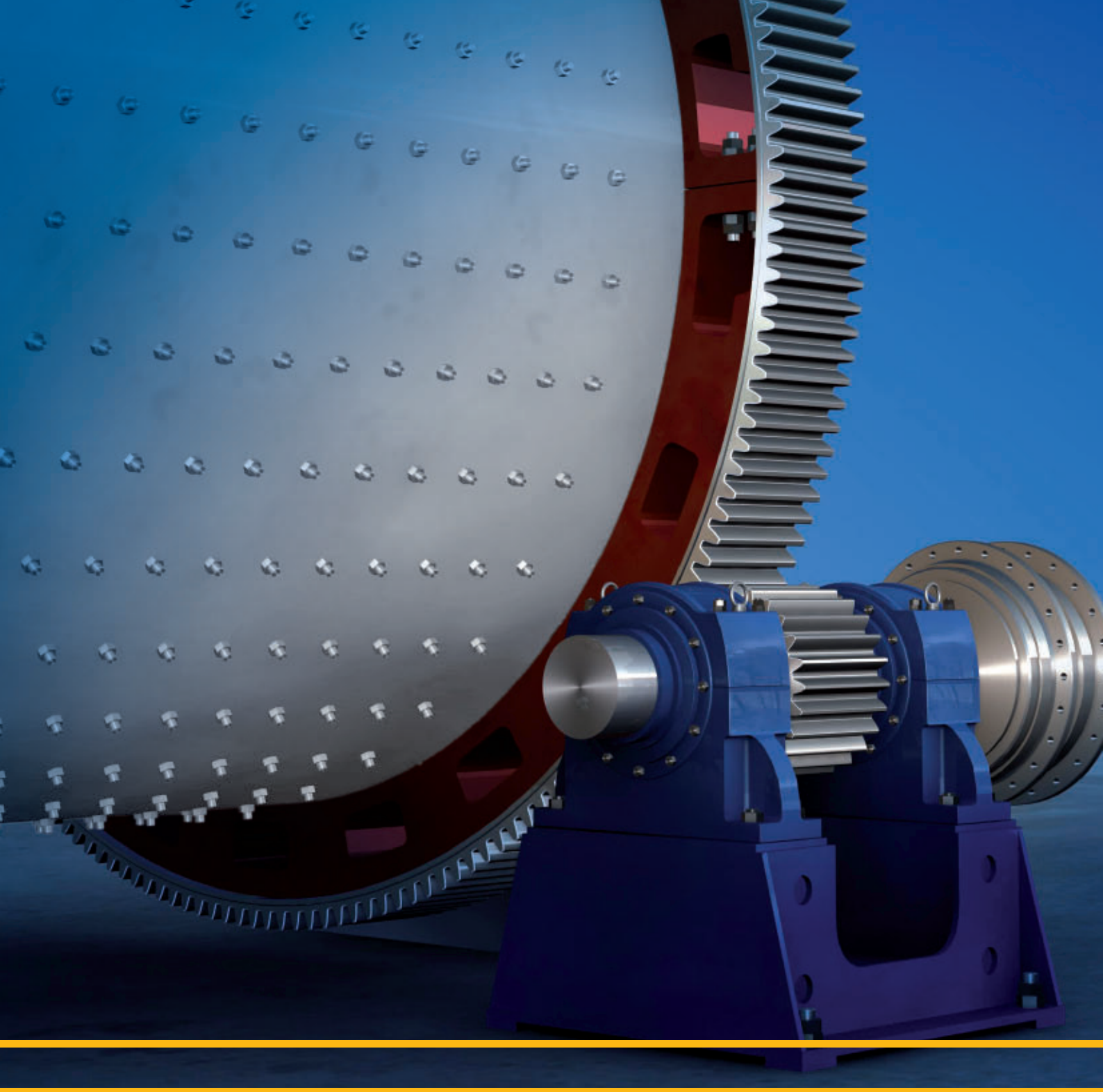


Special Lubricants for Open Gear Drives

BECHEM
LUBRICATION TECHNOLOGY

The BECHEM Open Gear Lubrication System

Due to low speeds and the very high torques to be transmitted and the fact that hydrodynamic lubrication conditions are hardly reachable tooth flanks of open gear drives are endangered by damages. Deformations depending on temperatures and loads, inaccuracies in adjustment, insufficient lubricant supply but also the use of unsuitable lubricants often result in tooth flank damages although high quality gear materials are being used. A precise alignment, a carefully carried out running-in process and high-sophisticated lubricants can prevent or minimize such damages. The importance of high quality lubricants is constantly getting higher with rising dimensions of the drives.

Based on many years of experience, BECHEM has developed a series of products which meet the requirements of all kind of open gear drives. Depending on size and speed of the drive, torque to be transmitted, operational and environmental conditions and above all on application method BECHEM offers a wide variety of gear greases, high-viscous fluids and gear oils.

For many drives graphite containing gear greases have proven to be most effective. For those drives BECHEM has developed the BERULIT Open Gear Lubricant System. It is based on a very stable metal complex soap and contains selected solid lubricants as well as a combination of special additives. It reduces wear and permits operation under most severe service conditions. The high graphite content in the products protects the flanks even under partial lubricant starvation. The products of the BERULIT Open Gear Lubricant System are free of chlorine and bitumen and do not contain any toxic heavy metals or solvents.

BERULIT Open Gear Lubricants protect open gear drives such as in ball mills, rotary kilns, driers and mixing drums used in the cement, lime, steel, paper and fertiliser industry and in mineral processing. They ensure a long life time of the drives with simultaneous low consumption rates. BERULIT Open Gear Lubricants are also well usable for slewing gears of shovels, excavators, draglines and cranes.

Large open gears can only operate safely if contact pattern and surface quality have been optimised by running-in processes. These running-in processes require special products which, together with BECHEM service lubricants, form a complete system.

The BERULIT Open Gear Lubricant System consists of:

1	Priming lubricant	BERULIT 443
2	Running-in lubricant	BERULIT EL 420
3	Service lubricants	BERULIT GA 400 BERULIT GA 800 BERULIT GA 2500 BERULIT GA 800 FLUID BERULIT GA 2500 FLUID

The lubricants harmonise so that cleaning after each individual process is not necessary. For the treatment of special tooth flank problems tailor-made products are available on request.

Priming Lubrication with BERULIT 443

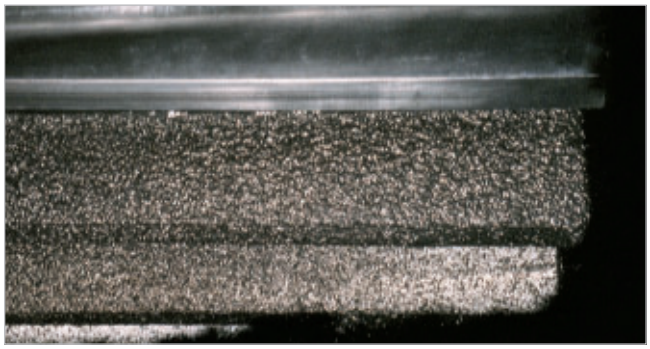
BERULIT 443 prevents lubricant starvation and as a consequence initial damages for the period before the lubrication system is taken into operation.

The alignment of the drive should be finished before applying the priming lubricant BERULIT 443. The measurement results of axial and radial run-out as well as backlash and root clearance should be recorded.

Before the priming lubricant can be applied, a fat free cleaning of the whole tooth flank surface e. g. by a cold cleaner is necessary. Then BERULIT 443 is "pushed" intensively onto the flanks by brush or spatula. To ensure that the tooth flanks get the best conditioning the layer should be at least 1,5 mm.

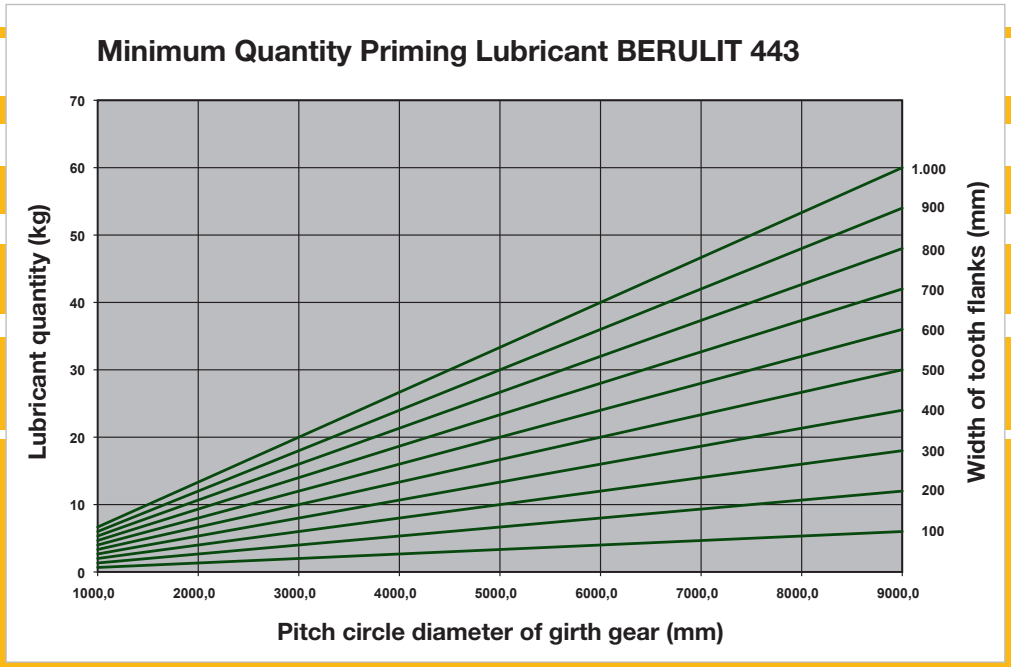
Intensive application on the tooth flanks prevents formation of air pockets, which could later have a negative influence on the formation of the lubricating film. For the root and the tip of the tooth flanks and the none load carrying flanks a thin application as corrosion protection is sufficient.

Manual application of BERULIT 443 by brush



BERULIT 443 in a sufficiently strong layer on the flanks

- The required quantity BERULIT 443 can be calculated by the following diagram. For a double pinion drive the quantity is to be multiplied by 1,15.
- The gear cover should already be mounted to prevent dust from sticking on the tooth flanks before applying the priming lubricant BERULIT 443.
- BERULIT 443 also eases inspection of the contact pattern during the installation and alignment. By turning the gears with the auxiliary drive the real contact pattern can be seen as a projection of the priming lubricant on the opposite wheel.
- BERULIT 443 must not to be applied in automatic spraying systems!



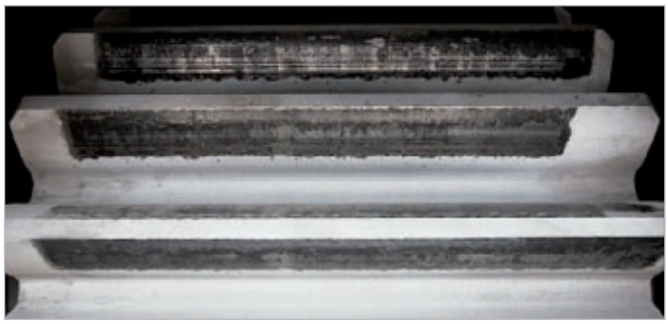
Controlled Running-in with BERULIT EL 420

Running-in lubricants are applied in order to increase the effective contact pattern of tooth flanks within a short period of time by chemical physical processes in order to ensure operation under full load.

Before starting the running-in process the functionality of the spraying system has to be ensured. This includes the check of the nozzle adjustment and the spray pattern. The installation of a system which enables a check of the spray patterns during operation is recommended.

During the running-in process the spraying system has to be adjusted to continuous or maximum lubrication. This does not only improve the supply to the flanks but also guarantees that small wear particles from the process of reducing the surface roughness are taken off.
The requirement of BERULIT EL 420 during the running-in process is 6-12 g per cm tooth width and operating hour, depending on the character of the drive. An exact calculation is possible by using the diagram on the following page.

The duration of the running-in process depends on the type of drive and factors such as mounting, material and production quality. In general, 300 to 500 operating hours are necessary. For drives to be lubricated manually or by immersion special running-in procedures are provided by BECHEM technicians.



Flanks of a Kiln gear drive before starting the running-in process

Flanks of the Kiln drive after 7 days running-in with BERULIT EL 420

During the running-in process the load has to be increased in stages. Running-in under full load can lead to tension peaks and as a consequence to initial damages. The following stages are appropriate for ball mills:

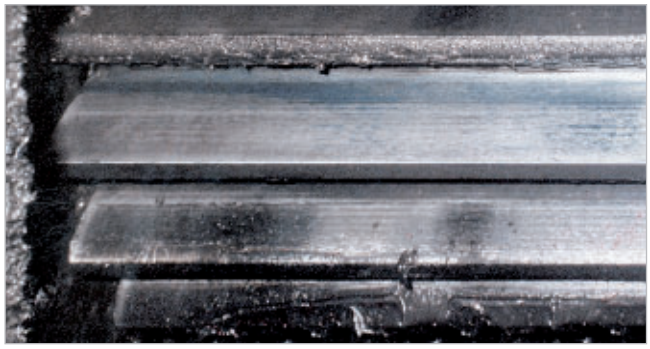
- **80 to 110 h** at **60 - 70 %** filling
- **100 to 150 h** at **approx. 80 %** filling
- **150 to 200 h** at **90 - 100 %** filling

The values stated are intended as a guide. They can vary considerably according to conditions. The condition of the tooth flanks and the contact pattern achieved are basis for the decision regarding further proceeding.

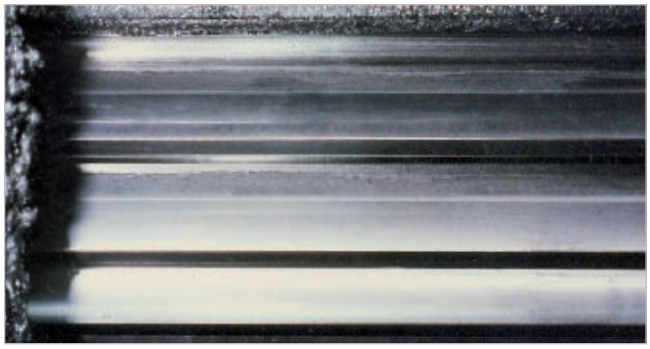
The change into the next load stage is only recommended if a contact pattern of at least 60 % in stage 1 and 70 % in stage 2 has been achieved.

The running-in process should only be finished after the surface roughness has been smoothened and a contact pattern of at least 80 % at full nominal load has been achieved.

The condition of the tooth flanks as well as the contact pattern has to be checked permanently during the running-in process. In case of possible damages or a negative development of contact pattern the manufacturer of the lubricant and the supplier of the drive should be contacted.



Flanks of a Mill gear drive after 3 days of running-in



Flanks of the drive after finishing the running-in with BERULIT EL 420

Operational Lubrication with the BERULIT GA series

Cleaning of the tooth flanks before switching over from running-in lubrication to service lubrication is not necessary. At the beginning of the application of service lubricants the increased quantity from the running-in process should be applied for approx. 50 hours. After that the quantity has to be reduced in stages to the normal quantity. A reduction in stages of 1-2 g per cm tooth width and hour during 50-150 operating hours has proven successful. After each reduction a condition check of the tooth flanks and of the temperature distribution across the flanks is necessary. In case of any negative changes, the quantity has to be increased again.

A reduction in usage quantity is achieved by prolonged interval periods or a reduction of the lubricant quantity per spray. For instructions on the adjustment of the spraying system, please see the corresponding manual.

Interval and spraying periods as well as quantity to be sprayed should be as small as possible. This prevents stronger fling-off effects of excess lubricant or lubricant starvation due to exceeded life time of the lubricant film.

As long as the operational lubricant is not sprayed on the girth gear flanks the interval and spraying periods should be adjusted in the range of seconds. Interval periods longer than five minutes should be avoided.

After standstill periods of more than 3 months the drive should again be started with continuous spraying.

The required lubricant quantity depends on constructive details and the present condition of the drive. The condition of the tooth flanks as well as contact pattern and temperature distribution should be especially considered.

The diagram at the bottom of the page helps to determine the minimum quantity with regard to the type of gear drive. Values below the minimum increase the risk of wear and damage and can reduce the life time of the drive. The values have always to be increased for unfavourable operating conditions.

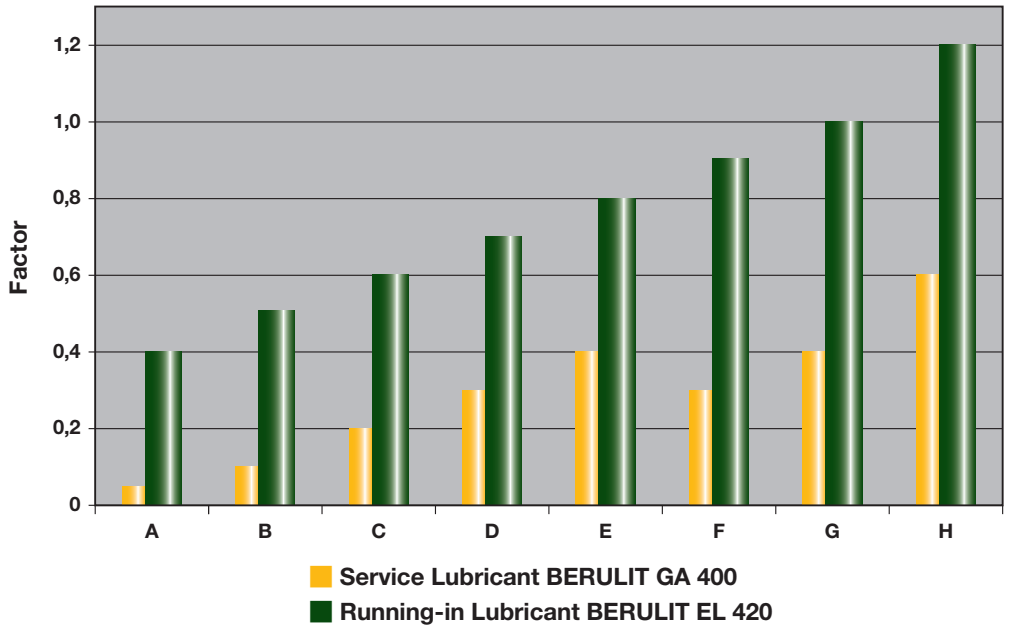
Under normal service conditions and undamaged tooth flanks the application of BERULIT GA 400 as service lubricant is sufficient from a tribological point of view.

Under high service temperatures, extreme loads, unfavourable contact conditions and/or damaged tooth flanks we recommend the application of BERULIT GA 800 or BERULIT GA 2500. These products have a higher base oil viscosity and thus a more stable lubricating film. On Open Gear drives with increased requirements on the lubricant film life time due to very long spray intervals, BERULIT GA 800 or BERULIT GA 2500 should also be used.

Depending on service conditions and sprayability a reduction in lubricant quantity of up to 20 % is possible when BERULIT GA 2500 is applied.

The operation of a gear drive with such small quantities requires, however, permanent checking and regular cleaning of the spraying system.

Lubricant quantity factor (g/mm tooth width/hour)



A drives of rotary driers, coolers and slew ring gears

B very small single pinion mill drives

C medium single pinion kiln drives

D medium single pinion mill drives

E large single pinion mill drives

F double pinion kiln drives

G medium double pinion mill drives

H large double pinion mill drives

BERUGEAR HV – Clean Highly Viscous Fluids

BERUGEAR HV stands for a new generation of solid free transparent gear lubricants. The highly viscous gear fluids of the BERUGEAR HV series are intended to be used for large gear drives with higher requirements concerning operational viscosity, thermal stability or difficult discharge conditions and for those drives for which the black colour of conventional adhesive lubricants is undesired. They are available in different viscosities.

BERUGEAR HV fluids were developed to fulfil the requirements of AGMA 9005 D 94 and to meet the demand of some equipment manufacturers for gear lubricants of very high viscosity. Opposite to other products they do not contain solvents.
They form thick, extremely adhesive transparent lubricating films. This transparent film makes the inspection of drives including the determination of possible tooth flank damages easier. BERUGEAR HV fluids should especially be used at large gear drives of smaller modules exposed to very high tooth flank pressures or running with a low circumferential speed. A use for drives without a proper dust protection is not recommended. BERUGEAR HV fluids are applicable by spray systems, circulation systems and dip systems depending on their base oil viscosity.
When applied by spray systems the products of the BERUGEAR HV series offer the possibility for a significant reduction in lubricant consumption. Lower disposal costs support the cost effectiveness of the products.

BERULIT GA FLUID – Adhesive Gear Greases for Dip Baths

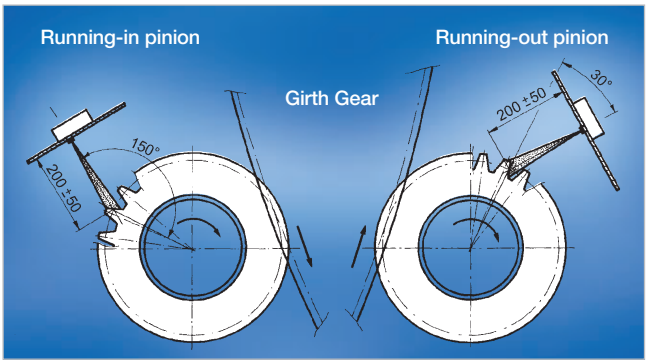
For gear drives with bath or circulating systems special adapted products of the BERULIT GA FLUID series are available. The improved flow characteristics of these products prevent lubricant starvation due to groove formation – the so called channelling effect - in the dip baths. Special additives improve the adhesion of the fluids on tooth flanks.

Prerequisite for a successful use of BERULIT GA FLUID greases in dip baths is an appropriate maintenance of the bath. The dip baths have to be protected from solid or liquid contaminants. The lubricant level in the bath has to be checked and if necessary to be topped up regularly to prevent starvation.

The tooth flanks should dip into the lubricant with approximately 30 % of their height during running and approximately 50 % of their height during stop. The paddle elements of paddle wheels should completely dip into the lubricant.

Spray Systems

The condition and the operation of an installed spray system should be checked prior to the application of BERULIT or BERUGEAR Open Gear Lubricants. The check should include a functional test, nozzle adjustment, spray pattern and applied lubricant quantity. Special attention should be paid to an overlapping of the spray patterns of the singular nozzles. Gaps in between these singular spray patterns may easily lead to initial damages.



The spray nozzles should be adjusted in a way that they spray on the flanks of the pinion in an angle of 30°. The distance between the outlet of the nozzles and the tooth flank surface should be approximately 200 mm.

A clean spray system is prerequisite to prevent spray problems caused by ingressed foreign particles. Special care has to be taken when changing the lubricant drum or refilling the container. Transfer pumps in combination with an additional lubricant filter reduce the danger of contaminated lubricant in the spray system significantly.

The lubricant filter of the spray system needs to be cleaned regularly. Especially with lubricants of very high viscosity there is a tendency for some components to settle down in the filter. When using lubricants with high base oil viscosity we recommend cleaning the lubricant filter every 3 weeks at least.

For drives equipped with a spray system a permanent dredging of the tooth flanks in the used lubricant in the sump should be prevented. It may contain abrasive foreign impurities. Therefore the used product needs to be removed regularly from the gear guard.

The BERULIT and BERUGEAR Open Gear lubricants are well sprayable in all common spray systems taking the application temperature into consideration. Respective spray test results are available.

Drums of BERULIT GA 2500 connected to spray systems

Spray pattern of BERULIT on the control panel of a Woerner system

Comprehensive BECHEM Service

Reliable and cost effective lubrication of open gear drives does not require high performance products only but also skills to ensure their correct application and the ability to provide durable solutions for overcoming unfavourable developments. The combination of advanced products and skills of their service technicians made BECHEM a leading supplier of open gear lubricants on all continents.

BECHEM provides regular service inspections as well as special maintenance support operations by our world-wide operating team of well trained technicians.

Since not product performance only but also service quality decide about life time of the machinery the service component is highly rated by the equipment manufacturers.
The excellent service, provided by BECHEM, convinced leading equipment manufacturers to recommend BECHEM open gear lubricants.

The service operations are planned and prepared in our Service Centres around the world. The coordination is managed in our headquarters in Hagen. There also the central reporting system and the training of the service staff are organised.

Grinding of pitting marks on the tooth flanks of a Ball Mill drive

BECHEM offers a complete service package for open gear drives to all customers. Based on agreements this package can include:

- a lubrication management with selection of the most suitable (technical and economical) product and optimisation of consumption rates and re-lubrication intervals
- regular inspections of drives and application systems at agreed intervals including a measurement of the temperature profile across the flanks and a vibration measurement at the pinion bearings, the assessment of contact pattern, gear flank condition and possible damages as well as a complete check of the lubricant application system
- a detailed written report with appropriate documentation for each inspection service
- surveillance or carrying out of running-in processes
- support in alignment of transmission gears in case of requirement
- repair services such as grinding of pitting marks and mechanical treatment of flanks
- support in optimisation of lubricant application systems
- recommendations for a better protection of the drives from contamination or lubricant leakage
- analysis of lubricant samples
- preparation of inspection plans
- single lessons or a complete training program for the plant staff

The package with exception of repair services is provided free of charge to customers using BECHEM open gear lubricants over a longer period of time at their drives.

Grinding of Ball Mill tooth flanks damaged by a single sided contact pattern

Application of "Machining Blue" for a check of the contact pattern

Discussion of the drive condition of a Ball Mill in a cement plant

Inspection of the contact pattern of a Bucket Wheel Excavator slewing gear

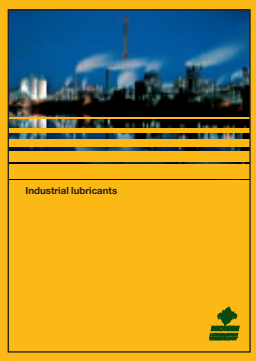
That'Special!

A tradition we are proud of since 1834. This is still today demonstrated by our trademark: the Rhus Flower. After permanent development, BECHEM is today a »Global Player«.
BECHEM special lubricants, industrial lubricants, metal working fluids and solutions for forming technology are based on our extensive experience in the development of special chemistry and on the latest tribologic knowledge. Our know-how with regard to friction, wear and lubrication always takes account of our customers' requirements for economical and ecological optimisation. We feel obliged to tradition and progress. That'Special!

Besides the headquarter in Hagen, BECHEM has two other production sites in Germany – in Mieste and Kierspe. In addition to that, our worldwide distribution network allows us to develop markets all over the world. With daughter companies in France, India and Switzerland, as well as Joint Ventures in the USA, South Africa, Sweden and China, BECHEM shows its international presence.

It is our target to supply our customers with high-quality products and to simultaneously meet the corresponding international standards. The quality of our products is guaranteed by our quality management system in accordance with the automotive standard ISO/TS 16949. All our production sites are systematically controlled by internal audits and regular external inspections by the certification association TÜV NORD CERT GmbH. Audits which are regularly carried out by our customers confirm the compliance with our high quality requirements.

Further information material is available either direct from us or at www.bechem.com



Special lubricants

- Low and high temperature lubricants
- Plastic lubrication
- Electrical contact lubricants
- Food grade lubricants
- Valve lubricants
- Anti-Friction-Coatings

Industrial lubricants

- High performance multipurpose greases
- Heavy duty and high temperature lubricants
- Hydraulic oils
- Gear lubricants
- »Green« lubricants

Metal working

- Coolant lubricants
- Cutting and grinding oils
- Deep drilling oils
- Corrosion protection oils
- Cleaning agents

Forming technology

- Wire drawing lubricants
- Cold forging oils
- Massive forming
- Tube drawing lubricants
- Sheet forming

Thanks to FLSmidth and Shutterstock for the provided photo material.

BECHEM
LUBRICATION TECHNOLOGY

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