Special lubricants for open gear drives

BECHEM – Lubrication solutions for industry

As the oldest German manufacturer of industrial lubricants, BECHEM is one of the leading producers of high-quality special lubricants and metalworking fluids today.

BECHEM products stand out through innovative formulations in the most diverse industrial applications – in machining and forming for metalworking processes, in coating technology and as for-life lubricants in various technical components.

A strong network of distributors and several national and international production sites ensure that BECHEM products are readily available worldwide.

Tomorrow's technologies. Today.

APPLICATIONS

- Open gears
- Plain bearings
- Chains
- Wire ropes

PROPERTIES

- High loads
- Low temperatures
- High temperatures
- Noise dampening
- Corrosion protection

All indications and values correspond to latest knowledge and do not represent any product specification

The BECHEM open gear lubrication system

Due to low speeds and very high torques to be transmitted, and the fact that hydrodynamic lubrication conditions are barely attainable, the tooth flanks of open gear drives are at risk of damage. Deformations depending on temperatures and loads, inaccuracies in adjustment and insufficient lubricant supply, but also the use of unsuitable lubricants, often result in tooth flank damage although high quality gear materials are being used. Precision alignment, a carefully carried out running-in process and highly sophisticated lubricants can prevent or minimize such damage. The importance of high quality lubricants is continually rising with greater drive dimensions.

	Graphite containing greases	Graphite-free light colored products
Priming lubricant	**Berulit 443**	**Berugear HV PR**
Running-in lubricant	**Berulit EL 420**	**Berugear HV RI**
Service lubricants	**Berulit GA 400** **Berulit GA 800** **Berulit GA 2500** **Berulit GA 800 Fluid** **Berulit GA 2500 Fluid**	**Berugear HV 10** **Berugear HV 20**

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

Adhesive lubricants containing graphite have proven to be most effective for a wide range of open drives. For these 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. The high graphite content in the products protects the flanks even under lubricant starvation conditions. For many other drives, high viscous gear fluids perform better. Here BECHEM offers the high performance products in the **Berugear HV series.** Both product lines reduce wear and permit operation under the most severe of service conditions.

The products of the **Berulit** and **Berugear Open Gear Lubricant Systems** are free of chlorine and bitumen and do not contain any toxic heavy metals or solvents.

Berulit and Berugear Open Gear Lubricants protect open gear drives such as those deployed in ball mills, rotary kilns, driers and mixing drums used in the cement, lime, steel, paper and fertiliser industries and in mineral processing. They ensure prolonged service life of the drives with simultaneous low consumption rates. The products are also excellently suited for slewing gears of shovels, excavators, draglines and cranes.

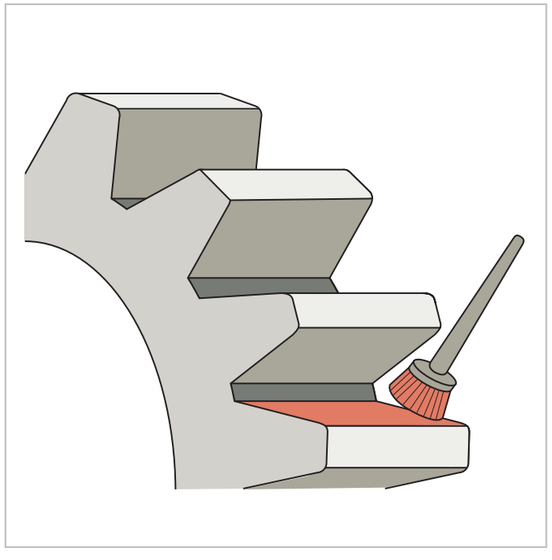
Large open gear drives can only operate safely if contact pattern and surface quality have been optimised by running-in processes. These running-in processes require special products which, together with BECHEM service lubricants, form a complete system. The lubricants harmonise so that cleaning after each individual process is not necessary. Custom products are available on request for the treatment of special tooth flank.

Priming lubrication with Berulit 443 or Berugear HV PR

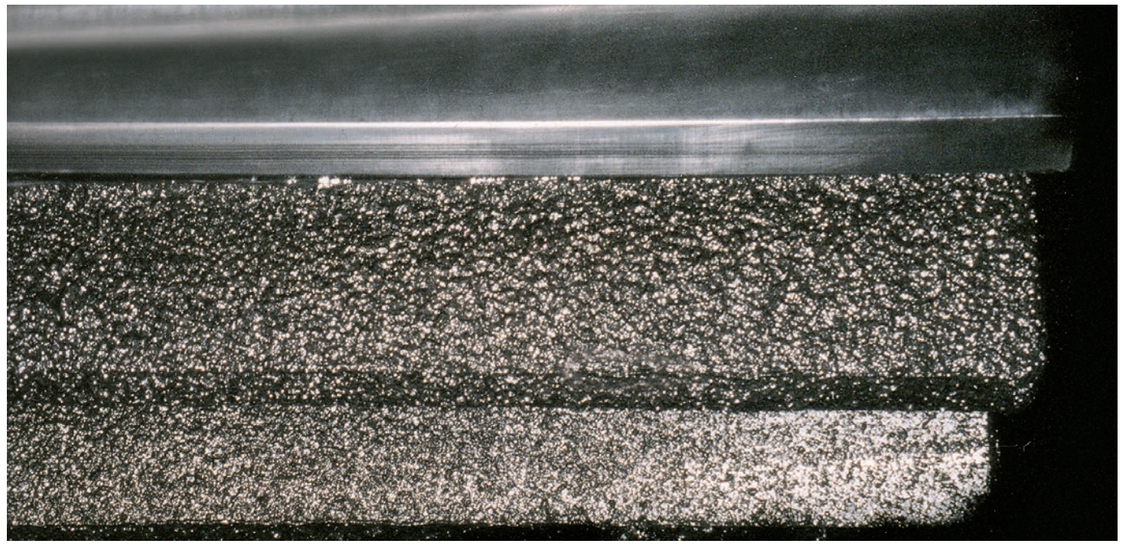
Berulit 443 and Berugear HV PR prevent lubricant starvation and – as a consequence – initial damage for the period before the lubrication system enters operation.

The drive should be fully aligned before application of the Berulit 443 or Berugear HV PR priming lubricant. 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, fat-free cleaning of the whole tooth flank surface, such as by a cold cleaner, is necessary. Then the priming lubricant is ”pushed“ liberally 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 impact on the formation of the lubricating film. For the root and the tip of the tooth flanks, and the non load-bearing flanks, a thin application as corrosion protection is sufficient.



Manual application of priming lubricant by brush



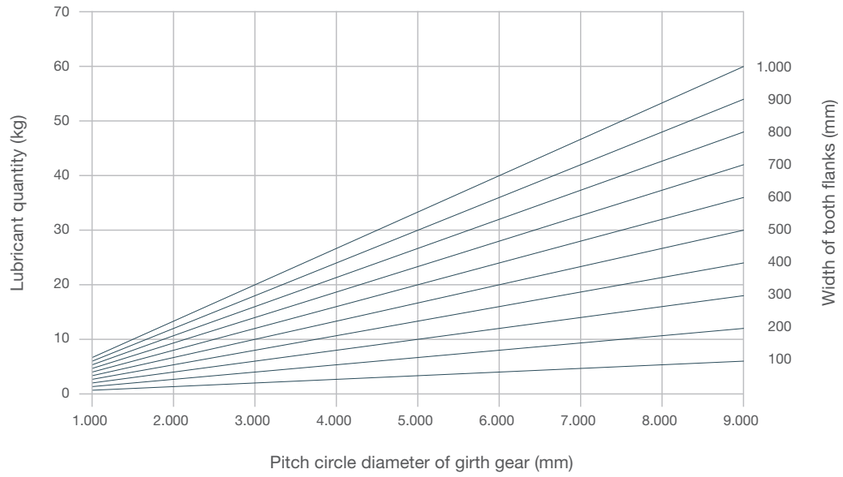
Berulit 443 in a sufficiently strong layer on the flanks

Using Berulit 443 / Berugear HV PR

- The following diagram can be used to calculate the quantity Berulit 443 or Berugear HV PR. For a double pinion drive, the quantity must be multiplied by 1.15.
- The gear cover should already be mounted to prevent dust from sticking on the tooth flanks before application of the Berulit 443 or Berugear HV PR priming lubricant.
- Berulit 443 or Berugear HV PR also simplifies inspection of the contact pattern during 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 and Berugear HV PR may not be applied in automatic spraying systems.

Minimum quantity priming

Berulit 443 / Berugear HV PR



Controlled running-in with Berulit EL 420 or Berugear HV RI

Running-in lubricants are applied 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. Thanks to a higher contact ratio, the risk of partial overloads and resulting initial damage is reduced significantly. In addition, the running-in process smooths the tooth flank surface. The combination of an increased contact ratio and lower surface roughness increases the long-term milling strength and scruffing load capacity of the tooth flanks, thus extending their service life.

When applying the lubricant using a spray system, the entire system, the nozzle alignment and the spray pattern should be checked. The installation of a system which enables checking 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 not only improves the supply of lubricant to the flanks, it also guarantees that small particles from the process of reducing the surface roughness are taken off.

The requirement of Berulit EL 420 or Berugear HV RI during the running-in process is 6 to 12 g per cm tooth width and operating hour when applied with a spray system, depending on the characteristics of the drive. An exact calculation is possible using the diagram on the following page.

When applying the lubricant via a dip bath or circulation system, permanent supply of the running-in lubricant must be ensured. If lubricants are in a circulation system, they must be checked for a sufficient flow.

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

The specified number of operating hours is intended to serve as a guide. They can vary considerably according to conditions. The condition of the tooth flanks and the contact pattern achieved form the basis for the decision as to subsequent action. Changing to 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.

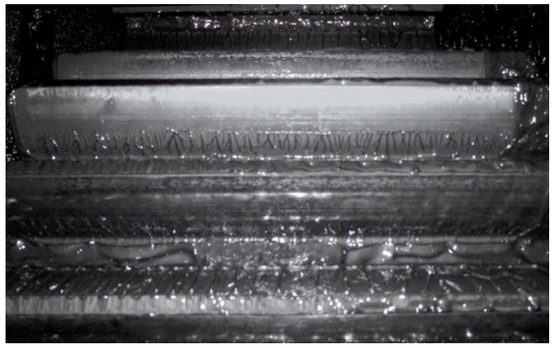
The condition of the tooth flanks as well as the contact pattern has to be checked continually during the running-in process. The manufacturer of the lubricant and the supplier of the drive should be contacted in the event of potential damage or a negative development of contact pattern.

During the running-in process, the load has to be increased in stages. Running-in under full load can result in tension peaks and as a consequence in initial damage.

Appropriate load 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

Flanks of a kiln gear drive before the running-in



Flanks of the kiln drive after 7 days running-in with Berulit EL 420

Operational lubrication with the Berulit GA series

Cleaning of the tooth flanks before switching 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 / cm and hour during 50–150 operating hours has proven successful. After each reduction, a check of the condition of the tooth flanks and temperature distribution is necessary. The quantity must be increased again for negative changes. A reduction in usage quantity is achieved with prolonged interval periods or a reduction of the lubricant quantity of the pump. For instructions on the adjustment of the spraying system, please refer to the corresponding manual.

Interval and spraying periods as well as the 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.

Provided the operational lubricant is not sprayed on the girth gear flanks, the interval and spraying periods should be adjusted to be within the seconds range. Interval periods longer than five minutes should be avoided. After idle periods longer than 3 months, the drive should again be started with continuous spraying.

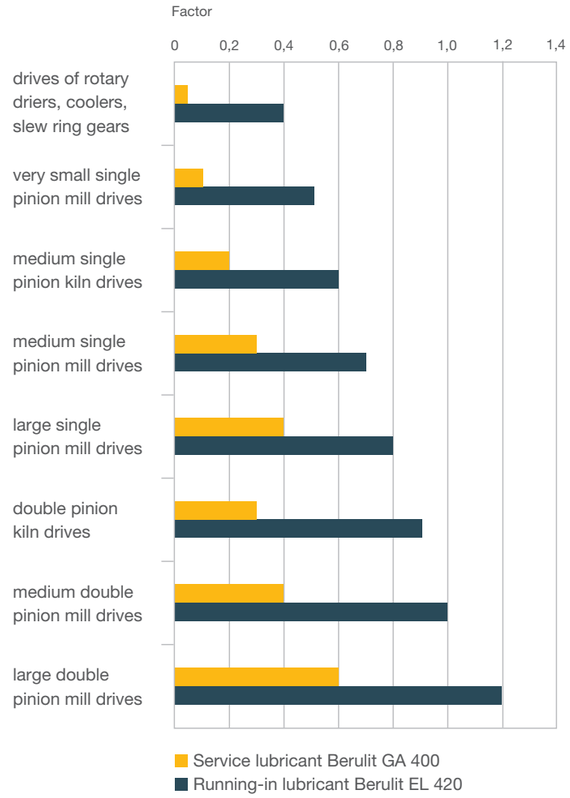
The lubricant quantity required depends on design details as well as on the present condition of the drive. The condition of the tooth flanks as well as contact pattern and temperature distribution should be taken into account in particular. The diagram on the opposite page helps to determine the minimum quantity with regard to 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 must always be increased for unfavourable operating conditions. On request, BECHEM will provide recommendations for factors to apply taking a wide range of operating conditions into consideration.

Under normal service conditions and for undamaged tooth flanks, the application of Berulit GA 400 as a service lubricant is sufficient from a tribological point of view. For high service temperatures, extreme loads, unfavourable contact conditions and/or damaged tooth flanks, we recommend the application of Berulit GA 800, Berulit GA 2500 or Berulit GA 2500 LV. These products have a higher base oil viscosity and thus form a more stable lubricating film. For Open Gear drives with increased requirements made of lubricant film life time due to very long spray intervals, Berulit GA 800, Berulit GA 2500 or Berulit GA 2500 LV should also be used.

With regard to service conditions and sprayability, a reduction in lubricant quantity of up to 20% is possible when Berulit Berulit GA 2500 or Berulit GA 2500 LV is applied.

Operation of a gear drive with such small quantities requires, however, continual checking and regular cleaning of the spraying system.

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



Berugear HV – light-colored high-viscous service lubricants

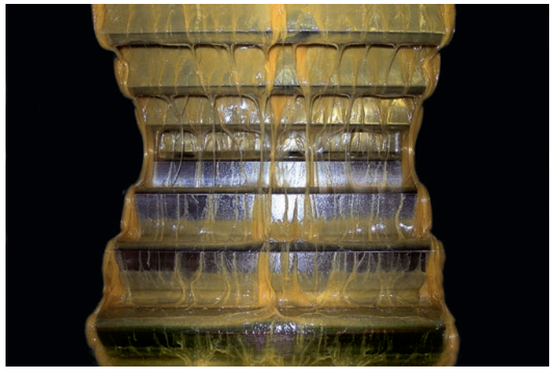
Berugear HV is synonymous with a new generation of light colored high viscous service lubricants. The fluids in the Berugear HV series are intended for use in large open drives with higher requirements concerning operational viscosity, life of lubricating film, thermal stability, low lubricant consumption rates as well as disposal of the consumed lubricant from the gear ring housing and for those drives for which the black color of conventional adhesive lubricants is undesired. They are available with different viscosities.

Berugear HV fluids were developed to fulfil the requirements of AGMA 9005 D 94 and to meet the demands of many equipment manufacturers for gear lubricants of high viscosity. Unlike other products, they do not contain solvents. The fluids form very thick, long-lasting and extremely adhesive light-colored lubricating films on the tooth flanks.

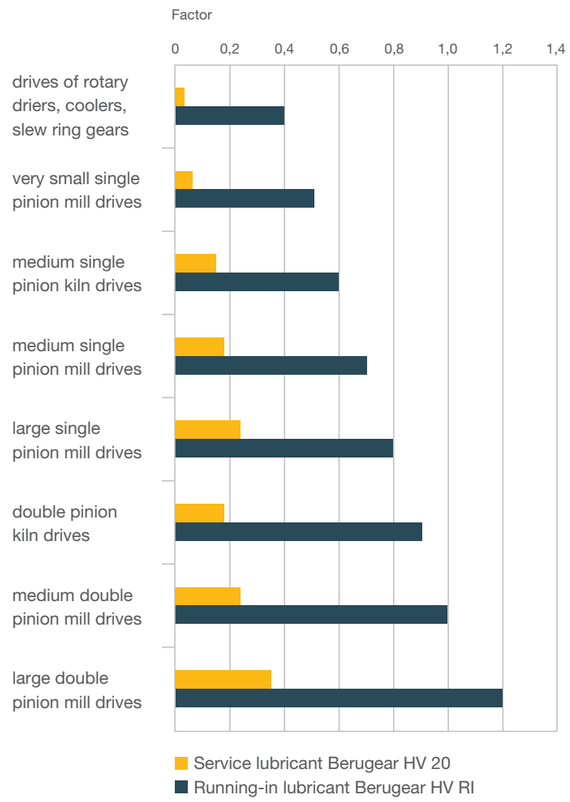
Berugear HV fluids can be used for almost any open gear drive for grinding mills and rotary kilns. Best performance is, however, achieved if used for large gear drives of smaller modules exposed to very high tooth flank pressures or running with a high circumferential speed, gear drives with complicated discharge of used lubricant or gear drives with long intervals in lubricant application. Due to their very high adhesion capacity, they are not recommended for use in drives with insufficient protection against very abrasive dust and other contaminants.

Berugear HV fluids can be applied by spray systems, paddle wheel systems, circulation systems and dip systems. Their suitability should be verified first, taking into consideration the base oil viscosity as well as a possible filterability in circulation systems.

When applied by spray systems, the products in the Berugear HV series offer the possibility for a significant reduction in lubricant consumption. Lower disposal costs support the cost effectiveness of the products.



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



Berulit GA Fluid – adhesive gear greases for dip baths

For open drives lubricated using a dip bath, the transparent fluids of the Berugear HV series are available, in addition to the specially adapted products in the Berulit GA Fluid series. 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.

A prerequisite for successful use of Berulit GA Fluid adhesive lubricants is appropriate maintenance of the bath. The dip bath has to be protected from solid and liquid contamination. The lubricant level in the bath has to be checked and if necessary be topped up regularly to prevent starvation. The tooth flanks should dip into the lubricant by approximately 30% of their height during operation and approximately 50% of their height during stop. The paddle elements of paddle wheels should dip fully into the lubricant.

Open gear drive with paddle wheel lubricated by Berulit GA 2500 Fluid

Spray systems

Adhesive lubricants of the Berulit GA and Berugear HV series are ideal for spraying provided the application temperatures are taken into consideration. Spray test reports are available on request.

The condition and 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.

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

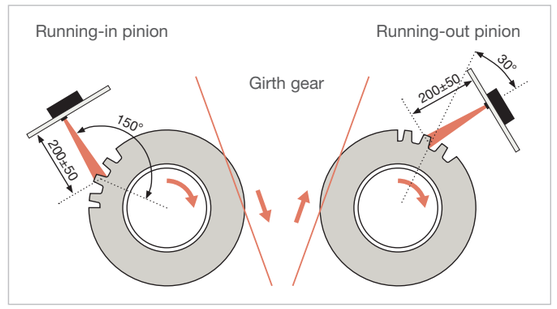
A clean spray system is the prerequisite for preventing spray problems. Special care has to be taken when changing the lubricant drum and refilling the container. Transfer pumps in combination with an additional lubricant filter significantly reduce the risk of contaminated lubricant in the spray system.

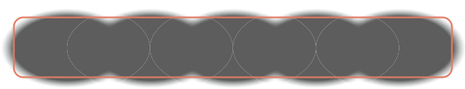
The lubricant filter of the spray system needs to be cleaned regularly. With lubricants of very high viscosity in particular, there is a tendency for some components to settle down in the filter. When using lubricants with high base oil viscosity, we recommend cleaning the lubricant filter at least every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

For drives equipped with a spray system, continual dredging of the tooth flanks in the used lubricant in the sump must be prevented. It may contain abrasive foreign impurities. Often, used lubricant contains abrasive impurities that can result in increased wear or other damage to the tooth flank.

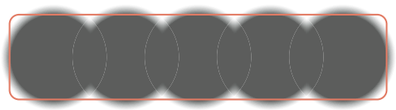
Drums of Berulit GA 2500 connected to spray systems

BECHEM has a spray testing system for adhesive lubricants to simulate customer-specific conditions





Tooth flank with good coverage by flat spray nozzles



Tooth flank with good coverage by round spray nozzles

Special lubricants for open gear drives

With the **Berulit GA** and **Berugear HV series,** BECHEM offers a wide selection of adhesive lubricants for all applications. Thanks to the high number of lubricants, a wide range of operating conditions, differences in drive and housing design and numerous types of lubricant supply can be taken into consideration.

Reliable, cost-effective lubrication under tough conditions requires not only the use of high-performance lubricants, but also experience in correct application. BECHEM has the necessary expertise to provide individual consultation to users. BECHEM offers customers comprehensive technical services even before using its products. Please inquire about BECHEM services.

Products of the **Berugear HV series** were designed for the mechanical and dynamic loads in drives with circulation systems. When selecting a lubricant, the ambient temperature, supply pump and – if used – the design and size of installed filters all have to be considered.

PRODUCT	Base oil	Thickener	NLGI-grade	Kinematic viscosity [mm²/s] at 40 °C / 100 °C	Service temperature range [°C]		Typical applications	Description
Berulit 443	Mineral oil	Aluminum complex soap	2	260 16	-20	+180	Open gear drives without automatic spray system, low-speed highly stressed plain bearings and sliding guides, ring mounts, steel guide plates of crane booms, telescopic booms	Priming lubricant for open gear drives and lubricating paste, very high graphite content, excellent wear protection, good adhesion, high load-carrying capacity, not sprayable
Berulit EL 420	Mineral oil	Aluminum complex soap	0–00	490 32	-20	+180	Open gear drives, ring mounts on converters, cranes, crushers and excavators with spray or central lubricating systems	Running-in lubricant for open gear drives, excellent wear protection, good adhesion, very high load-carrying capacity, contains graphite, application by means of spray units and dip baths
Berulit GA 400	Mineral oil	Aluminum complex soap	0–00	490 32	-20	+180	Open gear drives, chains of large diameters, closed wire ropes, ring mounts, highly stressed toothed couplings, highly stressed sliding guides, inflow seals of rotary kilns	Operating lubricant for open gear drives, extremely high base oil viscosity, excellent wear protection, extremely high load-carrying capacity, good adhesion, contains graphite, preferably applied by spray equipment
Berulit GA 800	Mineral oil	Aluminum complex soap	0–00	1000 45	-10	+180	Open gear drives, chains of large diameters, closed wire ropes, ring mounts, highly stressed toothed couplings, highly stressed sliding guides	Operating lubricant for open gear drives, very high base oil viscosity, excellent wear protection, very high load-carrying capacity, strong adhesion, contains graphite, sprayable and also suitable for dip baths
Berulit GA 800 Fluid	Mineral oil	Aluminum complex soap	000*	1000 45	-10	+120	Open gear drives, closed wire ropes, chains of large diameters, highly stressed toothed couplings	Operating lubricant for open gear drives, very high base oil viscosity, excellent wear protection, very high load-carrying capacity, strong adhesion, contains graphite, sprayable and also suitable for dip baths
Berulit GA 2500	Mineral oil, synthetic oil	Aluminum complex soap	00	2500 100	+5	+200	Open gear drives, chains of large diameters, closed wire ropes, ring mounts, highly stressed toothed couplings, highly stressed sliding guides	Operating lubricant for open gear drives, very high base oil viscosity, excellent wear protection, very high load-carrying capacity, strong adhesion, contains graphite, preferably applied through spray equipment
Berulit GA 2500 Fluid	Mineral oil, synthetic oil	Aluminum complex soap	000*	3175 113	0	+200	Open gear drives, chains of large diameters, highly stressed toothed couplings	Operating lubricant for open gear drives, very high base oil viscosity, excellent wear protection, very high load-carrying capacity, strong adhesion, contains graphite, sprayable and also suitable for dip baths
Berulit GA 2500 LV	Mineral oil, synthetic oil	Aluminum complex soap	00	6500	+10	+200	Open gear drives, ring mounts on converters, cranes, crushers and excavators with spray or central lubricating systems	Operating lubricant for open gear drives, very high base oil viscosity, excellent wear protection, very high load-carrying capacity, strong adhesion, contains graphite, preferably applied through spray equipment
Berulit GA 2500-2	Mineral oil, synthetic oil	Aluminum complex soap	2	2500 100	+10	+200	Open gear drives without automatic spray system, ring mounts of excavators, converters, cranes	Operating lubricant for manual application, very high base oil viscosity, excellent wear protection, very high load-carrying capacity, strong adhesion, contains graphite
Berugear HV PR	Mineral oil	Polyurea	2	150 11	-30	+150	Open gear drives, priming lubricant for tooth flanks prior to running-in processes, low-speed, highly stressed plain bearings and sliding guides, ring mounts	Running-in lubricant for open gear drives, excellent wear protection, very good adhesion, very high load-carrying properties, manual application or application by lubricating wheels or other pressure lubrication systems, not sprayable
Berugear HV RI	Mineral oil	Aluminum complex soap	000	490 32	-20	+180	Open gear drives, ring mounts	Running-in lubricant for open gear drives, excellent wear protection, good corrosion protection, good adhesion, very high load-carrying capacity, application by means of spray units and dip baths
Berugear HV 10	Mineral oil, synthetic oil	–	–	10000 320	–	–	Open gear drives, large, low-speed closed gear units and bearings	High-performance fluid with extremely high base oil viscosity for open and slow-running closed gear units, excellent wear protection, very high load-carrying capacity, excellent adhesion
Berugear HV 20	Mineral oil, synthetic oil	–	–	18500 550	–	–	Open gear drives, large, low-speed closed gear units and bearings	High-performance fluid with extremely high base oil viscosity for open and slow-running closed gear units, excellent wear protection, very high load-carrying capacity, excellent adhesion

*Value indicates unworked penetration [1)] Value in grey indicates a possible short-term maximum temperature

Comprehensive BECHEM service

Reliable and cost-effective lubrication of open gear drives not only requires high performance products, 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 skill of their service technicians has made BECHEM a leading supplier of open gear lubricants on all continents.

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

Given that product performance and quality of the service provided determine the life time of the machinery, the service component is highly rated by equipment manufacturers. The excellent service provided by BECHEM has convinced leading equipment manufacturers to recommend BECHEM open gear lubricants.

The service operations are planned and prepared in our Service Centres around the world. Coordination is managed at our headquarters in Hagen. The central reporting system and training of service staff are also organized there.

Inspection of a ball mill in a cement plant

BECHEM service package for open gear drives

- 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 lubrication systems at agreed intervals including measurement of the temperature profile across the flanks and a vibration measurement at the pinion bearings, an assessment of the tooth flank condition, the contact pattern and potential damage, as well as a complete check of the lubrication system
- A detailed written report with appropriate documentation for each inspection service
- Surveillance or carrying out of running-in processes
- A lubricant consumption optimisation program
- 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 improved 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 the exception of repair services – is provided free of charge to customers using BECHEM open gear lubricants over a longer period for their drives.

Grinding of pitting marks on the tooth flanks of a ball mill drive

Vibration measurement at a ball bill drive