RUNNING GEAR DRIVE REPAIRS
Not long ago, the only way to make repairs to large girth gear drives involved costly mechanical procedures and the dreaded downtime. Klüber has a better idea.

By Wolfgang Gerhold

When it comes to repairing the tooth flanks of large girth gear drives, repair lubrication provides a number of advantages over mechanical processing. Even the operation of seriously damaged gear drives can be improved through repair lubrication so that replacement can often be postponed for several years. Further advantages are life span extension of girth gear drive components, and the ability to repair the girth gear drives in operation. To the operator this means that the girth gear drive can remain in operation and production can continue. No costs for gear outage arise. As the procedure is complex, it is recommended to consult experts before undertaking it.

Not long ago tooth flank damage in large girth gear drives was repaired exclusively by applying mechanical treatments and costly repair procedures. High tooth flank qualities could not be obtained as demands regarding the life span and operation of a girth gear drive prevailed. In turn, costs arising through the loss of production and through the human resources needed to repair the damage caused were very high. Nowadays, repair lubricants are widely used to repair tooth flank damage. Repair lubricants make it possible to restore damaged tooth flank surfaces in a way that the gear can remain in use with improved operating performance. Moreover, repair lubrication prevents renewed breakage of restored surfaces and new tooth damage.

The decisive advantage of repair lubrication over mechanical processing is that the girth gear drive remains fully operable and that high loads even increase the success of repair lubrication. Compared to several days of standstill, as in the case of mechanical processing, short girth gear drive downtimes for control and documentation purposes during the repair lubrication process are all but negligible.

PRINCIPLE AND EFFECT

Repair lubricants wear off material. They contain specially developed compounds that are highly active and effective. These compounds subject metallic surfaces to mechanical, chemical and corrosive wear. Thus a small amount of lubricant can remove just the right amount of flank material—corresponding to the customer’s repair needs and technical feasibility—in a short period of time.

The material is worn off evenly at the contact points. The ability to repair through material removal is limited by the thickness of the hardened tooth flank surface layer [1]. There is only minor influence on the hardened surface layer itself. Surface wear and hence damage repair can be controlled by the amount, application duration and reaction time of the lubricant in each application cycle, and by the repair time as a whole. By applying controlled wear, the tooth flank profile is evened across the entire tooth width and height so that it matches its mating gear.

Scuffing, scratches and scoring are very easy to repair with this technique. Plastic material deformation can be repaired up to a certain extent.

When pittings are encountered, the progress of damage and the formation of new pitting are prevented by eroding material at the overloaded flank parts, which leads to a more even load distribution over the tooth flanks and hence a reduction of specific
tooth flank peak loads and a higher rolling endurance.

In mill drives, successful repair lubrication can be achieved in a relatively short time. Compared to kiln drives, the speed of rotation is higher and thus tooth contacts are more frequent. The repair procedure is also accelerated by higher sliding speeds. Depending on the damage, repair lubrication takes one to two working days for mill drives. Kiln drives require higher amounts of repair lubricants due to lower rotation and less frequent tooth contacts. In this case, the process of repair lubrication takes about two to three working days.

LIMITATIONS OF REPAIR LUBRICATION

Repair by controlled wear is limited by the degree and type of damage. Depending on the drive’s base material, removal of a few hundredths to several tenths of millimeters can be achieved. Generally, “only” a few hundredths millimeters are removed, but this can lead to significant operational improvement.

It is not recommended to use repair lubrication for the repair of burrs at the tip and the side of the teeth, material elevation, wear steps at the tooth root, sharp edges and deep pitting. These types of damage have to be repaired mechanically by milling (end-milling cutter, spherical cutter).
or grinding (cutting-off wheel for material steps or abrasive buffs for flank treatment).

**OPERATOR INVOLVEMENT**

To start with, please note: during the warranty period of a large gear drive, the manufacturer’s and the operator’s permission must be obtained prior to repair lubrication.

For the preparation of repair lubrication, it is vital to identify the causes of the damage and to eliminate them. Depending on the type and degree of the tooth flank damage, mechanical treatment (grinding, milling) might be required prior to repair lubrication.

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To document the condition of the tooth flanks and the contact ratio unambiguously before and after repair lubrication, photographs are taken and silicone impressions of some representative tooth flanks are made. It is important to always document the changes of the same tooth flanks. In doing so, the operator obtains an illustration of the actual condition of the flanks and how it has changed.

Repair lubrication is effected under operating conditions, thus permanent operation is normally ensured, although short interruptions needed for inspection by the service engineer have to be allowed for. Despite the damage, a contact ratio of 60 percent or more should be achieved prior to the repair lubrication process because otherwise the gear drive will have to be readjusted.

![Fig. 4: Damage repair through the use of repair lubrication. The effect is clearly visible in the lower image.](image-url)
While the lubrication system runs on “continuous operation” with a running-in lubricant, the repair lubricant is applied by the use of a manual spray equipment (e.g., Klübermatic LB) which is connected to a pneumatic system.

The manual spray equipment is used to apply the repair lubricant in larger quantities to the bearing pinion flanks and the gear rim so that the lubricant is distributed evenly over the tooth flanks. The process of material removal begins.

Afterwards, the repair lubricant is applied in smaller quantities to correct elevations and edges on the tooth flank profile.

MEASURING SUCCESS

There are the following means to measure the effectiveness of repair lubrication:

- Visual inspection of rotating girth gear drive by means of a stroboscope (applies to mill drives only);
- Measuring the temperature distribution across the tooth’s width and around the circumference by means of an infrared thermometer;
- Measuring vibrations at the pinion bearings (applies to mill drives only);
- Taking photographs of the tooth flanks under stroboscope light in regular intervals

All measured values enter the statistics. If necessary, low lubricant quantities will be used for fine tuning in spots where slight material elevations still occur on the flanks. These spots are light, bright metal areas that experts can easily make out. If there are no such
areas, the repair lubricant will be sprayed evenly across the entire flank.

Repair lubrication is completed when the temperature curve is even across the entire tooth flank’s width and around its circumference. This means that the estimated contact ratio is above 80 per cent, that surface roughness, minor scuffing damage, scoring, scratches and minor plastic deformations have been smoothed and that there are no more significant vibrations.

On the termination of the repair process it is recommended to use running-in lubricants for a short while, as these help to smooth minor roughness caused by the repair process.

**CONCLUSION**

Due to the complexity of the repair process, and to avoid unintended damage, repair lubrication should only be carried out by a trained and experienced application engineer. Nevertheless, if implemented correctly, repair lubrication is a very interesting alternative to mechanical treatment. When it comes to repair issues, repair lubrication should always be the first choice.

Operators of large girth gear drives can avoid costly production downtimes as the repairing process can be implemented in full operation. In addition, the repair lubricant on tooth flank surfaces improves the girth gear’s operational performance and prevents new flank damage. Replacements can often be postponed for years.

**REFERENCE:**

1) For case-hardened materials with a hardening depth (Rht) of approx. 2 mm, as well as for surface-hardened materials (Rht up to 10 mm attained with induction hardening and approx. 2 to 4 mm attained with flame hardening), repair lubrication is a highly suitable technique. For nitride-hardened materials, whose nitriding depth (white layer + diffusion layer) is approx. 1.5 mm, repair lubrication with its special compounds is not suitable since it would also remove the extremely thin (5 to 30 µm) white layer, which shows the greatest hardness.