

A Clear Choice

Angus Macdonald, Lubrication Engineers International Ltd, UK, details ways enhanced open gear lubricants provide tangible benefits in heavy industry.

The maintenance of the large open gear systems at industrial sites, such as mines, power plants and cement plants, presents a significant challenge due to heavy loads and harsh environmental conditions. Common lubrication issues include housekeeping due to the large quantity of lubricant that is traditionally required to provide a continuous coating to the open gears. In addition, when asphaltic products are in use for

many years, the result is a buildup of hardened lubricant in the roots of the gears. This presents many problems with cleaning and mechanical interference that can result in gear misalignment or stress on the pedestal mountings. Since the late 1980s, a range of new, improved enhanced lubricants were developed in order to address these problems and allow mines, power plants and cement plants to reduce their maintenance and operating costs for their critical ball mills

and kilns. Since their introduction, these lubricants have established a proven record of providing superior lubrication, wear protection and operational savings for large open gears. This article will outline the nine key features and benefits of converting critical open gear applications to enhanced lubricant technology.

Proprietary anti-wear additives

Solid film additives, such as the well-known molybdenum disulfide or graphite, were traditionally the most common form of anti-wear protection used in open gear lubricants. However they had a number of disadvantages, which included a tendency to build up on themselves; this could then affect machinery with close tolerances. For open gears, this could result in a buildup of product in the roots of the gear teeth that solidified over time – difficult to clean and remove, as well as creating mechanical interference.

However, another type of solid film additive has been available for more than fifty years and integrated into specially developed open gear lubricants in the late 1980s. Metallic oxide type additives, such as Almasol[®], provide thin film lubrication protection to the gears due to the fact that they can resist loads of more than 400 000 psi (28 123 kgf/cm²) and temperatures in excess of 1000°C. These extreme temperatures and load levels are found at the microscopic asperity level on all metal gear teeth. Additives, such as Almasol, prevent any possible metal-to-

metal contact between the gears and act like a very thin, but powerful, glove of anti-wear protection around the metal surfaces.

Finally and importantly, metallic-oxide type additives do not build up on themselves because the technology has a natural affinity with metal surfaces but repels itself. The immediate and tangible result of such additives is a reduction in the operating temperature of the gear teeth once the new lubricant has been applied via the auto lubrication system.

Superior gear protection

It is common for heavily loaded open gears to be damaged as a result of shock loading and inadequate protection from the lubricant in use. Asphaltic-based compounds have typically only had a Timken OK Load rating of 20 – 25 lb and therefore had to be used in excessive quantities in order to provide sufficient protection to gears. However, the Timken OK Load ratings of new, enhanced lubricants generally exceed 60 lb, and some synthetic lubricants, such as Pyroshield, achieve results as high as 90 lb.

Gear healing solution

Many large open gears experience damage over time: scoring, pitting or spalling can roughen the gear tooth contact area. High-performance lubricants provide a healing solution to this expensive maintenance problem.

The healing process begins with a redistribution of the load over the surface

area of the gears, made possible by high film strength and film thickness. Pyroshield’s ability to keep the gears separated and not allow asperities and high points to come into contact allows the nondestructive deformation of the gear surface, which ultimately results in healed gear appearance. Often small pits will close up completely and disappear due to this deformation of the gear surface.

The photographs of the gear teeth in Figure 1 at a cement plant in Halkis, Greece, are just one example of gear healing that substantially increased open gear life and reduced maintenance costs for the customer, Titan Cement.

Less energy consumption

The annual electricity cost of open gear applications, such as ball mills, is one of the biggest operating costs for mines and other industrial plants. Due to the previously outlined superior anti-wear and lubricating qualities of enhanced lubricants, it is normal for significant energy savings to be achieved. The metal-to-metal contact has been reduced and therefore so have friction, heat and wear. The source of heat in an open gear set is friction and, when this friction is reduced, it means that less energy is required to overcome that friction.

Enhanced lubricants enable substantial open gear temperature reductions to be achieved, sometimes in excess of 15°C during the conversion process and continuing during normal operation. Importantly, the Delta T across the face of the pinion gears is also reduced,

Table 1. Metallic oxide type anti-wear additives outperform conventional solid additives

Solid additive	Maximum service temperature	Load carrying capacity	Acid resistance	Drawbacks when used in industrial lubricants
Almasol [®]	1038 °C	400 000 psi 28 123 kgf/cm ²	Inert	None.
Molybdenum Disulfide	343 °C	400 000 psi 28 123 kgf/cm ²	Some	Oxidises in air above 343 °C (650 °F), forming abrasive molybdenum trioxide. Tendency to build up on itself, affecting machinery with close tolerances. Cannot tolerate hydrochloric and nitric acids, especially when heat, water and air are present.
Graphite	426 °C	80 000 psi 5625 kgf/cm ²	Some	Known to exhibit galvanic corrosion problems. Tendency to build up on itself, affecting machinery with close tolerances.
Fluorocarbon (PTFE)	260 °C	5000 psi 352 kgf/cm ²	Inert	No load-carrying capability. Tendency to build up on itself, affecting machinery with close tolerances.



Figure 1. Gear healing solution on ball mill open gears at Titan Cement, Halkis, Greece.

demonstrating that there is improved distribution of load.

Despite varying loads on the equipment, customers are able to analyse longer-term energy trends, as well as the productivity of mills and kilns in order to assess energy savings. Some mines in South Africa have recorded a reduction in energy consumption of approximately 400 – 600 kW or approximately 12% on mill motors, while still maintaining the same production output. A South African platinum mine recorded a reduced power consumption on each of their 2500 kW mills of up to 200 kW.

Lower lubrication costs

Although high-performance enhanced lubricants cost more initially than alternative commercial-type lubricants, the resulting reduction in lubricant consumption leads to an overall reduction in lubrication costs.

Operators regularly experience lubricant consumption reductions of more than 80% when they convert their open gears to Pyroshield open gear lubricants. These reductions in consumption quantities alone can more than justify the initial higher purchasing price. One Bulgarian cement plant's estimated savings due to consumption reduction were €86 904 – this did not take into account other important cost-reducing factors, such as reduced energy consumption and lubricant disposal costs, longer equipment life, cleaner

working environment and ease of inspection. A South African platinum mine was able to reduce its lubricant consumption from 800 kg/month down to only 80 kg/month – equating to a 90% reduction in lubricant consumption.

No more hazardous waste

Enhanced lubricants, such as Pyroshield, can be treated as an ordinary lubricant and can often be added to the fuel or coal burned in the normal operation of many plants. However, many asphaltic compounds contain lead or other heavy metal compounds as extreme pressure additives, contributing to their designation as hazardous waste products. The asphaltic compounds could also contain polycyclic aromatic hydrocarbons that require disposal as hazardous waste. Hazardous waste disposal is expensive and necessitates tedious cradle-to-grave record keeping.

A cement plant in Bulgaria dramatically reduced its disposal costs by converting its two KHD kilns and two of its Polysius ball mills to Pyroshield. The waste reduction was 600 kg per kiln alone – a tonne less hazardous waste to dispose of annually. The reduction for its two ball mills using Pyroshield was even greater: nearly 1800 kg per mill. With a total of nineteen fewer drums of hazardous waste to dispose of each year at an approximate cost of €350 per drum, the plant experienced a total saving of €6650.

The previously mentioned platinum mine's 90% reduction in lubricant consumption meant that the mine was no longer having to dispose of large volumes of used lubricant, which then assisted their carbon reduction targets. An Indonesian cement plant was able to reduce its disposal costs by reducing open gear lubricant consumption from 6 kg/day down to 1.4 kg/day – a 77% reduction (Figure 2).

Faster, safer clean-up

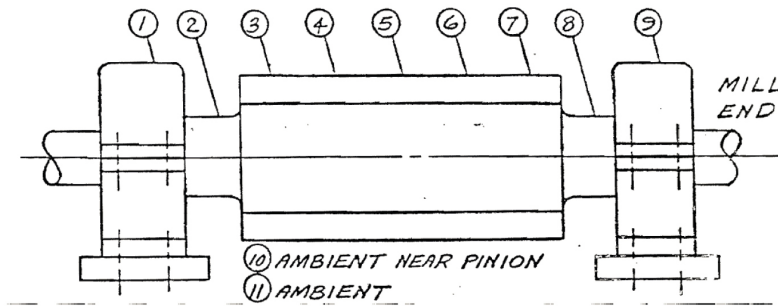
Clean-up and other housekeeping associated with the use of asphaltic-based products can be time-consuming and expensive. Although total costs are difficult to estimate, operators have reported labour requirements in excess of four man-days to clean some units. In addition, the large amount of lubricant that is generally used creates buildup around the shrouds, which creates a messy, sticky, potentially unsafe work environment. However, with the current enhanced synthetic lubricants, such as Pyroshield, the lower application quantities mean that open gear housekeeping is significantly improved.

The cement plant in Halkis, Greece, reduced its annual open gear lubricant consumption in its six ball mills by an impressive 87% – from 7200 kg to only 960 kg – by converting all six mills to Pyroshield. An additional safety point that is regularly mentioned by plants is that after the conversion of their open gears to



Figure 2. Reduction in consumption of enhanced open gear lubricant for two kilns at an Indonesian cement plant.

Data Sheet for Pinion Temperature Profiles
LE 9011 PYROSHIELD Syn XHvy Open Gear Lubricant
Open Gear Conversion



Mill No.	Date	Time	Meter Valve Set	Air Press	Spray Interval	Temperatures °C																
						1	2	3	4	5	6	7	8	9	10	11						

Figure 3. Recording of gear surface temperatures is an important part of the open gear conversion process.

enhanced lubricants, there is also a noticeable reduction in noise levels around their mills and kilns due to the improved lubrication and reduction of metal-to-metal contact. This reduction in noise tends to match the zero harm philosophy of industrial plants.

Simple open gear conversion process

Downtime is expensive and important to be avoided. Converting large open gears to enhanced lubricants, such as Pyroshield,

does not involve any interruption to production or operation. It is a seamless operation with effective cleaning and wear protection of the gear system throughout the conversion process.

Local lubricant consultants are able to assist plant maintenance personnel with the process, as well as provide detailed conversion reports. A key element of the process is the regular recording of the temperature of the gear face at a number of specified points (Figure 3).

As previously explained, the conversion of an open gear to an enhanced lubricant normally involves a dramatic drop in the temperature of the gear surfaces due to the superior anti-wear protection and lubrication that the new lubricant provides the open gears. As long as those temperatures continue to drop or remain stable at a lower temperature, it is then clear that sufficient lubrication is being provided.

Easy visual inspection

A final major benefit of the new generation of synthetic enhanced lubricants is that several of them are translucent when applied to open gears. The lubricant is actually clear and this makes it easy for maintenance personnel to inspect the surface of gears by using a strobe light while the mills continue to work.

No cleaning or expensive downtime is required for periodic gear inspection, thereby once again further reducing maintenance and operating costs for the plant in question. It is this translucence that has enabled certain customers to understand how and when the gear healing phenomenon starts to occur: they are actually able to see that wear and pitting starts to disappear over a longer period of time.

Conclusion

Enhanced lubricants have been proven in the field for nearly 30 years to offer companies improved profits and return on net assets by increasing the reliability and productivity of open gears, while reducing the costs of operating and maintaining them. As the cost of energy to industry continues to rise, these superior lubricants are also able to offer significant savings by considerably reducing the generally high levels of open gear energy consumption. The conversion of open gears to enhanced lubricants is a win-win scenario for maintenance personnel, financial officers, as well as companies' environmental credentials – like the lubricants themselves, the choice should be clear. ^WC