Revolutionising open gear lubrication in mills with novel anti-wear additives

***Dr Sergei Mamykin**, Tribologist, copper filming technology developer, at NEOL Copper Technologies and **Rafe Britton**, Lubrication specialist and consultant at Lubrication Expert.*

Lubrication is critical in ensuring the optimal performance of mills worldwide. The key area that poses a significant challenge is lubricating the open gear sets that drive ball mills, grinding mills, kilns and dryers. Large, exposed mill gears are often found in cement, power generation, and mining industries and are essential components that demand meticulous care and maintenance thanks to the significant loads placed upon the gear teeth. The asset's value and the importance of uptime make open gearing a critical lubricant application.

Lubrication challenges in open gear sets

Open gear sets in mills present unique challenges due to their size, exposure to harsh environmental conditions, and the significant load they carry. Unlike enclosed gears, open gears are subject to more severe contamination with dust, water, and debris, which can accelerate wear and tear. The sheer size of these gears also requires the lubricant to have excellent adhesion properties to remain effective over the entire gear face, despite the centrifugal forces and varying speeds encountered during operation.

Misalignment issues are a common problem in mill operations and can lead to uneven distribution of loads across the gear teeth. This uneven load distribution results in excessive heat generation, further stressing the lubricant and leading to an uneven film thickness across the face of the gear. An effective lubricant must protect against wear and possess properties that mitigate these thermal challenges.

Choosing between open gear greases and lubricants

Many products have been developed over the years to cope with the challenges described. The two main product groups are semi-fluid greases, and liquid lubricants (although these can be further differentiated into asphaltic, polymers, and high viscosity synthetics). The decision to use either an open gear grease or an open gear lubricant hinge on several factors. Open gear greases typically provide a robust protective layer and are adept at sealing out contaminants. Their consistency and tackiness can provide better adhesion, and they can be beneficial in scenarios where environmental contamination is a significant concern.

On the other hand, open gear lubricants, which are usually more fluid, offer the advantage of more straightforward application and better penetration, especially in high-speed or heavily loaded gears. They are designed to form a thin, protective film that ensures consistent coverage and reduced friction, essential for gears operating under high load conditions.

Challenges for the industry

The challenges faced by the industry in open gear lubrication are multifaceted. Environmental contamination, misalignment issues, and the need for consistent thermal performance create a complex scenario where conventional lubricants often fall short. Traditional approaches struggle to address the evolving demands of modern mill operations,

leading to increased wear, higher temperatures, and decreased equipment longevity.

Tests and Case Study – Effectiveness of copper filming technology

A comprehensive case study was conducted in the mining industry to validate the effectiveness of copper filming technology. Mining is an ideal test case as it is known for its demanding operating conditions. The test focused on a ball mill with a useful load of 500 tons, equipped with a centralised lubrication system and utilising a standard EP, NLGI 0 open gear grease manufactured by a major European brand. Gear width was 1050 mm, and the module of the tooth was 45 (ratio of reference diameter to number of teeth). Throughout the gearbox's operation, temperature was recorded via three sensors positioned at the ends and middle of the gear face.

A standard lithium grease of EP0/00 grade with a synthetic base (viscosity of 220 cSt at 40 °C) and a fully oil-soluble CFT additive package was used for the test.

Before the start of the test, the mill had been in operation for over 40,000 hours, displaying a slight misalignment between gears. Temperature readings highlighted significant differences. The temperature readings were as follows: 42.1 °C; 54.5 °C; 63.2 °C, with a delta of 21.0 °C across the face.

After replacing the standard grease with a one with CFT in it, an initial temperature increase was observed. It has been determined that this was associated with the removal of the molybdenum disulfide (MoS_2) solid lubricant film formed by the incumbent product. The maximum temperature regime recorded after 5 hours of operation with CFT grease was: 42.8 °C; 55.8 °C; 64.7 °C, with maximum delta reaching 26.0 °C in the first 24 hours.

Based on previous experience with CFT greases, it is understood that around this time the MoS_2 layer was completely removed, and the CFT additive begins to work. At this point the processes of hydrogen smoothing in the friction zone and the formation of a protective copper coating begins.

After one and a half months of running on the new grease (over 1000 hours), the temperature regime recorded a remarkable improvement. The temperature regime recorded on CFT was 38.0 °C; 40.6 °C; 44.3 °C with a delta of 6.2 °C.

CFT significantly improved reliability of the ball mill, reducing temperatures at respective points and

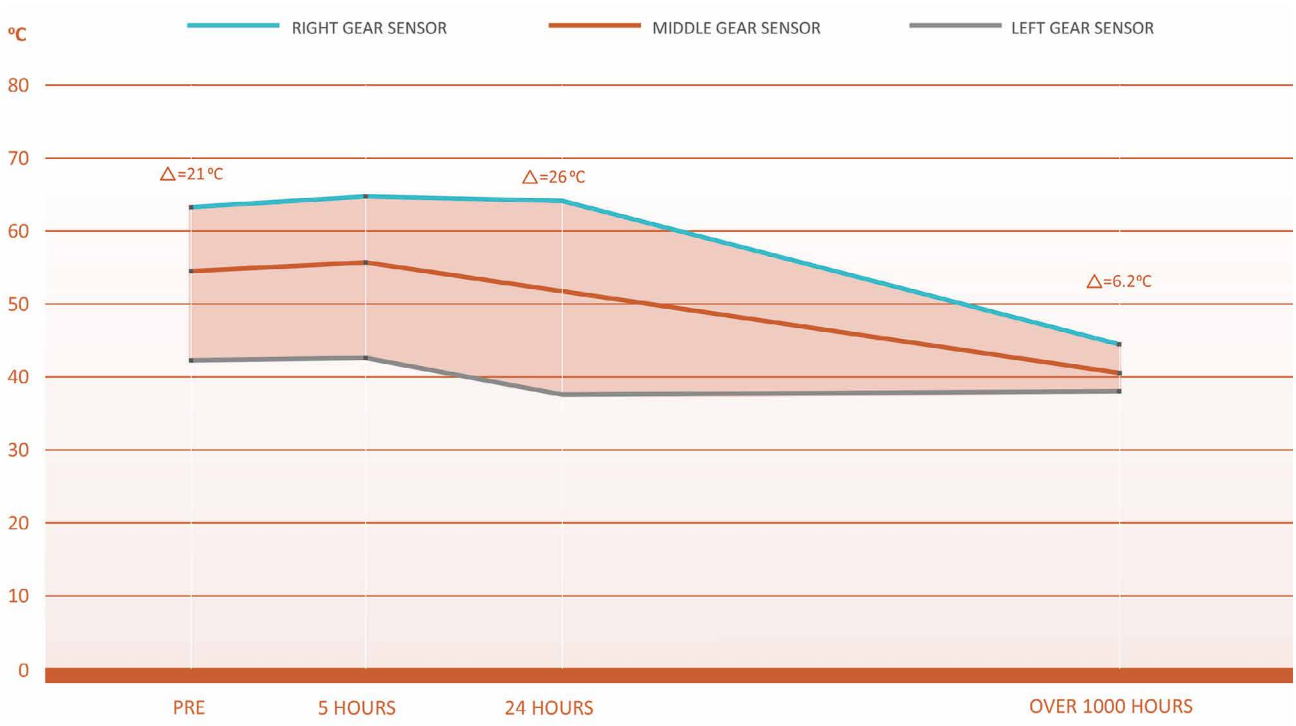

Figure 1: *Temperatures across the gear face.*

ensuring a more consistent and efficient operation. According to OEM specifications, the temperature difference across the tooth width should not exceed 7 °C for a gear width of more than 700 mm. The implementation of CFT in the real-life operation of the ball mill led to temperature reductions at respective points by 4.1 °C, 13.9 °C, and 18.9 °C. The overall temperature delta was reduced from 21.0 °C to 6.2 °C. Additionally, a reduction in the working pressure in the lubrication system from 150 to 54 bar was achieved.

The challenges faced by the industry in open gear lubrication are formidable, demanding innovative solutions to ensure equipment reliability and longevity. CFT based lubrication has proven to be a transformative solution, addressing the specific challenges posed by open gear sets. The case study presented demonstrates the tangible benefits of CFT in reducing temperatures, improving gear set longevity, and enhancing operational efficiency.

The journey towards revolutionising open gear lubrication underscores the importance of acknowledging challenges and adopting cutting-edge technologies that contribute to a more robust and resilient future in mill operations. The exploration of innovative lubrication methods demonstrates substantial advantages, including significant temperature reduction, prolonged gear set longevity, and the establishment of a more uniform and efficient operational environment.

(This comprehensive case study was conducted to validate the effectiveness of CuGlide™).

www.neol.world