THE ASPHALTIC ALTERNATIVES

SHELL LUBRICANTS
TOGETHER ANYTHING IS POSSIBLE

GREASE-TYPE AND HEAVY SYNTHETIC LUBRICANTS MAY IMPROVE OPEN-GEAR OPERATIONS

Many mills in the U.S. are more than 30 years old with some girth gearing approaching that age, and while they have years or decades of productive life ahead of them, operators often maintain them with outdated products or practices.

Modern production demands often require that today's mills run above their original design parameters, and the lubricants that were once appropriate for these conditions are no longer the best options for insuring continued production efficiency and component protection.

Understanding the latest advances in lubrication technology can save hundreds of thousands of dollars in repairs, avoid thousands of dollars an hour in downtime and reduce the frequency with which pinion gears must be replaced.

For years, grinding mills (ball, rod and SAG) and kilns relied on asphaltic grease for their open-gear lubrication because it was their only option. Today, however, mill operators and others that use open-gear systems have more choices, many of which offer advantages that traditional asphaltic lubrication doesn't.

3 TYPES OF HIGH-VISCOSITY LUBRICANTS

The purpose of lubricants in gear systems is to separate the mating gear surfaces, which reduces the probability for scuffing and wear, reduces friction and improves efficiency of the mill operation. Because of the load placed on these gears and the typical pitchline speeds, open-gear systems require extremely high-viscosity lubricants, which come in three basic categories:

- *Asphaltic*, a heavy mineral oil base combined with bitumen that create a tacky, high-viscosity lubricant with an undiluted viscosity of more than 100,000 centistokes(cSt).

- *Grease-type*, which uses a heavy base oil combined with a thickener and solid additives, such as molybdenum disulphide and graphite, to reduce friction and wear and allow the lubricant to function under extreme pressure. Its viscosity can vary from 700 to 10,000 cSt, but Shell greases and many others are between 1,500 and 5,500 cSt.

- *Heavy synthetics*, or "clear oils," are manufactured to rely purely on the high viscosity of the base oil, and without any solid additives, to do the work.

OPEN-GEAR LUBRICANT OPTIONS AT A GLANCE

	 Asphaltic	 Grease-type	 Heavy synthetics
Description	A tacky, high viscosity oil made from a mineral oil and bitumen base	A heavy base oil combined with a thickener and solid additives to reduce friction and wear	A "clear oil" manufactured to be as heavy as asphaltic but less tacky
Viscosity[1]			
Ambient Temp: -10 to +5° C or 14 to 41° F	**Viscosity:** 4140 cSt at 40° C	**Viscosity:** 428.5 cSt at 100° C	**Viscosity:** 4140 cSt at 40° C
Ambient Temp: +5 to 20° C or 41 to 68° F	**Viscosity:** 6120 cSt at 40° C	**Viscosity:** 857 cSt at 100° C	**Viscosity:** 6120 cSt at 40° C
Ambient Temp: 20 to 50° C or 68 to 122° F	**Viscosity:** 190 cSt at 100° C	**Viscosity:** 857 cSt at 100° C	**Viscosity:** 190 cSt at 100° C
Advantage	■ Provides high viscosity to separate heavy gear components	■ Repels dirt and dust from gear surfaces ■ Creates tackiness on gear surfaces that reduces maintenance and cleanup cost ■ Reduces buildup in gear teeth ■ Solid additives reduce friction in mating areas of the gear teeth	■ Purer molecules reduce friction and handle high temperatures better than grease-type lubricants ■ High viscosity enhances adhesiveness on gear surfaces ■ Clear nature improves gear inspection
Disadvantage	■ Poor performance at both extreme high and low temperatures ■ Builds up in gear teeth ■ Can attract dust and dirt, causing abrasive wear ■ High level of solvents results in "wasted volume" that doesn't contribute to lubrication ■ Certain solvents can present health and safety risks	■ Can have higher consumption rates than other lubricants	■ More expensive than other lubricants, resulting in higher up-front maintenance costs ■ Can be difficult to pump in cold temperatures because of high viscosity ■ May require modifications to existing spray systems

THE PITFALLS OF ASPHALTICS

While asphaltic lubricants have long been the standard, the market is moving toward alternatives that increase mill efficiency and reliability. Because of their heavy nature, asphaltics require solvents or other additives to dilute the lubricant enough that it can be applied to the gear. Stricter environmental regulations resulted in a ban on chlorine-based solvents, forcing mill operators to rely on petroleum-based solvents. Petroleum solvents are less effective and require a greater quantity to match the results of chlorine-based solvents. As a result, companies are paying for more solvents, which don't contribute to lubricity or component protection.

[1]Minimum viscosities based on ANSI AGMA 9005 for 5°C

In addition, extreme temperatures can compromise the performance of asphaltic lubricants. At colder temperatures, the lubricant becomes exponentially heavier and tends to crack and peel off the gear surface. In most cases, manufacturers must add more solvents to the winter versions of asphaltics, which only increases the consumption rate and drives up costs. At high temperatures, asphaltic lubricants tend to oxidize and fall off the gear surfaces easily.

Because of their heavy nature, asphaltic lubricants tend to create more build up in the root of the gear teeth if not managed properly.

> "Once this occurs, we see what some refer to as 'pinion jacking,' which can damage gearing and ancillary components," says Greg Paluska, who leads the Shell Lubricants team of LubeExperts, dedicated personnel for mining machinery.

The gears are designed primarily to carry the load at the pitchline on both the pinion and the girth gear. When this alignment is interfered with, the load begins to get carried in the addendum, or the portion of the gear tooth above the pitchline, which is not designed to carry the load. Subsurface cracks and fatigue can emerge, and in the worst cases, the teeth can break. Even in the best cases, production is at risk.

THE GREASE-TYPE ADVANTAGE

Grease-type lubricants can offer mill operators greater manageability and improved performance. They can be applied with the same spray systems as asphaltic lubricants, but grease-type lubricants provide better protection for the gear set, which can extend the pinion life.

"Grease-type lubricants can extend the maintenance cycle and improve the life of pinion gears," Paluska says.

"If you can extend the life of the gear, you can save significantly on the cost of production," he adds. "You also can maintain or increase production efficiency and asset utilization."

Grease-type lubricants provide better gear protection by creating a tacky protective film over the gear teeth that reduces dust and dirt accumulation on the gearing. At the same time, the formulation of grease-type lubricants inhibit buildup in the root of the gear teeth, avoiding the clearance issues and pinion jacking that asphaltic lubricants can cause.

A key ingredient in the formulation of grease-type open gear lubricants is the solid additive matrix. This is typically some form of molybdenum disulphide ("moly"), graphite or both. These solid additives have significant advantages in terms of friction and load carrying capability. In theory, a reduction in friction results in a lower temperature and more efficient movement, ultimately putting less load on the motor.

In addition to less friction, grease-type lubricants hold up better under heavier loads, which is critical to wear protection. Not only must the load be carried at the pitchline, the addendum and dedendum of the tooth can experience significant sliding, requiring a well-designed lubricant. Asphaltics handle this through their high viscosity oils, while the grease-type products rely on solid additives to manage this lubrication regime. Sliding load, if not lubricated properly, can lead to adhesive wear, a form of micro-welding of the mating teeth surfaces. As the gears continue to rotate, these welded areas tear away small portions of the gear, leaving damage that can escalate into severe spalling damage. These hard metal particles can break free into the mesh, potentially denting surfaces and causing catastrophic damage. While this torn portion is small, it builds over time. Solid additives have properties to aid this sliding motion, resulting in excellent wear protection without compromising efficiency.

Grease-type lubricants may result in higher consumption rates depending on the type of mill and the operating conditions, but most operators find the slightly higher upfront costs to be a small price to pay for improved gear life and lower maintenance costs in the long run.

THE HEAVY SYNTHETIC OPTION

As their name implies, synthetics don't use a mineral oil base. Instead, they are built from base molecules to have a viscosity that rivals asphaltic lubricants. Unlike asphaltics, however, heavy synthetics are clear fluids with no solid additives such as graphite or molybdenum. The load carrying capability and friction reducing properties come entirely from the viscosity of the lubricant.

"It's relying on the viscosity to do all the work, whereas the grease-type lets some of the solid additives do the work," Paluska says.

Because the molecules are purer, synthetics have a lower traction coefficient than asphaltics and grease-type lubricants. Their high viscosity combined with performance additives that enhance their adhesiveness on gear surfaces, gives these products excellent performance characteristics.

The clear nature of synthetics can make gear inspection easier. Asphaltic lubricants are black, and grease-types are black and gray and they must be wiped clear of the gear teeth to inspect for wear (with the help of solvents typically). **With synthetics, less cleaning is necessary, and the increased visibility offers a better view of overall wear patterns.** "You can just look at the gear because it's a true clear oil," Paluska says.

Synthetics are more expensive to produce than other open-gear lubricants, and as a result, they cost more. In addition, their high viscosity makes them difficult to pump in cold temperatures, and in some cases existing spray systems may need to be modified.

CONSIDERING BETTER OPTIONS

While asphaltic lubricants can still provide adequate gear protection that mills have relied on for decades, mill operators may find they can improve their operating efficiency, reduce maintenance expenses and enhance cost-effectiveness by considering lubricants that are better suited to the demands of today's operating environment. By improving their open-gear lubricants and maintain robust inspection practices their mills may continue operating efficiently for decades to come.

For more information, please contact your Shell Lubricants representative