TECHNI/TIPS

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LUBRICATING GRINDING/PULVERIZING MILLS WITH LE LUBRICANTS

INTRODUCTION

In many mining, electric utility and industrial plants, metallic and non-metallic minerals are pulverized or ground so they can be used as solid fuels or ingredients in products. For example, coal as a solid fuel requires a certain amount of processing before its latent energy can be fully exploited. For this to happen, the coal is pulverized in a mill. This coal is then fed into the boiler and used as fuel to heat water and generate steam to drive the turbine. Likewise, limestone must be ground to a fine size so it may be used to manufacture various types of cement or in scrubbers at power plants.

One of the methods employed to "grind" these materials is the use of various types of mills. Most of these are driven by large pinion and bull open gears. This heavy duty, expensive equipment operates under varying loads and temperatures. Frequently, these mills are critical to a plant's operation and cannot afford to be down except for scheduled maintenance. Therefore, lubrication of these gears with the most advanced lubricant available, such as LE's 9000/9001 PYROSHIELD®, 9010/9011 PYROSHIELD® XH and 5180 PYROSHIELD®, plays an important role in assuring continuous operation of these mills and also protects the expensive gears.

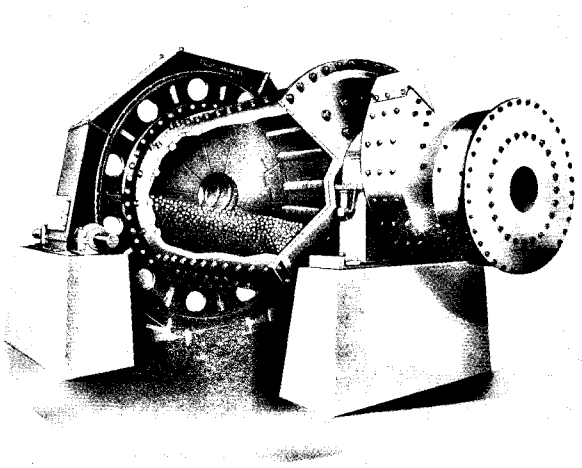
TYPES OF MILLS

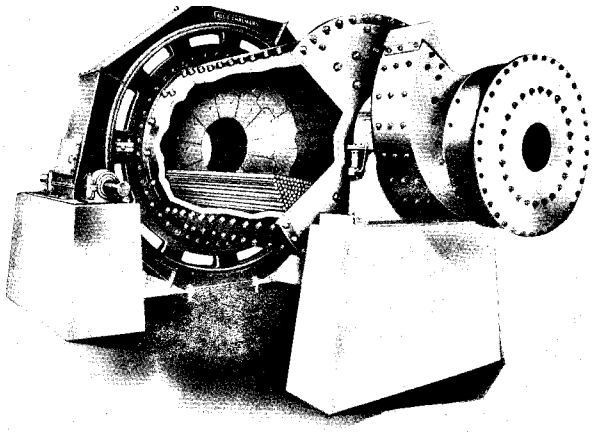
Although a variety of manufacturers supply mills, the design and principle of operation are very similar. While the units are similar, different manufacturers tend to concentrate or specialize in certain industries or minerals. The major ones are listed below:

Mill Manufacturer	Industry/Mineral
Foster Wheeler	Coal-Fired Power Plants
Riley Stoker (KVS) (Now Metso)	Coal-Fired Power Plants
F.L. Smidth	Cement
Allis Chalmers (Now Metso)	Cement, Glass Sand, Metallic & Non-Metallic Minerals
Denver	Metallic and Non-Metallic Minerals
MPSI (Koppers) (Now Metso)	Metallic Minerals
Fuller-Taylor	Cement, Non-Metallic Minerals

These mills are called by different names, depending on either the industry or the type of medium used to crush/pulverize the mineral. They are known as Ball, Rod, Tube, Pebble or Grinding Mills. The principle of operation is the same in all cases.

A large horizontal cylinder rotates, which is filled with the material to be ground or pulverized and a crushing medium. In the case of a ball mill (Figure A), as the cylinder rotates, steel balls tumble and crush the mineral. Rod mills have the same principle of operation; however, steel rods rather than balls are used as a crushing medium (Figure B). Other crushing mediums can be used, such as rocks in pebble mills.

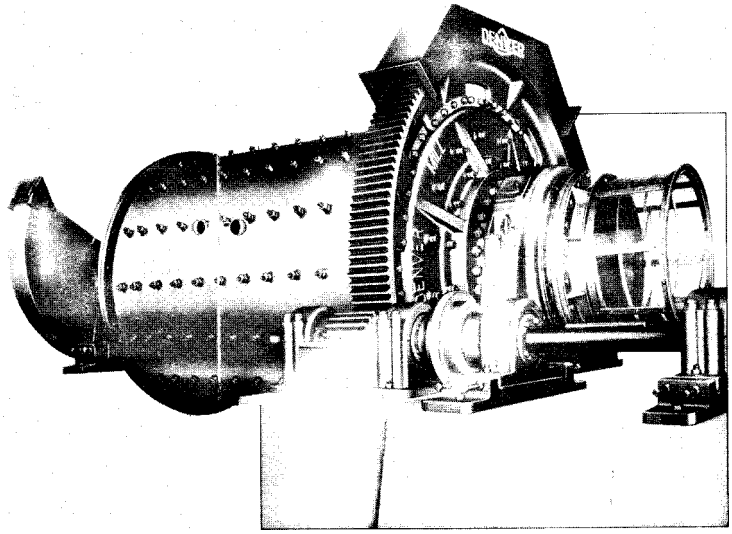




These types of mills can be found in practically every industry where there is a requirement to crush or grind a mineral. Particular industry types are:

Industry	Mineral
Coal-Fired Power Plants	**Coal, Limestone**
Cement Industry	**Limestone**
Refractories	**Fireclay**
Glass Sand Producers	**Quartz**
Sugar	**Sugar Beets**
Ore Processing	**Copper, Uranium, Iron, Gold, Molybdenum, Zinc**
Battery Manufacturers	**Lead**
Non-Metallic Minerals	**Phosphate, Perlite, Mica, Talc, etc**
Paint (Small Mills)	**Pigments**

In most units, rotation of the large cylinder is affected by a large open gear train (Figure C) which consists of spur, single helical or herringbone gears. The size of the bull gear will usually range from six to forty feet in diameter. The pinion gear normally varies from 1-1/2 to 2-1/2 feet in diameter. And, although various drive configurations exist, the pinion is usually driven by an electric motor through a gear reducer. Generally pinion speeds range from 15 to 250 rpm and bull gear speeds are approximately 20 rpm, to a maximum of 30 rpm.



Throughout the conversions which have been conducted, pinion operating temperatures have been recorded. On the larger mills with external heat sources, such as in coal pulverizers where hot (up to 700°F [371 °C]) primary air circulates through the mill, pinion temperatures with asphaltic lubricants in service reach 210°F to 220°F (99°C-104°C). Pinion temperatures with LE's 9000/9001 PYROSHIELD® 9010/9011 PYROSHIELD® XH or LE's 5180 PYROSHIELD® in service typically run 15°F to 25°F cooler. Depending on load, mills without external sources of heat generally have pinion temperature of 105°F to 180°F (41 °C-82°C) with asphaltics in service. Pinion temperatures will typically decrease with LE's 9000/9001 PYROSHIELD, 9010/9011 PYROSHIELD XH or 5180 PYROSHIELD 5°F to 10°F.

MILL GEAR LUBRICATION

With proper installation, careful maintenance and proper lubrication, users can expect long, trouble-free life of their mill gears.

Because of the tremendous loads in the cylinder which must be rotated, tooth loading is tremendous. Gear protection is important. Replacement costs for pinions range from $11,000 to $50,000. The cost of bull gears are as high as $500,000 and can require up to one year lead time for replacement. In most cases, these mills operate continuously, and the loss of their production time is even more expensive.

Historically, asphaltic products have been used in this application and have serviced more as "cushioning compounds", than lubricants. Many have relied on lead for extreme-pressure capabilities and now are classified as hazardous materials. Even some unleaded asphaltics are considered cancer-causing because they contain polycyclic aromatic hydrocarbons (PAHs) which are considered a potent carcinogen by the International Association for Research on Cancer (IARC). Asphaltic products remaining in the bottom of the drums and in the drip pans pose possible health hazards and must be disposed of at an approved hazardous waste disposal site. Normally, 25% of the amount of product purchased remains to be disposed of at a cost of $.50 to $2.00/lb. depending on the proximity of the disposal site. This is both inconvenient and costly.

In addition to health and disposal concerns, users of these products have been plagued with housekeeping problems with these black, sticky products. The asphaltic product also builds up in the gear tooth roots. Because of this, many plants experience worn pinions due to misalignment, pinion bearing failure and, sometimes, breakage of pinion pedestal bolts and disintegration of the pedestal concrete foundation.

Mill gearing may be either closely shrouded, loosely shrouded or unshrouded. In closely shrouded gear systems on ball mills, LE recommends 9000/9001 PYROSHIELD or 9010/9011 PYROSHIELD XH to enable the small amount of used lubricant to "flow" out of the shroud and be collected in a suitable container. Where gear shrouding is very loose and product build-up is not a concern, then the non-melt 5180 PYROSHIELD can be recommended.

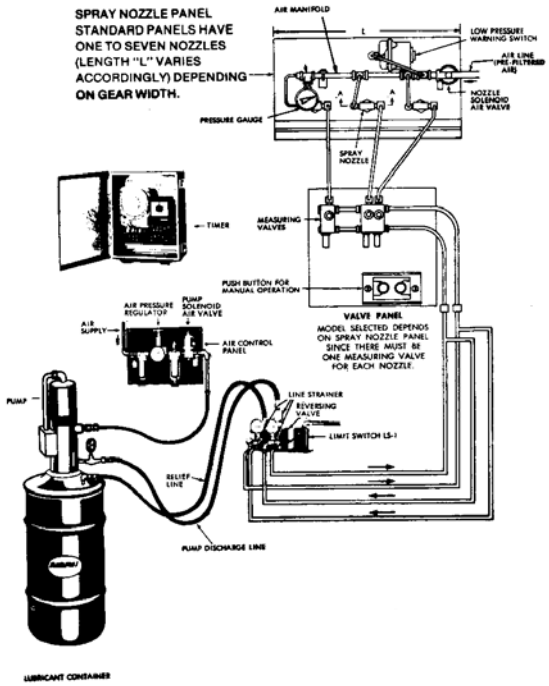
THE LUBRICATING SYSTEM

In open gear lubrication, it is critical to get the right quantity of the right lubricant at the right time to the right spot. An automatic spray type lubrication system is used for lubricating the gear train and does just that. Farval and Trabon are the most commonly used.

In these systems, air is used to pump and carry the lubricant to the gears. Although there are variations of these systems, the basic design and principles are the same.

Designed for automatic operation, the system uses an air-operated pumping unit which feeds the system directly from the drum of lubricant. These systems are.designed to operate with plus or minus 80psi air and it is critical that they do so to insure adequate lubrication to the mill gears. An electrically driven time clock or electronic timer controls the frequency of spraying and is fully adjustable for various lubricating cycles. They usually contain a warning device to indicate when the equipment is malfunctioning, such as during an air supply failure, and/or lack of lubricant.

The amount of lubricant supplied to the mill gears by the system as a whole is determined by the timing, as well as by the measuring valve size and adjustment. A typical automatic system is shown in Figure D.



Depending on the type of plant and mill location, some are exposed to cold temperatures during the winter months. During the winter, it is important that the lubricant can be pumped and sprayed at these temperatures. While both LE's 9000/9001 PYROSHIELD, 9010/9011 PYROSHIELD XH and LE's 5180 PYROSHIELD provide the lubrication protection required by these mill gears, the correct lubricant must be used at lower temperatures if drum heaters are not part of the lubrication system. Should the temperature to which the lubricant and lubrication system is exposed be less than 55°F (13°C), LE's 9001 PYROSHIELD or 9011 PYROSHIELD XH is the lubricant to use. Above this temperature either LE's 9000 PYROSHIELD, 9010 PYROSHIELD XH or LE's 5180 PYROSHIELD may be used.

Farval, a major lubrication systems manufacturer, reports that the asphaltic type products can harden in the lube lines and valves. This can cause lubricant starvation. If this situation is not detected before damage occurs, catastrophic failure can result.

We have observed that the close tolerance internal components of these lubricant systems, in particular the pistons in the reversing valve, are subject to abrasive wear due to the asphaltic compounds. Also, these components must handle 4 to 7 times more volume of the asphaltic compounds than either LE's 9000/9001 PYROSHIELD, 9010/9011 PYROSHIELD or LE's 5180 PYROSHIELD. Thus wear related failures occur drastically sooner with asphaltic use.

Because lubrication system malfunction is widespread with the use of asphaltic compounds, and an inevitable occurrence even with LE's 9000/9001 PYROSHIELD, 9010/9011 PYROSHIELD XH or LE's 5180 PYROSHIELD, the margin of safety provided by the lubricant is very important to operators. Operators have reported to us that when lube system malfunction occurs with asphaltic in service, temperatures begin to rise dramatically within an hour and in some cases they have had fires break out. LE's 9000/9001 PYROSHIELD, 9010/9011 PYROSHIELD XH and LE's 5180 PYROSHIELD have been tested to determine the margin of safety they provide. These results have shown LE's 9000/9001 PYROSHIELD, 9010/9011 PYROSHIELD XH and LE's 5180 PYROSHIELD provide up to two eight hour shift margins of safety before pinion temperatures rise.

THE LUBRICANTS

Most users of asphaltic materials have remained so because of no knowledge of alternatives. Many molybdenum based lubricants have offered some improvement as far as protection and consumption reduction; however, no product has proved to have the capabilities which approach those of LE's PYROSHIELD products.

The lubricant cannot overcome weak foundations, poor gear alignment, undetected vibrations, poor maintenance and an inadequate lubrication system. Any, or a combination of these adds extra loads of unknown magnitude on top of the designed gear load. Superior lubricants are not only desired but absolutely necessary to protect these gears from damage and excessive wear, and to provide long gear life and the lubrication margin of safety that is required. The advanced technology of LE's 9000/9001 PYROSHIELD, 9010/9011 PYROSHIELD XH and 5180 PYROSHIELD as "lubricants" versus conventional asphaltic cushioning compounds does just that.

LE's PYROSHIELD products are the latest technological breakthrough in high performance lubrication. These superior lubricants were specifically developed for applications subjected to high load, heavy shock and the high contact point temperatures experienced during boundary lubrication conditions. LE's proprietary wear-reducing additive ALMASOL®, is used with a unique combination of EP additives, which are synergistic with LE's ALMASOL, to provide outstanding load-carrying ability. Asphaltics have a Timken OK load of only 20 to 25 pounds as compared with 70 pounds for LE's 9000/9001 PYROSHIELD or LE's 5180 PYROSHIELD and 90 pounds for LE's 9010/9011 PYROSHIELD XH. Plants with mills lubricated with LE's 9000/9001 PYROSHIELD, 9010/9011 PYROSHIELD XH or 5180 PYROSHIELD have eliminated the problems with their previous gear lubricant and obtained additional benefits.

The Problem:	Health, safety and disposal problems with asphaltic products and disposal costs and inconvenience.
The Benefit of LE:	***There are no disposal problems using the LE PYROSHIELD Products. The H1 diluent evaporates within minutes of application, and poses no environmental problems.***
The Problem:	Messy, black products-drip pans, equipment, housekeeping problems, unhappy workers and extra labor to keep clean.
The Benefit of LE:	***With the clean purple lubricants, 25% of previous product is used due to the superior lubricating ability of LE's PYROSHIELD products***.
The Problem:	Build up in tooth roots. Alignment and bearing problems.
The Benefit of LE:	***There is no buildup. Should pulverized material buildup occur on the gear teeth, LE's 609 ALMASOL® Vari-Purpose Gear Lubricant can be used to clean the gears.***

The Problem:	Gear wear, with low or no margin of safety.
The Benefit of LE:	***There are 10°F to 30°F lower pinion temperatures which means better lubrication, less friction and wear, which in turn gives longer gear life and a greater lubrication margin of safety to protect gears. "Healing" of moderate gear damage has also been observed.***
The Problem:	Lubrication system malfunctioning because of black, sticky products.
The Benefit of LE:	***There are no malfunctions caused by the lubricant. In fact, a lubrication system was purposely shut off for two eight hour shifts with no gear temperature rise. This confirms the extra protection of LE's 9000/9001 PYROSHIELD, 9010/9011 PYROSHIELD XH and 5180 PYROSHIELD even when the lubrication system has mechanical problems:***

These benefits have been experienced with all types of mills operating in various industries. Previous products used among others have been:

Whitmore Surtac	Petron Gearshield
Molub-Alloy 907B and 957	Mobiltac
Exxon Surret	Texaco Crater

SUMMARY

Mill open gears are subjected to high shock loads and require lubricants that will provide the protection necessary to give the long gear life that users expect while eliminating health hazards, disposal problems, housekeeping problems and minimizing lubrication system malfunctions. All this has been proven to be accomplished through the use of LE's 9000/9001 PYROSHIELD, 9010/9011 PYROSHIELD XH or LE's 5180 PYROSHIELD high performance lubricants from Lubrication Engineers,® Inc.

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