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Now that you have a solid understanding of what grease is, it's time to refresh yourself on which type of product is best for the job.

Be Kind To Your Bearings & Other Critical Components This article is a continuation of a discussion that was featured in the July/August 2009 issue of *Lubrication Management & Technology*. While grease is used in a wide range of applications, this installment will focus on bearings (primarily rolling element).

Part I of this article provided a basic introduction to grease, with discussions of composition, types, properties and evaluation tests. Part II will focus on the correct grease for the application and some of the key criteria in the selection process, including compatibility, amount to be added and relubrication frequency.

Table I, compiled by the National Lubricating Grease Institute (NLGI), illustrates the consumption of grease in North America in 2008. This table, which exceeds 100% because of rounding, illustrates that more than 60% of greases produced in North America in 2008 were lithium-based soaps with the use of lithium complex grease exceeding that of simple lithium soaps. Complex lithium soaps are the fastest growing thickener type worldwide. Simple lithium soaps accounted for 58% of the worldwide production in 2008, while lithium complex accounted for 15%. Simple lithium soaps are more widely used because of their lower costs, but lithium complex greases, because of their inherently better properties, are faster growing.

Table 1. 2008 North American Consumption of Grease by Type (courtesy NGLI) **Thickener T**
%

Straight Lithium

	30
Lithium Complex	36
Calcium Soaps	10
Aluminum Soaps	9
Polyurea	6
Organophilic Clay	6
Sodium & Other Soaps	2
Other Non-Soaps	2

The general rule is to use oil for lubrication, if possible, because of the ability to clean and cool oil versus doing so with grease. There are, however, many applications where oil use is not possible or practical. Table II lists a few of the industrial and mining components utilizing grease as a lubricant. Rolling bearings are a major component lubricated with grease—*in fact, most of them are* .

Table II. Industrial and Mining Components that Utilize Grease

Industrial	**Mining**
Bearings (rolling element general)	Bearings (rolling element)
Bearings (electric motor)	Bearings (Journal)
Bearings (Journal)	Gears
Couplings	

Slides

Gears Linkages

Slides
Chains

Linkages
Pins

Chains
Buckets

Wheel Hubs

Grease selection
The major criteria in selecting a grease type for the application are the thickener type, base oil viscosity and NLGI Grade. Table III denotes general guidelines for grease selection based on bearing speed.

Table III. General Guidelines for Grease Selection Based on Bearing Speed

Application	**Viscosity**	**Consistency**	**Oil Release**
Fast	Thin	Stiff	High
Slow	Thick	Soft	Low

As stated in Part I, oil is the lubricant in a grease—*and the most important property of an oil is viscosity*. Therefore, the correct viscosity must be selected for the application. The grease manufacturer provides this information. Although viscosity of a grease is not usually listed on its container, it is listed on the product data sheet. Table IV shows viscosity selection based on application.

Table IV. Correct Viscosity Selection for an Application

Viscosity	**Application**
ISO 100	Electric motors and high-speed bearings > 3600 rpm
ISO 150 & 220	Multipurpose grease operating at moderate speeds
ISO 460	High loads and good water resistance
ISO 680*	High-speed couplings
ISO 1500	Very low speed, high loads and good water resistance
ISO 3200*	High-speed couplings
*	*Coupling grease can have ISO 680 or ISO 3200 depending on the manufacturer.*

The thickener type is a very important consideration in grease selection. The following grease properties are directly related to the type of thickener:

- Amount determines consistency
- Shear stability
- Oxidation resistance
- Water resistance
- Dropping point
- Compatibility
- Oil separation
- Cost

Table V illustrates the major thickener types and their common uses.

Table V. Major Thicken Types & Their Common Uses

Thickener Type	**Application**
Straight Lithium	Versatile and less expensive than the Li Complex. Should not be used over 275 F.
Lithium Complex	Most versatile thickener for wide variety of industrial and automotive applications. Used up to 350 F. D

Aluminum Complex	Good high-temperature and water-resistant properties. Used in steel and paper mills. Most common fo
Polyurea	Excellent oxidative resistance because of non-metallic thickener. Grease of choice for electric motors a
Organophilic clay	Non-melt resulting in good high-temperature properties along with H1 approval for food grade. Used in
Calcium Complex	Good water resistance and H1 approval. Used in steel and paper mills. Also used in food plants. Used
Calcium Sulfonate	Very good inherent corrosion resistance and high EP along with H1 approval, but expensive because c
Sodium	Inexpensive and used where good adhesion and corrosion protection required. Cannot be used in pres

Many plants have too many types of grease and should consolidate down to just a few. Table IV reflects a practical consolidation option to consider.

Table VI. A Practical Grease-Consolidation Option

Application	**Grease Type**
General Purpose	Lithium Complex EP
Electric Motors	Polyurea
Couplings	Lithium/Polymer with same density as base oil specially designed to avoid separation due to centrifuga
Food Grade	Aluminum Complex
High Temperature	Clay

Eighty percent of a facility's applications can be addressed with the first three greases listed in Table VI. The remaining 20% are for specific applications such as food grade, high-temperature and other specialized applications.

Incompatibility is a major issue when mixing greases—*something that can result from having too many types of grease in a plant*.
When changing grease thickener types in an application, always consult your lubricant supplier on the compatibility of a proposed product with one that's being replaced. This is of the utmost importance as incompatible greases will usually lead to a softening of the thickener resulting in oil being released; that chain of events can result in equipment failure. If your supplier is unsure of the compatibility, ask that an ASTM 6185 compatibility test be performed.

The following greases are the most incompatible in this order: barium, clay, aluminum and conventional polyurea. Be very careful about using published compatibility tables when making a decision to change thickener types. When in doubt, always consult your lubricant supplier.

The most common NLGI grade used is #2, but there are situations where a more- or less-consistent grease should be used. Table VII reflects guidelines for the selection of NLGI grades.

Table VII. Guidelines for Selection of NLGI Grade Grease

NLGI Grade	**Application**	**Consistency**
6	Slow-moving journal bearings	Block
5	Low-speed journal bearings	Very stiff
4	Very high speed and low load	Stiff
3	High-speed rolling element bearings. Typically ball bearings.	Medium
2	Most common grade for all rolling element bearing types	Medium soft
1		

	Centralized lubrication systems and low temperatures	Soft
0	Centralized lubrication systems	Very soft
00	Enclosed gears	Semifluid
000	Enclosed gears	Fluid

Grease application

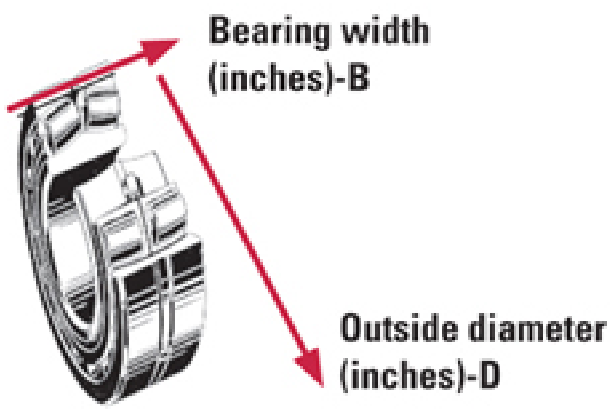
Once the correct grease has been selected, it has to be applied properly with the right amount at the right frequency. There are many different options for doing this. Ideally, a small amount should be applied more frequently. This is the advantage of using an automated system, such as single-point lubricators and centralized grease systems. The most common application system, though, is still the manual grease gun—*the device on which this particular article focuses*. (Automated systems are beyond the scope of this article. Moreover, the remaining discussion will focus only on bearings—*primarily rolling element*.)

Amount…

Journal bearings are not usually grease lubricated and there is a speed limitation of 200-400 ft./min. The bearings have wide, deep axial grooves, extending about 80% along the bearing. The grease is introduced along the groove which is 90 to 180 degrees away from the load zone. When greasing, completely displace the old grease by observing fresh grease from the bearing. Normally, slow-moving journal bearings don't have to be greased frequently unless they are exposed to a high level of contaminants.

Rolling element bearings require calculated lubrication amounts for an effective greasing program—*unless they are in a contaminated environment where total grease displacement is required.* This certainly doesn't apply to electric motor bearings, where over-greasing is very common. Correct greasing procedures for electric motors, of which there are many opinions, will be discussed in a future article.

Lubricators should have specific instructions in work orders on the exact amount of grease to add to a bearing. This should not be left up to the oiler, but instead developed by someone in the organization through proper techniques. Grease guns need to be calibrated on the amount per shot put out by the grease gun. The following formulae are used to calculate—*by weight*—t he correct amount of grease to apply to a rolling bearing.



$$G_q = .114\ DB$$

The amount of grease calculated is in ounces.

Since most bearing dimensions are expressed in millimeters (mm) the following is a more usual formula:

G (ounces) = 0.00018 × DB (mm)

Take, for example, a 150 hp motor with a 313 size bearing that has the following dimensions:

65 mm bore
140 mm OD
33 mm width

In this example, utilizing the foregoing formula, we calculate G = 0.00018 × 140 × 33 = 0.83 ounces of grease required for the bearing.

The next step is to calculate the number of shots per ounce the grease gun delivers. This can be done by using a postage scale and weighing out 10 shots of grease and calculating ounces per shot and then equating this to shots per ounces. Assume we had 0.5 ounces in 10 shots. This equates to 0.05 ounces per shot, which converts to 20 shots per ounce for that particular gun. Another method not as accurate is to fill a 35-mm film canister and count the number of shots. This is approximately 1 ounce of grease. Therefore, 0.83 ounces required for the bearing using a 20-shot-per-ounce gun results in applying 0.83 × 20 = 17 shots.

Be sure to calibrate all of your grease guns and use one particular type per application. For example, when greasing electric motors, try to use the same type of gun for all motors. Meters can be purchased to measure the exact amount of grease in ounces, grams, cubic inches and cubic centimeters. One company calculated the number of shots for all of its electric motors by horsepower and constructed a table that is put on the grease guns relating the amount of shots required by horsepower of motor.

Relubrication frequency…
Once we have calculated the right amount for a rolling element bearing, we then have to establish lubrication frequencies for that bearing. The following is a formula used to establish initial frequency guidelines.

$$t = K \left[\frac{14{,}000{,}000}{n\sqrt{d}} - 4d \right]$$

t = K [14,000,000 _ 4d] n d
t = relubrication interval in hours
d = bearing bore diameter, mm
n = speed, rpm

K = 1 for spherical or tapered roller bearings
K = 5 for cylindrical or needle bearings
K = 10 for radial ball bearings

The above data is used as a starting point. The following adjustments need to be considered.

- *Temperature*—For example, every 27 F degree increase over 160 F requires the frequency to be cut in half.
- *Position*—Vertical bearings need to be greased twice as frequently.
- *Vibration*—Higher vibration readings require more frequent greasing.
- *Contamination*—Higher contamination requires more frequent greasing.

Keep in mind that there are precise correction factors with these variables beyond the scope of this article. Such correction factors can be obtained from bearing manufacturers.

Removing the mystery
This article has been written to help take the mystery out of the topic of grease and to give you some techniques to improve the selection and application of grease in your facility. While it may be one of the oldest lubricants known to man, grease continues to be a vital part of any lubrication program. That's because the majority of bearings in a typical industrial plant are grease lubricated.

The importance of selecting the correct grease and applying it properly—*both in amount and frequency* —cannot be overstated. These activities are key factors in a world-class lubrication program. Getting them right is crucial in improving (and ensuring) the reliability of the equipment within your operations. **LMT**

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