PORTER'S ELECTRIC MOTOR SERVICE, INC.

1310 N. Limestone Street
Gaffney, South Carolina 29340

(864) 487-7551
(800) 768-4895

Grease Basics

Jeremy Wright, Noria Corporation

The American Society for Testing and Materials (ASTM) defines lubricating grease as: "A solid to semifluid product of dispersion of a thickening agent in liquid lubricant. Other ingredients imparting special properties may be included" (ASTM D 288, Standard Definitions of Terms Relating to Petroleum).

Grease Anatomy

As this definition indicates, there are three components that form lubricating grease. These components are oil, thickener and additives. The base oil and additive package are the major components in grease formulations, and as such, exert considerable influence on the behavior of the grease. The thickener is often referred to as a sponge that holds the lubricant (base oil plus additives).

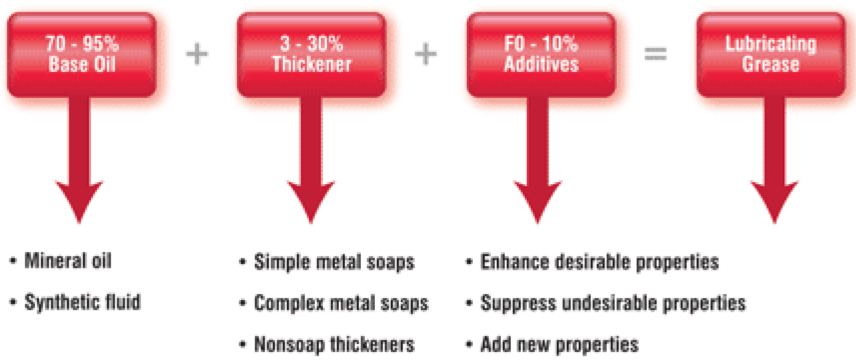

Figure 1. Grease Anatomy

Base Oil

Most greases produced today use mineral oil as their fluid components. These mineral oil-based greases typically provide satisfactory performance in most industrial applications. In temperature extremes (low or high), a grease that utilizes a synthetic base oil will provide better stability.

Thickener

The thickener is a material that, in combination with the selected lubricant, will produce the solid to semifluid structure. The primary type of thickener used in current grease is metallic soap. These soaps include lithium, aluminum, clay, polyurea, sodium and calcium. Lately, complex thickener-type greases are gaining popularity. They are being selected because of their high dropping points and excellent load-carrying abilities.

Complex greases are made by combining the conventional metallic soap with a complexing agent. The most widely used complex grease is lithium based. These are made with a combination of conventional lithium soap and a low- molecular-weight organic acid as the complexing agent.

Nonsoap thickeners are also gaining popularity in special applications such as high-temperature environments. Bentonite and silica aerogel are two examples of thickeners that do not melt at high temperatures. There is a misconception, however, that even though the thickener may be able to withstand the high temperatures, the base oil will oxidize quickly at elevated temperatures, thus requiring a frequent relube interval.

Additives

Additives can play several roles in a lubricating grease. These primarily include enhancing the existing desirable properties, suppressing the existing undesirable properties, and imparting new properties. The most common additives are oxidation and rust inhibitors, extreme pressure, antiwear, and friction-reducing agents.

In addition to these additives, boundary lubricants such as molybdenum disulfide (moly) or graphite may be suspended in the grease to reduce friction and wear without adverse chemical reactions to the metal surfaces during heavy loading and slow speeds.

NLGI#	ASTM - Worked Penetration	Food Analogy
000	4445-475	Ketchup
00	400-430	Applesauce
0	355-385	Brown Mustard
1	310-340	Tomato Paste
2	265-295	Peanut Butter
3	220-250	Vegetable Shortening
4	175-208	Frozen Yogurt
5	130-160	Smooth Paté
6	85-115	Cheddar Cheese Spread

Table 1. NLGI Consistency

Function

The function of grease is to remain in contact with and lubricate moving surfaces without leaking out under the force of gravity, centrifugal action or being squeezed out under pressure. Its major practical requirement is that it retains its properties under shear forces at all temperatures it experiences during use.

Applications Suitable for Grease

Grease and oil are not interchangeable. Grease is used when it is not practical or convenient to use oil. The lubricant choice for a specific application is determined by matching the machinery design and operating conditions with desired lubricant characteristics. Grease is generally used for:

1. Machinery that runs intermittently or is in storage for an extended period of time. Because grease remains in place, a lubricating film can instantly form.
2. Machinery that is not easily accessible for frequent lubrication. High-quality greases can lubricate isolated or relatively inaccessible components for extended periods of

time without frequent replenishing. These greases are also used in sealed-for-life applications such as some electrical motors and gearboxes.
3. Machinery operating under extreme conditions such as high temperatures and pressures, shock loads or slow speed under heavy load.
4. Worn components. Grease maintains thicker films in clearances enlarged by wear and can extend the life of worn parts that were previously lubricated by oil.

Functional Properties of Grease

1. Grease functions as a sealant to minimize leakage and to keep out contaminants. Because of its consistency, grease acts as a sealant to prevent lubricant leakage and also to prevent entrance of corrosive contaminants and foreign materials. It also acts to keep deteriorated seals effective.
2. Grease is easier to contain than oil. Oil lubrication can require an expensive system of circulating equipment and complex retention devices. In comparison, grease, by virtue of its rigidity, is easily confined with simplified, less costly retention devices.
3. Grease holds solid lubricants in suspension. Finely ground solid lubricants, such as molybdenum disulfide (moly) and graphite, are mixed with grease in high-temperature service or in extreme high-pressure applications. Grease holds solids in suspension while solids will settle out of oils.
4. Fluid level does not have to be controlled and monitored.

Characteristics

As with oil, grease displays its own set of characteristics that must be considered when being chosen for an application. The characteristics commonly found on product data sheets include the following:

Pumpability. Pumpability is the ability of a grease to be pumped or pushed through a system. More practically, pumpability is the ease with which a pressurized grease can flow through lines, nozzles and fittings of grease-dispensing systems.

Water resistance. This is the ability of a grease to withstand the effects of water with no change in its ability to lubricate. A soap/water lather may suspend the oil in the grease, forming an emulsion that can wash away or, to a lesser extent, reduce lubricity by diluting and changing grease consistency and texture.

Consistency. Grease consistency depends on the type and amount of thickener used and the viscosity of its base oil. A grease's consistency is its resistance to deformation by an applied force. The measure of consistency is called penetration. Penetration depends on whether the consistency has been altered by handling or working. ASTM D 217 and D 1403 methods measure penetration of unworked and worked greases. To measure penetration, a cone of given weight is allowed to sink into a grease for five seconds at a standard temperature of 25°C (77°F).

The depth, in tenths of a millimeter, to which the cone sinks into the grease is the penetration. A penetration of 100 would represent a solid grease while a penetration of 450 would be semifluid. The NLGI has established consistency numbers or grade numbers, ranging from 000 to 6, corresponding to specified ranges of penetration numbers. Table 1 lists the NLGI grease classifications along with a description of the consistency of how it relates to common semifluids.

Dropping point. Dropping point is an indicator of the heat resistance of grease. As grease temperature increases, penetration increases until the grease liquefies and the desired consistency is lost. The dropping point is the temperature at which a grease becomes fluid enough to drip. The dropping point indicates the upper temperature limit at which a grease retains its structure, not the maximum temperature at which a grease may be used.

Oxidation stability. This is the ability of a grease to resist a chemical union with oxygen. The reaction of grease with oxygen produces insoluble gum, sludges and lacquer-like deposits that cause sluggish operation, increased wear and reduction of clearances. Prolonged exposure to high temperatures accelerates oxidation in greases.

High-temperature effects. High temperatures harm greases more than they harm oils. Grease, by its nature, cannot dissipate heat by convection like a circulating oil. Consequently, without the ability to transfer away heat, excessive temperatures result in accelerated oxidation or even carbonization where grease hardens or forms a crust.

Effective grease lubrication depends on the grease's consistency. High temperatures induce softening and bleeding, causing grease to flow away from needed areas. The mineral oil in grease can flash, burn or evaporate at temperatures greater than 177°C (350°F).

Low-temperature effects. If the temperature of a grease is lowered enough, it will become so viscous that it can be classified as a hard grease. Pumpability suffers and machinery operation may become impossible due to torque limitations and power requirements. As a guideline, the base oil's pour point is considered the low-temperature limit of a grease.

References

1. Pirro, Wessol. *Lubrication Fundamentals*. New York: Marcel Dekker, 2001.

2. U.S. Army Corps of Engineers. *Engineering and Design - Lubricants and Hydraulic Fluids*. EM 1110-2-1424 CECW-ET, 1999.