

PROPER STORAGE AND USE OF GREASE TO AVOID EXCESSIVE OIL BLEEDING AND SEPARATION

Lawrence G. Ludwig, Jr. CLS, OMA, CMFS, Schaeffer Mfg

How often has a drum, pail or keg of grease been placed in storage then opened to find a puddle of oil sitting on top of the grease? Or the grease being used is in a cartridge tube that has been left in a grease gun or lying in the back of a bed of pick-up truck exposed to the elements only to have oil either dripping out of the grease gun or running out of the cartridge. What about the case where the grease is applied to the bearing and during use it is noticed that the grease's base oils have begun to run or drip out of the bearing. The first thoughts made by the user of the grease are:

1. Is this grease actually suitable for use
2. If I go ahead and use it will it cause a bearing failure or unscheduled downtime?

During storage and even during use a certain amount of oil bleeding is common and will occur. Though oil bleeding is common the rate at which this bleeding can be controlled through proper storage and usage techniques. Before looking at these techniques it is best to review the make-up of grease and the types of oil release that can occur.

Composition of Grease

A grease's composition consists of the following make-up

Grease = 70-95% Base Oil + 3-30% Thickener System + 0-10% Additives

In general a grease is a solid-to-semifluid product of that consists of a dispersion of a thickening agent in a liquid lubricant. This thickener system can consist of either simple or complex metal soaps of lithium, calcium, aluminum, barium or sodium or non-soap such as clay (bentone) or polyurea. The thickener system can be thought of a sponge that consists of a matrix of fibers or platelets that consist of a high surface area that forms a dense network of micro-asperities (voids) or fibers. It is in these voids or fiber structure where the base oil and additives are stored until they are needed to lubricate.

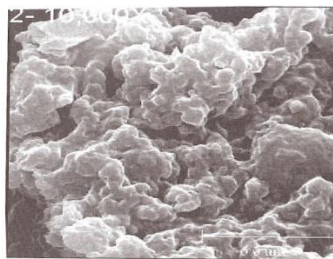
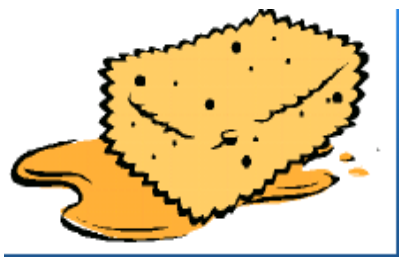
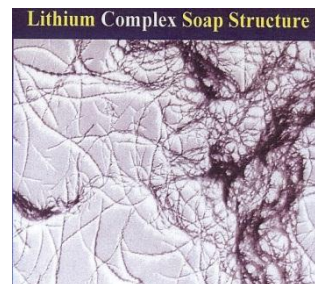


Figure 1.10 - Aluminum Complex



Just like a sponge which releases water when it is squeezed, the grease releases its base oils from the thickener system when it is squeezed or stressed. The stresses a grease can encounter can be generated either mechanically or thermally in application or during storage. In an application greases function over time by gradually releasing oil into the working areas of the machine surfaces in order to lubricate these working areas. The greater the amount of shear stress encountered the faster the grease's thickener system releases its hold on the base oils. The thickener system matrix imparts little or no lubricating characteristics. If the thickener system matrix did not release the base oils, the grease would be unable to perform its lubricating properties.

By the same token during use the grease should also have the ability to exhibit some type of reversibility characteristics after the stresses that can be encountered in a bearing are relaxed. Reversibility is defined as the grease's ability to recapture its base oils in order to return to its original consistency and to continue to function as intended. When the machine is shut off, or when conditions of mechanical or thermal stress are relaxed, the grease must have the ability to recapture its base oils in order to return to its original consistency. A grease's reversibility characteristics are dictated by the type and amount of thickener used. Generally the higher the thickener content the less the grease's reversibility.

Types of Oil Release

Though a grease's thickener system is not soluble in the base oil that it thickens, it does have an attraction to the base oil. Depending upon the amount of the thickener system used in the grease's formulation this attraction can be strong. The higher the proportion of thickener used the greater its attraction to the base oil. As the base oil content is increased and the amount of thickener system is decreased, the forces of attraction also decrease, thus resulting in the base oil being loosely held in the thickener system matrix and easily separated. From these statements one would think that using a higher thickener content is better. However, as was mentioned previously a thickener system matrix that does not release its base oils, would be unable to perform its lubricating properties. Therefore it is important that grease must have the proper balance of base oil and thickener system content in order to function properly and do its intended job.

Oil release or separation from greases can be found in two distinct modes:

1. Static Bleed
2. Dynamic Bleed

Static bleed is the release of the grease's base oil from the thickener system in the container it has been placed in or in a non-moving part it has been introduced into. Static bleed which can also be referred to as oil puddling occurs naturally for all types of greases and at a rate dependent on their composition¹ Static oil bleeding can be

affected by storage conditions such as the temperature at which it is stored at and for how long it is stored, any vibrations the containers maybe exposed to during transport or storage, an uneven grease surface in the container (the presence of high and low spots) or even by the natural force of gravity. These different aspects can cause extremely weak stresses to be placed on the grease resulting in the release of small amounts of base oil. Over time a puddle of oil can form on top of the grease. Static bleeding is more pronounced if the grease is soft in consistency (NLGI grades 00, 0 and 1) and/or if the grease's base oil viscosity is low (ISO 68 and lighter).

Static bleeding does not result in the grease being unsuitable for use. Any base oil that has puddled or laying on top of the grease can be either removed by decanting the free oil from the surface or manually stirring it back into the grease. The quantity of oil that has separated from the grease is generally insignificant and represents a mere fraction of the total quantity of base oil that is held in the thickener system matrix (<1% typically). This small amount of oil will not adversely affect the consistency of the remaining product and will have little or no effect on the performance of the product.

Dynamic bleed is the actual controlled release of the base oils and additives in the application during use due to temperature or mechanical stresses. It is important that during use the grease being used has a controlled rate of bleeding in order for it to do its job of properly lubricating the bearing or component it has been placed in. Dynamic bleed conditions can also be caused or aggravated by the following conditions:

- Over-greasing of the bearing - Over-greasing can cause high temperatures, which result in oxidation of the grease and rapid separation of the base oils from the thickener due to churning
- Thermal Run-away – Too much grease in a bearing, mechanical conditions (misalignment, excess preload, etc.) and starvation can lead to higher running temperatures which causes the base oils to be readily released from the thickener system matrix leaving the thickener system left behind to lubricate
- The presence of cake locks in an over-greased bearing – These cake locks can act as a microscopic log jam that are immobile and jam flow paths and even mechanical motion of the bearing. When fresh grease is applied the grease's base oils are separated and flow through the built-up thickener due to hydrostatic extrusion leaving the thickener system left behind. Additional build-up of this log jam can lead to increased operating temperatures further resulting in increased bleeding of the base oils from the grease's thickener system.
- Contamination – Gross contamination by dust, dirt, fly ash, dry powder contaminants can draw out the base oils from the thickener system over time resulting in the thickening of the grease.

- Mixing of incompatible grease thickener systems – This accelerates de-gelling and oil separation
- Hydrostatic Extrusion – Grease that is subjected to constant pressure can separate by hydrostatic forces just like water flowing through sand filter. The grease's base oils are literally squeezed from thickener system. This can occur by either the use of single point auto-lubers (spring-type) expose grease to constant pressure or failure to release or bleed off a grease gun or a centralized lube system's pump pressures.
- Vibration and Centrifugal Forces – Prolonged vibration and/or centrifugal forces can cause grease separation

Without exhibiting some bleeding, whether it is static or dynamic bleeding, greases will not provide lubrication for the application it is being used in. What is important is the balance between these two modes of bleeding being the key to the grease's performance. The grease's oil bleed rate can be affected by a number of factors ranging from its composition (type of thickener system, base oil type, addition of polymeric materials used), the type of manufacturing process used to distribute the thickener system within the base oil and to produce the grease and how the grease is stored once it reaches the customer. The ability of the grease to retain or release the oil depends upon all of these factors.

Tests for Oil Bleeding

There are a number of different tests that can be measure a greases bleeding and oil separation characteristics. These bleeding tests can be categorized in two groups: static and dynamic bleed tests. The most common tests used to evaluate oil separation and bleeding are:

Static Tests

1. ASTM D-1742 Oil Separation from Lubricating Grease During Storage - Predicts the tendency of a grease to separate oil during storage when stored at room temperature. This test is useful because the results obtained correlate directly with oil separation which occurs in 35lb (16kg) containers and other size containers stored at room temperature. The ASTM D-1472 test method is an accelerated test in which a sample of grease is placed on a 75 micron (200 mesh) sieve subjected to a pressure of 0.25 psi (1.72 kPa) for 24-hours at 77°F (25°C). Any oil that seeps from the grease is collected, weighed and reported as percent weight of oil separated. The test method is not suitable for greases softer than NLGI No. 1 consistency because of a tendency for softer greases to seep through the sieve. The test method should not be used to predict the oil separation characteristics of a grease under dynamic service conditions.

2. ASTM D-6184 Test Method for Oil Separation from Lubricating Grease (Conical Sieve Method) – This test method which is based upon the Federal Test Method 321.3 Oil Separation from Lubricating Grease (Static Technique) determines the tendency of the oil in a lubricating grease to separate at elevated temperatures. Like the ASTM D-1742 test method it correlates with oil separation that occurs in 35lb (16kg) containers and other size containers when they are stored at elevated temperatures. In this test method a measured amount of grease in a 250 micron screen (60 mesh) wire screen is stored in an oven for 30 hours at a test temperature of 212°F (100°C). At the end of the test, the oil accumulated in the beaker is weighed and converted to a weight percent oil bleed.

In these static tests a grease is considered to have very good oil separation resistance if it exhibits a weight percent of oil bleed of 5% or less.

Dynamic Tests

1. U.S Steel Pressure Oil Separation Test – This test method is used to measure the oil separating and caking characteristics of a grease under fixed conditions that indicate the stability of a grease under high pressures and small clearances in a centralized grease pumping system. In this test the grease is first worked for 60-strokes in a grease worker and its worked penetration is measured according to the ASTM D-1403 Test Method for Cone Penetration of Lubricating Grease Using One-Quarter and One-Half Scale Cone Equipment. After the worked penetration is measured and recorded a 50 gram sample of the worked grease is charged to an S.O.D pressure viscometer cylinder which consists of piston and a filter unit. The pressure end of the S.O.D cylinder is permanently sealed and attached to a vertical post connected to a nitrogen cylinder with flexible hosing and a pressure regulator. Once the grease is charged into the cylinder the piston is placed above the grease sample and the filter unit which consists of two steel rings with perforated brass plates soldered to them is then screwed in and tightened with Allen wrenches. The size of the perforations is 31 microns (500 mesh). Pieces of No.1 filter paper separate the discs and prevent the grease from pushing past the bottom grids of the filter unit. The cylinder is slowly pressurized with Nitrogen gas over a period of 15 to 30 minutes to 100 psi (689.5 kPa). A tared beaker is placed under the filter unit to collect any separated oil. After 22 hours the amount of oil that had separated is weighed and the cylinder is disassembled. A sample of grease taken from the layer of grease closest to the filter unit is measured for its work penetration per the ASTM D-1403 Test Method. A grease is considered to have very good resistance to bleeding and oil separation if it exhibits no more than 10 milligrams of oil separation and no more than a 45 point change in consistency.

2. ASTM D-4425 Oil Separation from Grease by Centrifuge – This test method evaluates the oil separation tendency of a grease when subjected to high centrifugal forces. It predicts performance in high-speed coupling, universal joints, rolling element thrust bearings and other machine components subjected to large or prolonged centrifugal forces. In this test pairs of centrifuge tubes are charged with the grease being tested and placed in a high speed centrifuge. The centrifuge is spun at a speed which results in a centrifugal force of 36,000 Gs' at a test temperature of 122°F (50°C). The normal test time is 24- hours, but it can be extended to 48 or 96-hours. At specified times, the centrifuge is stopped, and the amount of separated oil is measured and its volume percent calculated. The resistance-to-separation ratio, called the K36 value, is reported as the volume percent of separated oil/total test hours. This K36 value is basically the ratio of the volume percent oil separated to the total number of hours of testing. Most coupling OEMs have set their own K36 limits for their equipment.
3. Trabon Method 905A – This test method is used to predict the tendency of a grease to separate oil while under pressure in a centralized lubrication system (Trabon delivery system). In this test 10lbs (4.5kgs) of grease is supplied to one primary feeder and three secondary feeders. Each feeder is filled with grease and the back pressure is raise to 1000 psi (6,894.8 kPa). The system is operated at a rate of 1 stroke per hour for a test time of 500 hours. The pressure in the secondary feeders is recorded daily. At the end of 500 hours all four feeders are examined for firm grease and separated oil. The grease being tested is rated based upon a combination of pressure increase in the secondary feeders and the amount of oil separated from the grease during the test. Less than a 500 psi (3,447.4 kPa) increase in pressure is considered acceptable if there is little or no thickened or separated grease build-up in the feeder plate passages.

Though a grease may exhibit good to very good resistance to oil bleed and separation in these static and dynamic tests proper storage and handling of the grease is still a key component to ensuring that the grease is able to perform its job.

Storage and Handling Techniques

Like most materials lubricating grease will gradually deteriorate with time. For greases the rate and degree of deterioration depends a lot on the storage and handling conditions the product is exposed to.

Grease may change its characteristics during storage. The product could oxidize, bleed, change in appearance, pick up contaminants, or become firmer or softer. The amount of change varies with the length of storage, temperature and the nature of the product. Depending upon the conditions the grease is stored under some greases can either undergo age hardening, which results in the product becoming firmer and increasing in

consistency or even soften in consistency. These changes in consistency can cause the grease to slip out of its original NLGI consistency grade. This behavior can be further aggravated by prolonged storage conditions. Because of this aspect it is recommended that prolonged storage be avoided. If a grease is more than one year old the National Lubricating Grease Institute recommends that it should be inspected and the worked penetration be ran to ensure that it is still within its intended NLGI Grade. **It is further a recommended industry practice that whenever any type of lubricant is received that usage and storage methods follow a First-In, First-Out (FIFO) inventory system. This simply requires the user of the lubricating grease to first use the grease that was put into the storage system first.** In addition to this aspect you will find that the grease manufacturer will have placed on the individual packages or cartons either some type of date code or a bath number which can be used to ask the lubricant supplier on what month, day and year the grease was made.

As was previously stated in this article in addition to possible changes in consistency, greases tend to bleed and release their base oils during storage. The rate of oil release from the grease will increase with time and the temperature it is stored at. Ideally the grease should be stored in a cool, dry place indoor area that does not exceed 86°F (30°C) and remains above 32°F (0°C). In the plant or out at the job site during use it sometimes is not unusual to find the grease containers being placed in storage areas that have temperature as high a 130°F (54°C) or next to a heat source or direct sunlight. These storage areas can even be exposed to contaminants such as dust, dirt, moisture or rainwater. Even these contaminants can severely deteriorate the quality of the grease during storage.

The grease container should never be stored in an area directly near a heat source such as a steam pipe, a furnace, the cab of a pick-up truck during warm or hot weather, etc. or exposed it to direct sunlight. This will only aggravate the rate of oil release that can occur. Always store the grease in its original packing or container and keep the container closed until it is time to use the grease. Wipe the lid or cover on the grease container clean before opening and always use clean tools and dispensing equipment when handling, pumping the grease. Wipe off any dust, dirt or excess grease that may have gotten on the container lid or cover before placing the lid back onto the container. After use the container should be closed immediately and kept closed to. Further any cartridge tubes of grease should be stored upright at all times. If the grease gun is left in a grease gun, the grease gun should be depressurized, wiped with a clean cloth to remove any contaminants and stored in a clean, cool, dry area in a horizontal position to keep the oil from bleeding out of the grease.

To further ensure the greases original quality, cleanliness and prevention against excessive oil separation during storage the following basic handling and storage techniques are recommended³:

- Do not use lubricating greases that have been stored for long periods of time unless their condition and cleanliness can be verified by a laboratory analysis. This laboratory analysis can be performed by the lubricant supplier
- When in doubt or if accidental mixing is suspected or has occurred, consult references, the lubricant supplier or conduct compatibility tests.
- The storage area or room should be separated from areas of contamination (such as metal debris, dust, dirt, chemical fumes, moisture. The room should be heated and well ventilated, as well as contain clean accessories, dispensing equipment and other necessities. Storeroom personnel should be properly trained in storage techniques, inventory control and other knowledge to prevent contamination.
- Grease containers should be clearly labeled with the type and brand of grease, the date they were received at the facility, etc. These markings should be kept in a position where they can be easily read.
- Keep the grease in its original container until used. Drums, pails, kegs, boxes should be kept off the floor and supported by a rack, platform or blocks at least several inches high.
- Never leave the grease container uncovered, or improperly covered, or open. Keep them tightly sealed between use. If stored outside a heavy canvas tarpaulin or plastic sheet or even sometime of lean-to should be used as a cover to keep off water or dirt. In addition drums, kegs and pails should be raised off the ground and stored either on their sides or titled at a 45° angle to prevent and moisture or dirt from being drawn into the product through very small openings because of the vacuum created internally by temperature changes inside of the container.
- Any tools used to handle or dispense grease should be cleaned before they are used.
- Never use wooden paddles or spatulas to remove or transfer grease from containers to grease guns or other types of dispensing systems. This practice poses a high risk of contamination.
- If a barrel warmer is used to warm or heat up the drum, keg or pail to facilitate the dispensing of the grease at very low temperatures, it should have some type of temperature regulating mechanism. The grease should never be heated above 75°F or the barrel warmer left on either unattended or overnight. This can cause the grease to readily release its base oils or even thicken in consistency due to oxidation and thermal stress.

- Never use a torch or open flame to warm-up a grease container. This only invites a fire hazard.
- Keep a separate inventory and utilization record for each product. Following this practice such as filling out a record sheet stating how much grease is used and on which machine or piece of equipment, helps keep an accurate inventory of lubricants.
- Use the oldest container received first (FIFO)
- Inspect containers received for any damage, such as severe dents, corrosion or moisture attack before storing or using the product
- Some type of coding and tagging system should be used to identify the contents of different lubricant containers, transfer/pumping systems, tools and pipes carrying the grease throughout a plant or facility. Make sure that all transfer valves, hoses and dispensing equipment are kept clean; seal and gaskets should be maintained in a proper condition.
- All transfer containers should be filled under clean conditions.
- Grease containers should be completely emptied before discarding,

References

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3. Belvac Production Machinery Technical Bulletin Issue 11, Volume 11, September, 2008 “Preservation of Grease Quality”, prepared by Nguyen H. Truong, Noria Technical Consultant, Noria Corporation, Tulsa, Oklahoma