



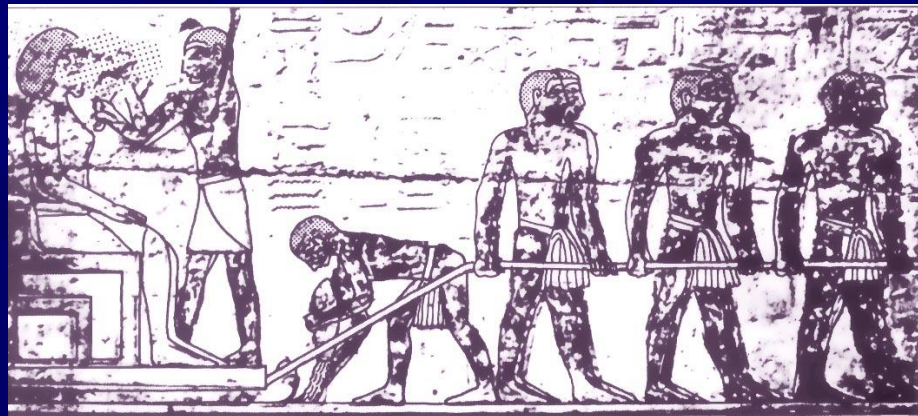
GREASE OVERVIEW & APPLICATION PRESENTATION

WHAT IS A GREASE

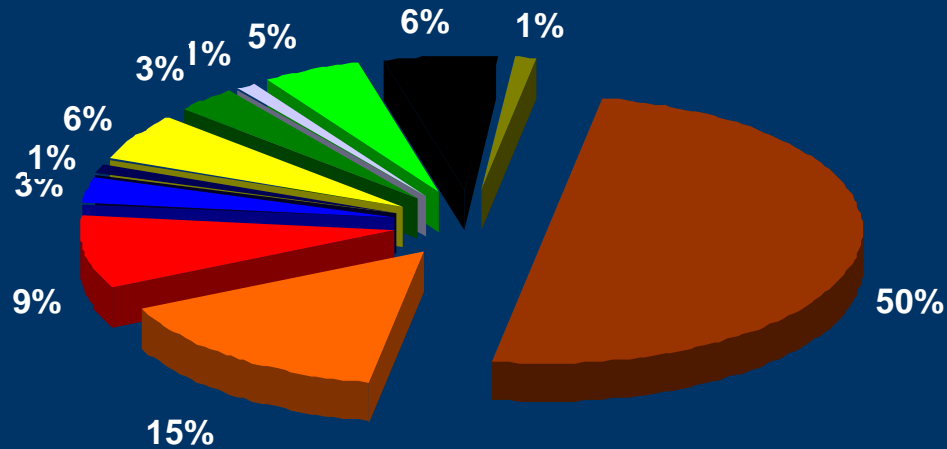
- ❖ A grease is a solid-to-semifluid product of dispersion of a thickening agent in a liquid lubricant. Other Ingredients imparting special properties may be included. (ASTM D288)
- ❖ Commonly referred as “a sponge that holds the lubricant”
- ❖ When the sponge is squeezed (worked) the lubricant and its additives are released.
- ❖ Lubricating oils and additives are the major constituents in a grease formulation.

GREASE FACTS

- ❖ Greases have been in use since Ancient Times
- ❖ The first greases were made from animal fats and pitch.
- ❖ The Ancient Egyptians made grease from animal fats, resins and lime. This was the first calcium base grease ever made.
- ❖ The first EP and anti-wear agents used consisted of sulfur, lead powder, graphite and antimony.
- ❖ Lithium, barium and aluminum soap base greases started to be used in the 1920's and 1930's.
- ❖ By the 1940's and 1950's the first complex base greases appeared.



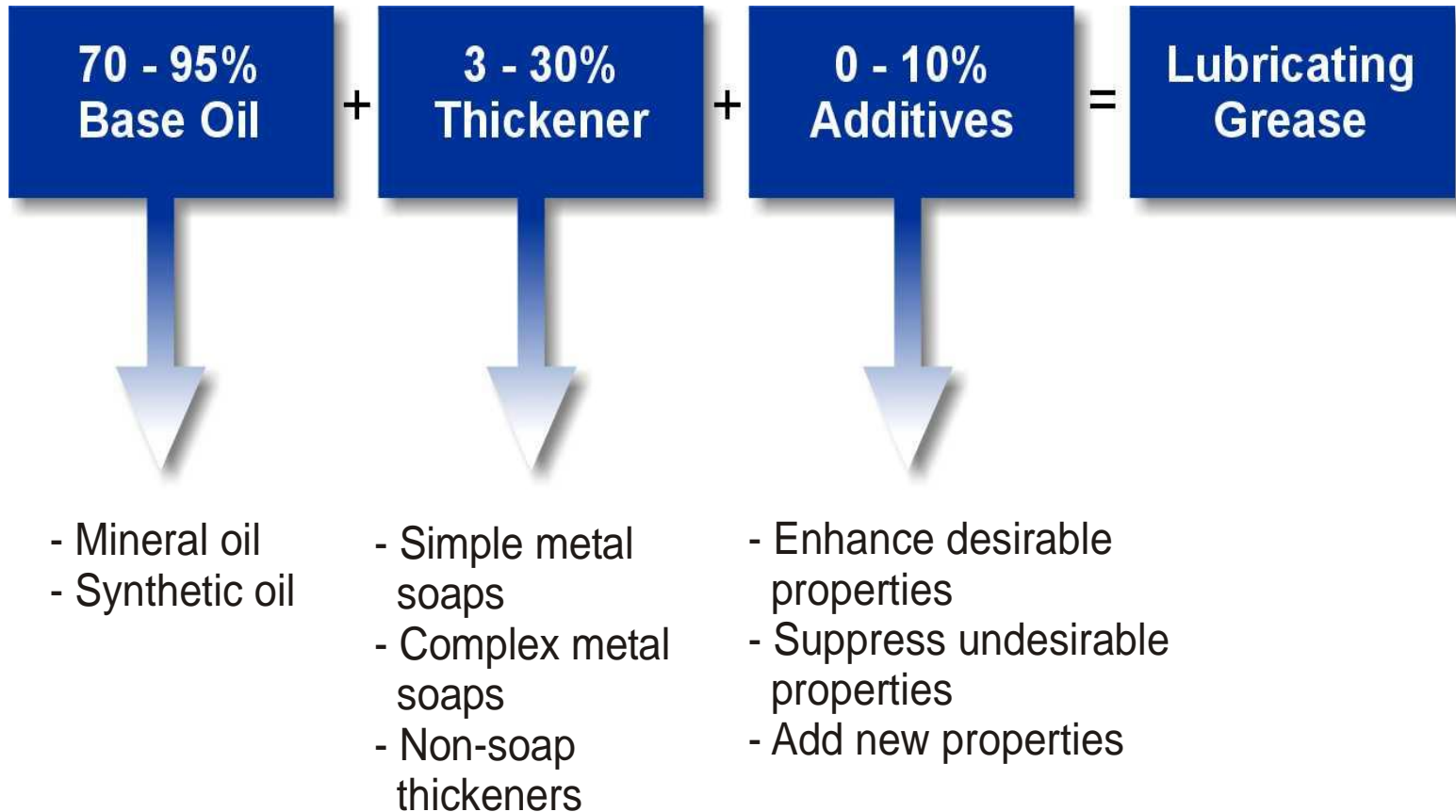
GREASE MARKET DISTRIBUTION BY THICKENER TYPE – US MARKET



- Li Soaps
- Ca Complex
- Sodium Soaps
- Bentone
- Li Complex
- Ca Sulfonate
- Other Soaps
- Other Nonsoap Thickeners
- Ca Soaps
- Aluminum Complex
- Polyurea

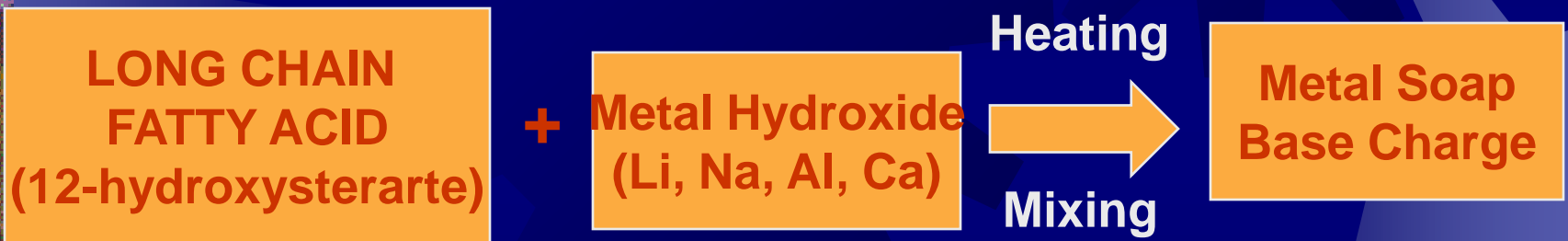


Anatomy of a Lubricating Grease



GREASE MANUFACTURING PROCESS

SIMPLE SOAP (Saponification)



GREASE MANUFACTURING PROCESS

Complex Soap (co-crystallization)

Long Chain
Fatty Acid
(stearic acid)

+

Short Chain
Organic Acid or
Inorganic Salt
(benzoic acid)

+

Metal Hydroxide
(Li, Ba, Al, Ca)

Heating

Mixing

Complex Metal Soap
Base Charge

GREASE MANUFACTURING PROCESS

Grease Finishing



+



+



Heating, Cooling
And Mixing



Colloidal Mill

ADVANTAGES OF MILLING A GREASE

- ❖ The Milling Process is a shearing process.
- ❖ Process and equipment used is similar to the process used to homogenize milk
- ❖ The grease is pumped under pressure between a stationary and a rotary member (stator and rotor) that have very fine clearances (.001 to .005 of an inch).
- ❖ Breaks up agglomerates and disperses the thickener and additives such as solid lubricants thoroughly throughout the grease.
- ❖ Results in a thicker grease product that has less thickener content.
- ❖ Results in a grease that is more mechanically shear stable.
- ❖ Improves the consistency of a grease.
- ❖ Improves the resistance of the grease to bleeding



Grease kettle is charged first with the fatty acids, short chain acids, alkali and a portion of the base oil. The saponification reaction is carried out by at temperatures between 185 to 195 F



Heating is continued with mixing to 385 to 395 F



The batch is then cooled through the use of heat exchangers and then transferred to the finishing kettle after it has been allowed to cure for 24 to 48 hours

FUNCTION OF A GREASE

- ❖ *Reduce friction and wear in the machine element being lubricated under various operating conditions.*
- ❖ *Protect against rust and corrosion.*
- ❖ *Prevent dirt, water and other contaminants from entering the part being lubricated.*
- ❖ *Maintain its structure and consistency during long periods of use.*
- ❖ *Permit free motion of moving parts at low temperatures and pump freely at those temperatures.*
- ❖ *Have suitable physical characteristics for the method of application and retain those characteristics during storage.*
- ❖ *Be compatible with Elastomer seals and other materials associated with the parts being lubricated.*
- ❖ *Tolerate or resist some degree of moisture contamination without significant loss of performance.*

WHEN TO USE A GREASE

- ❖ When oil can not be confined.
- ❖ When relubrication is difficult or dangerous.
- ❖ When the lubricant is required to exclude contaminant ingress.
- ❖ When equipment design specifies a grease.
- ❖ When it is required to reduce time spent lubricating.
- ❖ When it is required to reduce relubrication frequency.
- ❖ For equipment used intermittently.
- ❖ For extreme conditions of :
 - High Temperature
 - High Pressure
 - Shock Loads
 - Low speed combined with high loads



WHEN TO USE A GREASE

- ❖ When it is required to suspend solid additives.
- ❖ For machinery parts that experience severe wear.
- ❖ When noise reduction is important.

ADVANTAGES OF GREASE LUBRICATION

- ❖ **Better Stop-Start Performance** – When the system shuts down, oil drains away while grease remains in the component.
- ❖ **Squeeze Film Lubrication**-Under vertical loading conditions, grease acts as an elastic slide to provide enhanced lubrication.
- ❖ **Sealing Problems** – Surplus grease acts as an effective sealant.
- ❖ **Contamination** – The risk of contamination products such as food and pharmaceutical type products is reduced with the use of grease due to its resistance to flow into the products.



ADVANTAGES OF GREASE LUBRICATION

- ❖ **Supply of Surplus Lubrication** – The semi-solid nature of grease enables it to be fed easily into spaces around the working surfaces.
- ❖ **Lubricated “On the Run”** – A machine filled with greasing valves can be relubricated on-the run without shutting down the machine or interrupting operations.

DISADVANTAGES OF GREASE LUBRICATION

- ❖ **Reduced Cooling/Heat Transfer** – The flow of oil removes heat from the point of generation where it can be removed or dissipate. Grease tends to hold heat in place.
- ❖ **Bearing Speed Limitations** – The high effective viscosity of grease imposes speed limitations on bearings to avoid excessive heat generation. This problem is worsened by grease's poor heat transfer properties.
- ❖ **Poorer Storage Stability** - Grease are less stable than oils when stored under the same conditions. To long of storage can lead to separation of base oil and thickener and altered properties

DISADVANTAGES OF GREASE LUBRICATION

- ❖ **Lack of Uniformity** – Due to poor predictability of the batch process of greasemaking and the added variability associated with the thickener, uniformity of greases tend to be inferior to that of oil.
- ❖ **Compatibility** – The user must be careful about thickener compatibility of greases. In many cases, the compatibility is poor.
- ❖ **Lower Resistance to Oxidation** – The effects of oxidation products on the the stability of thickeners makes grease more susceptible to oxidation.

DISADVANTAGES OF GREASE LUBRICATION

- ❖ **Contamination Control** – Oil lubricants suspend and transport particles to filters and allow particles to settle under the force of gravity. Grease lubricant suspends particles, continuously subjecting component surfaces to their abrasive effects.
- ❖ **Difficult Volume Control** – The difficulty in gauging the proper quantity of grease to add, especially during relubrication, leads to frequent over and under greasing.

TYPES OF GREASE

❖ Soap Base Grease

◆ Complex Soap

-Formed by the joint reaction of an active metal hydroxide with a fatty acid and an organic acid (e.g. benzoic acid) or an inorganic salt. This process is known as co-crystallization.

❖ Non-Soap Base Greases

- Formed from either inorganic thickeners or organic thickeners (polymeric type)

- Bentone
- Silica Gel
- Polyurea
- Calcium Sulfonate

ALUMINUM COMPLEX BASE GREASES

- ❖ Low thickener content of 6.5 to 9.5% by weight
- ❖ Smooth and buttery texture
- ❖ Dropping point of 400°F-500°F (204°C to 260°C)
- ❖ Maximum usable operating temperature of 350°F-spot temperatures of 400°F (177°C to 204°C)
- ❖ Excellent resistance to water washout. Slightly hardens in consistency in the presence of water.
- ❖ Very good to excellent resistance against rusting, especially in the presence of moisture
- ❖ Very good to excellent work stability
- ❖ Very good to excellent mechanical and shear stability. Slightly to moderate hardening in consistency when subjected to high shock loading and severe shear stresses.
- ❖ Very good to excellent oxidation stability

ALUMINUM COMPLEX BASE GREASES

- ❖ 95% to 100% Reversibility
- ❖ Excellent pumpability
- ❖ Compatible with all types of greases except bentone base greases
- ❖ Excellent versatility. Can be used in a wide range of applications

BARIUM SOAP BASE GREASES

- ❖ Very high thickener content. Up to 35% by weight
- ❖ Fibrous and stringy in texture
- ❖ Dropping point of 370°F to 400°F
- ❖ Maximum usable temperature of 250° to 285°F
- ❖ Very good resistance to water washout
- ❖ Fair to good protection against rusting
- ❖ Good work stability
- ❖ Fair to good shear and mechanical stability. Will separate into its base oils and thickeners when high to severe mechanical shear stresses are encountered.
- ❖ Fair resistance to oil separation
- ❖ Poor Reversibility. 0% to 30% Reversibility
- ❖ Poor pumpability, especially at low temperatures
- ❖ Possibility that compounds containing barium are highly toxic

BARIUM COMPLEX SOAP BASE GREASE

- ❖ Very high thickener content of 20-30% by weight
- ❖ Fibrous and stringy in texture
- ❖ Dropping point of 380⁰F-400⁰F (193⁰C to 204⁰C)
- ❖ Maximum usable operating temperature of 285⁰F-300⁰F (141⁰C to 149⁰C)
- ❖ Highly water resistant
- ❖ Fair to good protection against rust, especially in the presence of moisture
- ❖ Good work stability
- ❖ Fair to good shear and mechanical stability. Will separate into its base oils and thickeners when high to severe mechanical shear stresses are encountered.
- ❖ Fair resistance to oil separation
- ❖ Poor Reversibility. 0% to 30% Reversibility
- ❖ Poor pumpability, especially at low temperatures
- ❖ Possibility that compound containing barium are highly toxic

BENTONE BASE

- ❖ Low to relatively high thickener content 6-15% by weight
- ❖ Smooth to buttery texture
- ❖ No dropping point
- ❖ Maximum usable temperature of 350°F to 700°F (177°C to 371°C)
The maximum usable temperature is dependent upon the quality and type of base oil used in the formulation of the grease and its re-lubrication cycle.
- ❖ Fair to excellent water resistance. The lower the thickener content the better the water resistance
- ❖ Good to excellent protection against rusting in the presence of moisture
- ❖ Good to very good work stability
- ❖ Good to very good shear and mechanical stability. Depends upon the thickener content
- ❖ Good to very good low oil separation characteristics.
- ❖ Moderate to very good Reversibility. 50% to 95%.
- ❖ Good to very good oxidation stability
- ❖ Good to very good pumpability
- ❖ Not compatible with any types of soap base greases and polyurea base greases.

CALCIUM SOAP BASE

- ❖ Relatively high thickener content 12-20% by weight
- ❖ Smooth and buttery texture
- ❖ The least expensive grease to manufacture
- ❖ Dropping point of 205⁰-220⁰F
- ❖ Maximum usable operating temperature of 195⁰F
- ❖ Fair to good resistance to water washout
- ❖ Poor to fair protection against rust in the presence of moisture
- ❖ Fair to good work stability. Will soften in consistency when severely worked in a bearing
- ❖ Fair to good mechanical shear stability
- ❖ Water is an essential ingredient in the process used to compound this grease. If the water evaporates at high temperatures, the grease will rapidly separate into base oil and thickener.
- ❖ Poor to good oxidation stability
- ❖ Good pumpability
- ❖ Poor reversibility. 5% to 30% Reversibility

CALCIUM 12-HYDROXYSTEARATE GREASES

- ❖ Relatively high thickener content 10-15% by weight
- ❖ Smooth and buttery texture
- ❖ Dropping point of 275° to 300°F
- ❖ Maximum usable operating temperature of 230°F
- ❖ Good to very good water resistance
- ❖ Poor to very good protection against rust in the presence of moisture.
- ❖ Good work stability. Will soften in consistency when severely worked in a bearing
- ❖ Fair to good shear and mechanical stability
- ❖ Poor to fair reversibility. 10-30% Reversibility
- ❖ Fair to very good pumpability
- ❖ Poor to good oxidation stability

CALCIUM COMPLEX GREASES

- ❖ High Thickener content 15% to 25% by weight
- ❖ Buttery to fibrous texture
- ❖ Dropping point of 450°F
- ❖ Maximum usable temperature of 350°F
- ❖ Good to very good resistance to water washout
- ❖ Fair to good protection against rust in the presence of moisture
- ❖ Good work stability
- ❖ Will soften in consistency when severely worked
- ❖ Poor to good mechanical stability
- ❖ Fair to good resistance against oil separation
- ❖ Poor Reversibility. 10 to 30% reversibility
- ❖ Poor to good oxidation stability
- ❖ Poor to fair pumpability
- ❖ Can harden in consistency in storage or under pressure in lubrication systems

LITHIUM SOAP BASE GREASES

- ❖ Low to relatively high thickener content 7-12% by weight
- ❖ Smooth to slightly fibrous texture
- ❖ Dropping point of 350⁰F-400⁰F (177⁰C to 204⁰C)
- ❖ Maximum usable operating temperature of 230⁰F-275⁰F (110⁰C to 135⁰C)
- ❖ Will emulsify with small quantities of water and soften significantly in the presence of high quantities of water
- ❖ Poor to fair protection against rusting in the presence of moisture
- ❖ Good work stability
- ❖ Fair to good shear and mechanical stability. Will immediately release its base oils when severe mechanical shear stresses are encountered
- ❖ Good resistance to oil separation
- ❖ Slight to moderate reversibility. 40% to 65% Reversibility
- ❖ Good oxidation stability
- ❖ Good to excellent pumpability

LITHIUM 12-HYDROXYSTERATE GREASES

- ❖ Relatively high thickener content 10-15% by weight
- ❖ Smooth buttery texture
- ❖ Dropping point of 350⁰F-400⁰F (177⁰C to 204⁰C)
- ❖ Maximum usable operating temperature of 250⁰F-285⁰F (121⁰C to 141⁰C)
- ❖ Good water resistance. Will slightly emulsify with water. In the presence of large amounts of water the grease will soften and run
- ❖ Fair resistance to rusting in the presence of moisture
- ❖ Good work stability. Softens in consistency when worked severely in a bearing.
- ❖ Fair to good shear and mechanical stability. Will rapidly release its base oils when severe mechanical shear stresses are encountered
- ❖ Fair to good resistance to oil separation
- ❖ Good oxidation stability
- ❖ Slight to moderate reversibility. 45% to 65% Reversibility
- ❖ Good to very good pumpability
- ❖ Rapid softening of the grease with increasing temperature

LITHIUM COMPLEX BASE GREASES

- ❖ Relatively high thickener content of 10-15% by weight
- ❖ Smooth and buttery texture
- ❖ Dropping point up to 500°F (260°)
- ❖ Maximum usable operating temperature of 300°F-350°F (149°C to 177°C)
- ❖ Good resistance to water. In the presence of large amounts of water these greases will soften in consistency and run out
- ❖ Good work stability. Some softening in consistency when severely worked in a bearing
- ❖ Good mechanical and shear stability. Will release its base oils fairly rapidly when severely worked
- ❖ Fair to good resistance to oil separation
- ❖ Moderate to good Reversibility. 70% to 85% Reversibility
- ❖ Good to very good stability
- ❖ Good to very good pumpability

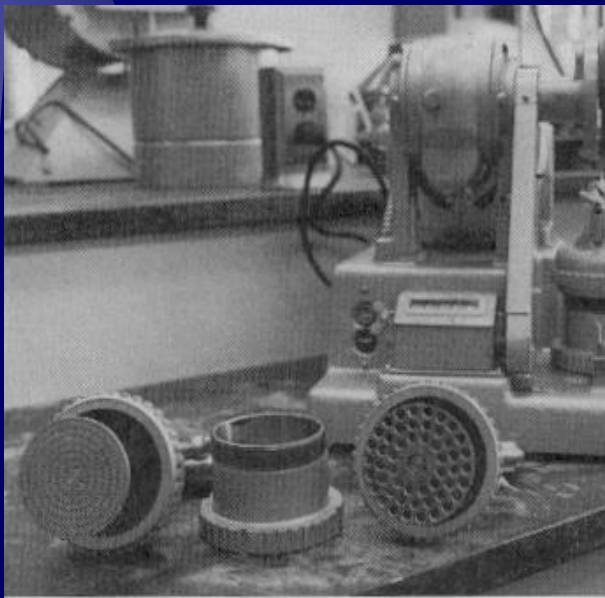
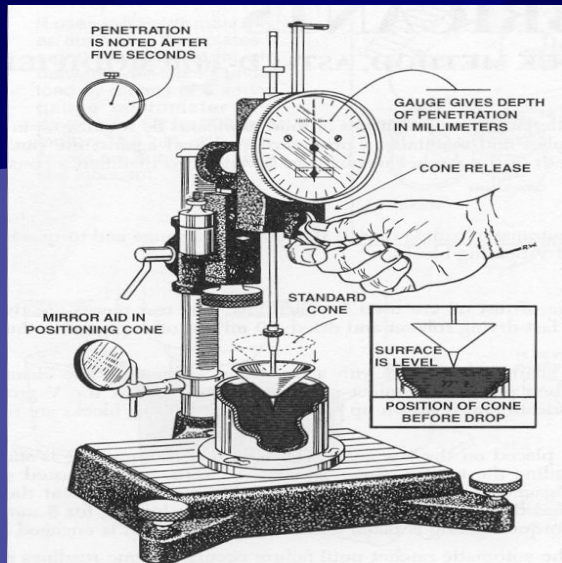
CALCIUM SULFONATE COMPLEX

- ❖ Thickener Content of 10% to as high as 20%
- ❖ Smooth to buttery texture
- ❖ Dropping points up to 572 F
- ❖ Maximum usable temperature of 350 F
- ❖ Very good to excellent oxidation stability
- ❖ Good to excellent water resistance
- ❖ Excellent resistance to water washout and spray-off
- ❖ Heavier than water (Specific Gravity of 1.1)
- ❖ Excellent work and mechanical stability
- ❖ Very good to excellent resistance to oil separation.
- ❖ Superior rust and corrosion protection. Calcium Sulfonates are used as rust preventatives
- ❖ Excellent extreme pressure and anti-wear properties. Calcium Sulfonates possess inherent natural anti-wear and extreme pressure properties.
- ❖ Good pumpability in centralized lube systems

GENERAL PROPERTIES

- ❖ The lubricating abilities of a grease depends upon both the type of base oil used and the type of thickener used.
- ❖ The properties that affect the ability of a grease to perform are:
 - Consistency (NLGI Grade)
 - Dropping point
 - Load carrying capabilities
 - Oxidation stability
 - Texture and structure
 - Flow characteristics and pumpability
 - Mechanical stability and reversibility
 - Bleeding characteristics
 - Water resistance
 - Rust and corrosion protection

CONSISTENCY



- ❖ Consistency is a measure of the relative hardness of a grease.
- ❖ Normally, greases soften with working.
- ❖ Consistency of a grease measured as penetration, is determined by the ASTM D-271 Standard Test Method For Cone Penetration
- ❖ The deeper the test cone penetrates the grease after being worked for 60 strokes in a grease worker, the softer the grease.

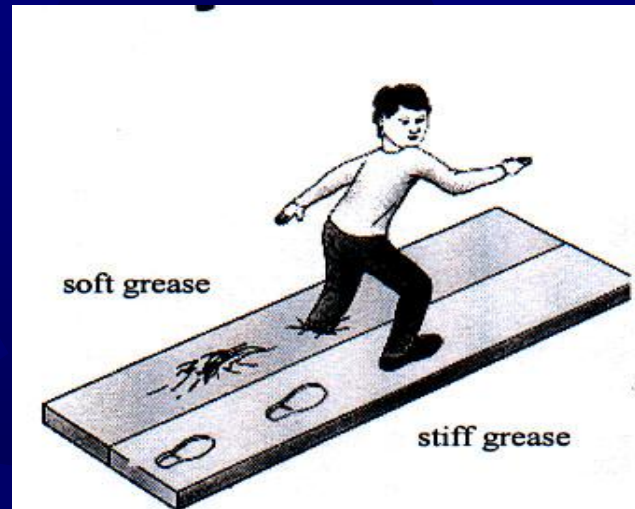
NLGI Grades

Grease is “graded” by thickness

More
Oil
Less
Thickener

NLGI Grades (9 grades)
000, 00, 0, 1, 2, 3, 4, 5, 6

Less
Oil
More
Thickener



NLGI GRADES

NLGI GRADE	WORKED PENTRATION	CONSISTENCY ANALOGY
000	445-475	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	175-205	Frozen Yogurt
5	130-160	Smooth Pate
6	85-115	Cheddar Cheese Spread

DROPPING POINT

- ❖ Dropping point is the temperature at which a grease passes from a plastic solid state to a liquid state.
- ❖ The dropping point of a grease is useful in characterizing the type of thickener used.
- ❖ Each type of thickener exhibits a particular dropping point range.
- ❖ The dropping point is not a measure of the service performance of a grease, nor does it establish the maximum usable temperature or the temperature limit where the grease can be used without relubrication.
- ❖ As a general rule of thumb the maximum usable if a grease should be at least 50 to 100 F below its dropping point.

DROPPING POINT

THICKENER	DROPPING POINT	MAXIMUM SERVICE TEMPERATURE
CALCIUM SULFONATE	572 F	350 F
LITHIUM SOAP	350 -400 F	230 -275 F
LITHIUM 12-HYDROXYSTERATE	350 -400F	230 -275 F
LITHIUM COMPLEX	+500 F	300 -350 F
CALCIUM SOAP	400 -428 F	195 F
CALCIUM 12-HYDROXYSTERATE	400 -428 F	400 -428 F
CALCIUM COMPLEX	450 F	350 F
BARIUM SOAP	370 -400 F	250 -285 F
BARIUM COMPLEX	380 -400 F	350 F
ALUMINUM COMPLEX	450 -+500 F	350 -400 F
POLYUREA	450 F	350 F
BENTONE	NONE	350 -500 f

LOAD CARRYING CAPABILITIES

- ❖ Load carrying capabilities refer to the E.P. and wear protection provided by a grease.
- ❖ Many bearing applications are subjected to high shock loading, continuous low speed/high torque conditions and in some cases severe overload conditions.
- ❖ These conditions often result in boundary lubrication conditions.
- ❖ Extreme pressure additives and anti-wear additives are commonly widely used in the formulation of grease to increase their load carrying capabilities.

LOAD CARRYING CAPABILITIES

- ❖ A grease's anti-wear and extreme pressure properties can be further enhanced by the use of solid lubricants such as molybdenum disulfide, graphite and teflon.
- ❖ The different tests used to measure the extreme pressure and anti-wear additive properties of a grease are the
 - Timken E.P. Test ASTM D-2509
 - The Four Ball Wear Test ASTM D-2266
 - The Four Ball E.P. Test ASTM D-2596
 - Falex Continuous Load Test ASTM D-3233`

OXIDATION STABILITY

- ❖ Oxidation stability is the resistance of the grease to chemical deterioration caused by exposure to air, especially at high temperatures .
- ❖ A grease's oxidation stability depends upon the type of base oil used, the type and amount of thickener used and the type of oxidation inhibitor additive system used.
- ❖ A high resistance to oxidation is important whenever long storage or service life is required or where high temperatures may be encountered for even a short period of time.
- ❖ The ASTM-D 942 Oxidation Stability Test Method is the most common test method used to determine a grease's oxidation stability.

TEXTURE AND STRUCTURE

- ❖ **Texture and structure refer to the appearance and feel of the grease**
- ❖ **It is a factor that influence the adhesiveness and ease of handling of the product .**
- ❖ **These characteristics depend on the viscosity of the base oil, the type of thickener, the amount of each of these components used in the formulation, presence of certain additives, and the manufacturing process used to make the grease.**
- ❖ **There are no standard test methods for quantitative definition of these properties; they are defined by visual and tactile inspection.**

TEXTURE AND STRUCTURE

- ❖ **Texture is the property observed when a small amount of grease is pressed together and slowly drawn apart, such as between the thumb and finger. Texture is described as:**
- ❖ **Buttery – The grease separates in short peaks with no visible fibers.**
- ❖ **Smooth – The surface of the grease is relatively free of irregularities.**
- ❖ **Stringy or Tacky – The grease tends to stretch out into long, fine threads but with no visible evidence of fiber structure.**
- ❖ **Short Fiber – The grease shows short break-off with evidence of fibers.**
- ❖ **Long Fibers – The grease shows a tendency to stretch or string out into a single bundle of fibers.**

FLOW CHARACTERISTICS AND PUMPABILITY

- ❖ **Flow characteristics of a grease are of great importance in selecting a grease for a given service.**
- ❖ **The grease must function as a viscous fluid as soon as it is in service**
- ❖ **A grease's flow characteristics and pumpability is controlled by the viscosity of the base oil used, the type of base oil used, the presence of viscosity index improvers, and the amount and type of thickener used in its formulation.**

FLOW CHARACTERISTICS AND PUMPABILITY

- ❖ **A grease's flow characteristics and pumpability at low temperatures are determined through the use of the following tests:**
 - **Apparent Viscosity of Lubricating Greases ASTM D-1092**
 - **U.S Steel Mobility Test**
 - **Low Temperature Torque Test ASTM D-1478**
 - **Lincoln Ventmeter Test**

SHEAR AND MECHANICAL STABILITY

- ❖ In many bearing applications a grease can be subjected to high mechanical shear stress or high loading conditions.
- ❖ A grease must exhibit shear stability otherwise the grease will either run out of the lubrication area or will separate into its base oil and thickener components, thus allowing the base oil component to run out of the lubrication area and leave the thickener behind to lubricate.
- ❖ Shear and Mechanical stability is the resistance of a grease to permanent changes in its consistency; due to the continuous application of shearing forces.

SHEAR AND MECHANICAL STABILITY

- ❖ **Shear and mechanical stability** measures a a grease's ability to “stay put” in a bearing.
- ❖ **Any change in consistency must be moderate only in order to enhance the grease's ability to stay in the bearing.**
- ❖ **A grease's shear and mechanical stability is dependent upon the type and amount of thickener used.**
- ❖ **A grease that contains a high thickener content will readily separate into its base oil and thickener when severely worked in a bearing. especially if high mechanical shear stresses or high loading conditions occur.**

SHEAR AND MECHANICAL STABILITY

- ❖ **A grease' shear and mechanical stability are determined through the use of the following tests:**
 - **Roll Stability Test ASTM D-1831**
 - **Modified Roll Stability Test ASTM D-1831(Mod)**
 - **Leakage Tendencies of Wheel Bearing Grease ASTM D-1263**
 - **Mechanical Stability Test ASTM D-217 Appendix A**

REVERSIBILITY

- ❖ When a grease encounters abnormally high temperatures for short periods of time and then returns to normal operating temperatures, or encounters high shock loading conditions, bleeding of the base oil from the grease occurs .
- ❖ During normal operation of a bearing, it is the function of the thickener to release its base oils and additives in order to lubricate .
- ❖ When the machine is shut off, or when conditions of high temperature or high shock loading occur, the grease must have the ability to recapture its bases in order to return to its original consistency.

REVERSIBILITY

- ❖ **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.**
- ❖ **A grease's reversibility characteristics are dictated by the type and amount of thickener used.**
- ❖ **The higher the thickener content the less the grease's reversibility.**

REVERSIBILITY

PERCENTAGE OF REVERSIBILITY DIFFERENT GREASE THICKENERS

THICKENER TYPE

PERCENT REVERSIBILITY

Aluminum Complex

95% to 100%

Barium

55 to 30%

Barium Complex

0% to 30%

Bentone

50% to 95%

Calcium Sulfonate Complex

75% to 90%

Calcium 12-Hydroxystearate

10% to 30%

Calcium Complex

10% to 30%

Lithium

40% to 65%

Lithium 12-Hydroxystearate

45% to 65%

Lithium Complex

70% to 80%

Polyurea

20% to 60%

BLEEDING CHARACTERISTICS

- ❖ Bleeding is the separation of base oil from the grease during storage.
- ❖ It is evidenced by pools of oil on the surface of the grease or by puddles in hollows left after scooping the grease from the container
- ❖ Bleeding is most pronounced in soft greases employing a low viscosity base oil. (NLGI Grades 00,0,1)
- ❖ While gross separation of the base oil from the grease is unacceptable, a small amount of bleeding is desirable because it ensures immediate lubrication of parts when the machinery is started.

BLEEDING CHARACTERISTICS

- ❖ **Pressure bleeding may occur when a grease is held under pressure in a spring-loaded grease gun, pressurized dispensers, or pressurized centralized lubrication systems.**
- ❖ **Greases that have a low thickener content are less affected by pressure bleeding than greases with a high thickener content.**
- ❖ **A grease's bleeding characteristics are determined through the use of the following tests:**
 - **Oil Separation from Grease During Storage ASTM D-1742**
 - **Pressure Oil Separation Test US Steel Method**
 - **Oil Separation From Lubricating Grease ASTM D-6184**

WATER RESISTANCE

- ❖ Many bearing applications are constantly exposed to water.
- ❖ A grease must have the ability to resist softening and/or emulsification with water.
- ❖ If a grease does not possess this ability it will washout.
- ❖ This results in the grease no longer having the ability to act as a seal against water contamination and protect against rusting and wear, along with the ability to effectively lubricate the bearings.

WATER RESISTANCE

- ❖ **A greases water resistance characteristics are directly related to the amount and type of thickener used.**
- ❖ **Generally the higher the thickener content used the more water the grease absorbs.**
- ❖ **A grease's water resistance characteristics are determined by the use of the following tests:**
 - **Water Washout Test ASTM D-1264**
 - **Water Sprayoff Test ASTM D-4049**
 - **Roll Stability Test in the Presence of Water ASTM D 1831 Modified**

RUST AND CORROSION PROTECTION

- ❖ In the presence of water a grease must protect against rusting.
- ❖ Greases should also not attack non-ferrous and ferrous metals.
- ❖ A grease's rust and corrosion protection depends upon its composition, how it reacts with water, its ability to form and maintain a seal.
- ❖ A grease's rust and corrosion protection is enhanced by the use of rust inhibitor additives in the grease.

RUST AND CORROSION PROTECTION

- ❖ A grease's rust and corrosion protection is determined by the following tests:
 - Copper Strip Corrosion Test ASTM D-4048
 - Rust Inhibition Test –1743
 - Emcor Rust Test ASTM D-6138

GREASE COMPATABILITY

- ❖ Grease compatibility is a question that is often raised in the field when one grease is being replaced by another type of grease .
- ❖ The NLGI defines incompatibility as:
“Two lubricating greases show incompatibility when a mixture of the products shows physical properties of service performance which are markedly inferior to those of either of the greases before mixing. Performance or properties inferior to one of the products and superior to the other may be due to simple mixing and would not be considered as evidence of incompatibility.”

GREASE COMPATABILITY

- ❖ **Mixing of two greases that have incompatible thickeners usually results in a softening of consistency, resulting in the grease leaking out of the bearing or the part being lubricated.**
- ❖ **The incompatibility of two greases can be determined by either laboratory tests such as the Worked Penetration and Prolonged Worked Penetration Tests ASTM D-217 or the Shell Roll Stability Test ASTM D-1831 or by simply mixing equal amounts of two greases together and stirring them together.**
- ❖ **If softening and bleeding occurs the two greases are incompatible.**

	Aluminum Complex	Barium	Calcium	Calcium12 Hydroxy	Calcium Complex	Clay	Lithium12 Hydroxy	Lithium Complex	Lithium	Polyurea
Aluminum Complex	Green	Green	Green	Green	Green	Red	Green	Green	Green	Green
Barium	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red
Calcium	Green	Red	Green	Green	Green	Red	Green	Green	Green	Green
Calcium12 Hydroxy	Green	Red	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow
Calcium Complex	Green	Red	Green	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow
Clay	Red	Red	Red	Red	Red	Green	Red	Red	Red	Red
Lithium 12 Hydroxy	Green	Red	Green	Green	Yellow	Red	Green	Green	Green	Yellow
Lithium Complex	Green	Red	Green	Green	Yellow	Red	Green	Green	Green	Yellow
Lithium	Green	Red	Green	Green	Yellow	Red	Green	Green	Green	Yellow
Polyurea	Green	Red	Green	Green	Yellow	Red	Yellow	Yellow	Yellow	Green



Grease Selection Guide for Antifriction Bearings

R.P.M.

- 7000-11000
- 4000-7000
- 2500-4000
- 500-2500
- 150-500
- 100-150

- White # 0
- Blue # 1
- Silver # 2
- Orange # 3
- Yellow # 4
- Red # 5
- # 6

- 355-385 (Soft)
- 310-340
- 265-295
- 220-250
- 175-205
- 130-160
- 85-115 (Hard)

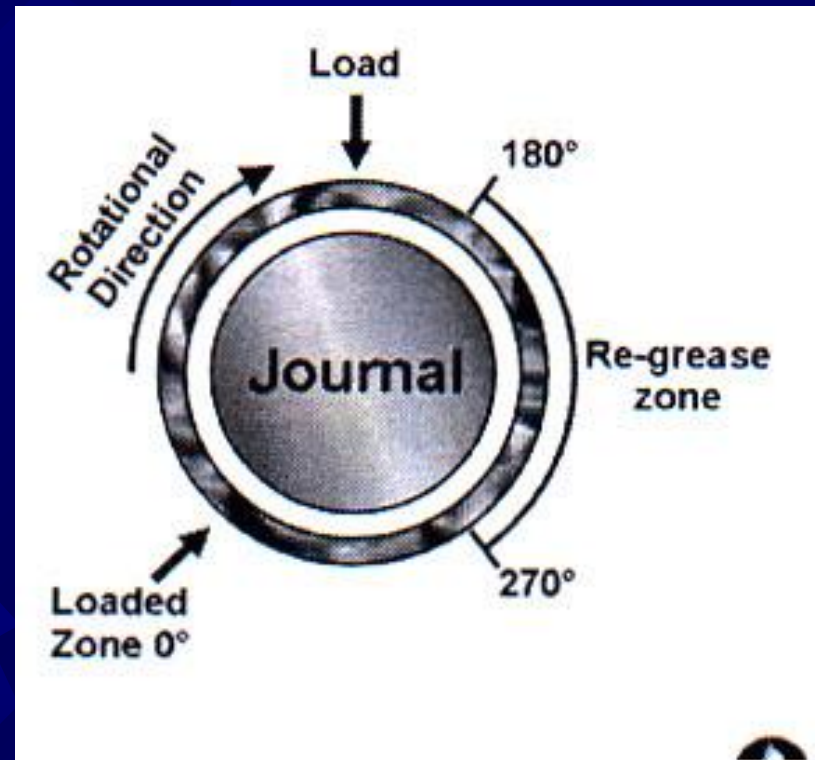
Green = Compatible Yellow = Borderline Compatibility

Red = Incompatible

Not all polyurea greases are mutually compatible

GREASE LUBRICATION FOR PLAIN BEARING

- ❖ Typically use an NLGI #1 or #2 grease.
- ❖ Initial charge should be sufficient to load the journal and bearing.
- ❖ Feed grease between 180 and 270 from the load zone on the entry side.
- ❖ Feed new grease until all the old grease discharges from the bearing.



GREASE LUBRICATION FOR PLAIN BEARING

- ❖ Grease is recommended for the lubrication of plain bearing when:
 - Speed is slow (below 400 rpm for a 2" bearing; below 50 rpm for an 80" bearing)
 - The bearing is subjected to frequent starts, stops or shock loading conditions
 - Bearing is inaccessible for re-lubrication
- ❖ The grease used should contain EP additives and/or solid lubricants since most types of journal bearing operate under boundary lubrication conditions

GREASE LUBRICATION FOR ROLLING BEARINGS

- ❖ The selection of the proper NLGI Grade to use depends upon the speed of the bearing, the amount of loading on the bearing and the base oil viscosity of the grease
- ❖ Generally the higher the bearing speed the lower the NLGI Grade should be used.
- ❖ If the grease contains a light viscosity base oil (NLGI Grade 100 or lower) the following rule of thumb can be used based upon on the bearings DN speed (DN= inside bearing bore in mm X rpm of the bearing)
 - DN Speeds below 200,00 Use NLGI Grades #1 or #2
 - DN Speeds at 200,000 Use NLGI #3 Grade
 - DN Speeds above 200,000 Recommend oil lubrication

GREASE RELUBRICATION INTERVALS

- ❖ The relubrication interval depends upon the bearing type, size, speed, operating temperature and the type of grease used.
- ❖ The relubrication interval for a bearing can be calculated using the following equation:

$$t = K \left(\frac{14 \times 10^6}{nd^{1/2}} - 4d \right)$$

Where t = relubrication interval, hours

K = factor, depending on bearing type

$K = 1$ for spherical roller, tapered roller and thrust bearings; 5 for cylindrical roller and needle bearings, 10 for radial ball bearings

n = bearing speed rpm

d = bearing bore diameter, mm

GREASE RELUBRICATION INTERVALS

- ❖ The formula is applicable to bearings in stationary machines where loading and temperatures are normal.
- ❖ It applies also to ball bearings fitted with shields or seals.
- ❖ It should only be used as a rough guide.
- ❖ The intervals obtained from the formula are valid only for operating temperatures up to 155 F (70 C) measured at the outer ring.
- ❖ The interval should be halved for every 25 to 30 increase above 155 up to the maximum permissible operating temperature of the grease being used.

GREASE- HOW MUCH IS ENOUGH

- ❖ Overlubricating rolling element bearings causes churning and generates excess heat.

Recommended Re-Lube Volume as % Total Volume

Bearing Speed	Roller Bearing	Ball Bearing
High Speed	30%	25%
Medium Speed	30%	30%-40%
Slow Speed	30%	40%-50%
Very Slow Speed	30%	50%-60%

Formula For Estimating Amount of Grease to Use

$$Gq = 0.114 DB$$

Gq = Grease quantity in ounces

D = Bearing outside diameter in inches

B = Total bearing width in inches (height for thrust bearings)

GREASE RECOMMENDATIONS

GENERAL

- ❖ Mining and industrial equipment OEMs recommend the use of either NLGI Grade #0, #1, #2 or #3 greases depending upon the ambient temperatures encountered.
- ❖ Some OEMs such as Caterpillar specify that the grease contain solid lubricant such as Molybdenum Disulfide.
- ❖ All greases used in mining applications must contain extreme pressure additives in order to withstand high shock loads.
- ❖ Grease must exhibit good to very good reversibility characteristics.
- ❖ Grease must be mechanically shear stable.
- ❖ Grease must be resistant to water washout.
- ❖ Grease must resist to oil separation.
- ❖ Some OEMs such as P&H and BE specify the grease have a minimum weld load of 315kg-f and Timken Load of 45lbs.

GREASE RECOMMENDATIONS

GENERAL

- ❖ Most greases used in industrial applications must contain extreme pressure additives in order to withstand high shock loads.
- ❖ Grease must exhibit very good reversibility characteristics.
- ❖ Grease must be mechanically shear stable.
- ❖ Grease must be resistant to water washout
- ❖ Grease must resist oil separation.
- ❖ Some OEMs such as Caterpillar specify that the grease contain solid lubricant such as Molybdenum Disulfide.

CATERPILLAR AND COMMERCIAL GREASE RECOMMENDATIONS

- ❖ Caterpillar and other OEM commercial requirements has a specification for a extreme pressure lubricating grease containing minimum 5% Molybdenum Disulfide.
- ❖ SynMax Gladiator 777 Calcium Sulfonate Complex Grease with Diamond Like Additives meets this requirement.
- ❖ The grease is intended for use in heavily loaded oscillating joints such as those found in loader hinge pins.
- ❖ The grease is dispensed by an automatic lube system.
- ❖ The grease is factory filled by Caterpillar and other OEM Commercial - industrial requirements in their equipment.
- ❖ The factory fill grease is a Calcium Sulfonate Complex Grease recommended for operating temperature range of -10 F to 332 F.



**GREASE OVERVIEW
& APPLICATION PRESENTATION**

END.