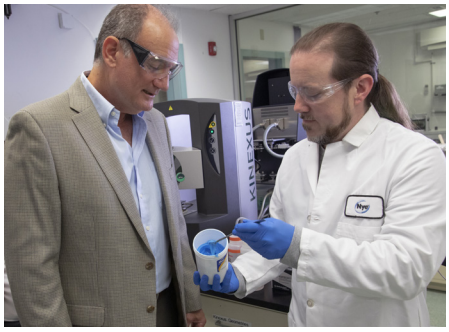
Since 1844

Nye® LubeLetter

September 2021

Lubrication

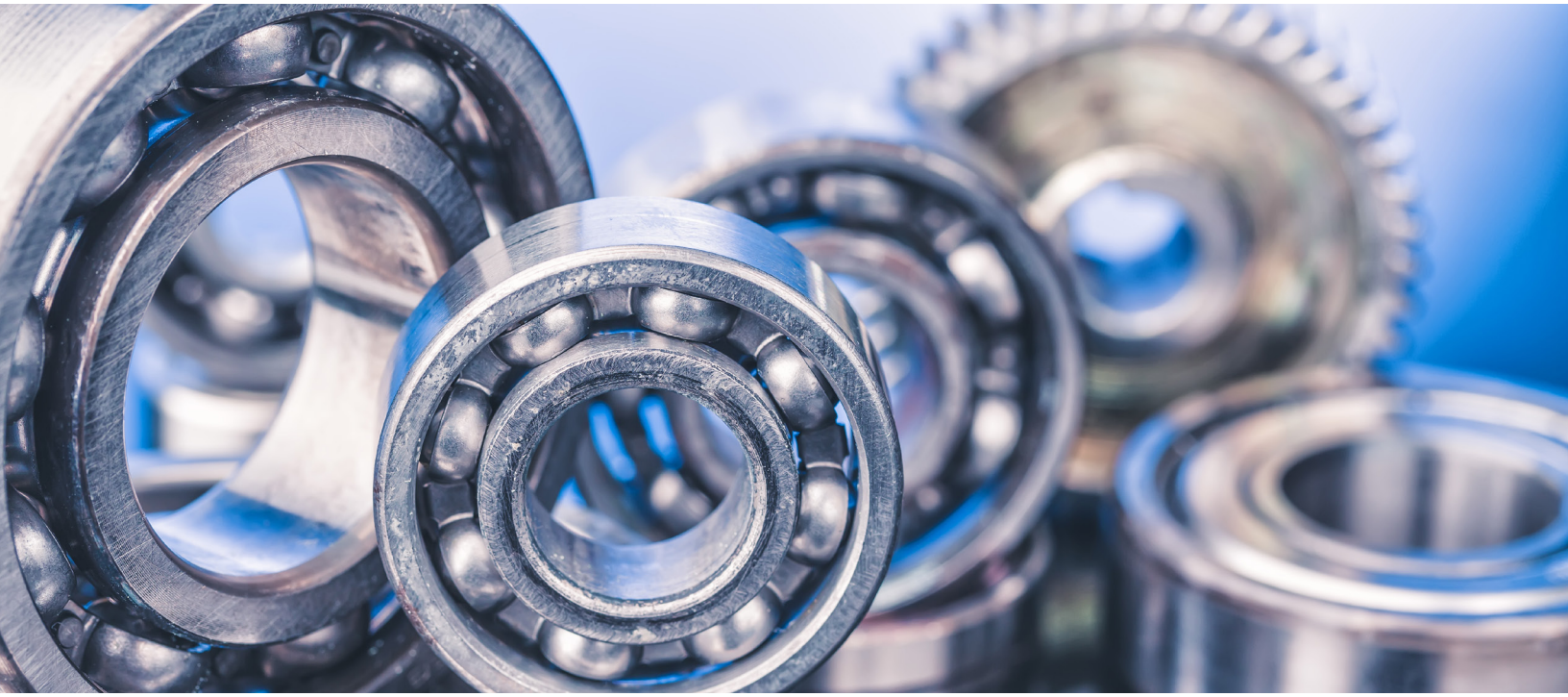
Collaboration



Innovation

5 Things to Consider When Selecting a Precision Bearing Lubricant

Precision bearings are used in a variety of industries where tight tolerances are required to optimize performance and negate risk. In the Industrial, Aerospace, Medical, and Semicon industries, the failure of precision bearings can be expensive and/or safety critical. According to Machinery Lubrication, as many as 60 to 80 percent of all bearing failures can be attributed to a contaminated, poorly selected, degraded, or poorly applied lubricant. This means that lubricant performance plays a critical role in ensuring how well, and for how long, a lubricant can minimize friction to prevent wear that leads to bearing failure.



Often, an improperly selected lubricant is to blame. Because precision bearings are manufactured with tight tolerances, there is little room for failure; meaning that your lubricant must meet the unique requirements of your specific application. There are several factors to consider when selecting the proper precision bearing lubricant.

Temperture

When a lubricant degrades, it is often because it cannot withstand the temperatures of an application. In these situations, high temperatures can cause the lubricant to polymerize, creating a tacky substance that could act like a "speed bump" in the raceway of the bearing which causes vibration and ultimately wear. Even if the lubricant simply evaporates under high temperatures, there is no oil to separate the surfaces which allows excessive metal to metal contact and wear. Lubricants with operating temperatures above 300°F, or non-burning lubricants should be considered in high temperature applications.

Load

Precision bearings supporting high loads demand a lubricant with excellent film strength to ensure metal surfaces remain separated and prevent wear. For higher loads, especially where vibration or shock loading is likely, special anti-wear additives can improve grease performance.

Speed

High and low speed applications require lubricants with different properties. High speed applications require a grease with an appropriate base oil viscosity and special thickeners. Low speed applications with little friction may only require oil lubrication. Nye also offers NyeBar®, a unique polymer which can be used on the bearing faces to prevent oil migration and leakage.

Contamination

Microscopic contaminants can also act as impediments and are equally as detrimental to bearing performance, particularly within vacuum and cleanroom applications, as they can contaminate other components nearby. Solid particles in lubricants come from many sources, but the most likely culprits are raw materials, the manufacturing process, and the environment. While lubricants are selected for their physical properties, such as temperature range, penetration grade and additive fortification, cleanliness should also be considered. The cleanliness of a grease is described by the number of particles within size ranges, in which the particles are counted under a microscope and are determined by the largest dimension in microns. The best way to ensure lubricant cleanliness is through ultrafiltration. Ultrafiltration is a rigidly controlled filtering process that reduces microscopic particulates in a lubricant. The objective of this process is to remove unwanted substances or contamination from the grease or oil.

Nye has ISO class 8 and class 7 certified clean rooms that are strictly regulated to prevent cross-contamination of any kind. Nye offers ultrafiltration services for not only our own greases, but also for those produced by other manufacturers. At Nye, we ensure ultraclean grease by following a strict manufacturing process from start to finish.

Often, it is not until there is a high percentage of rejects or, worse, failures in the field that the spotlight turns toward the lubricant. Carefully considering which lubricant to fill your precision bearing during the design phase will greatly reduce your risk for product failure.

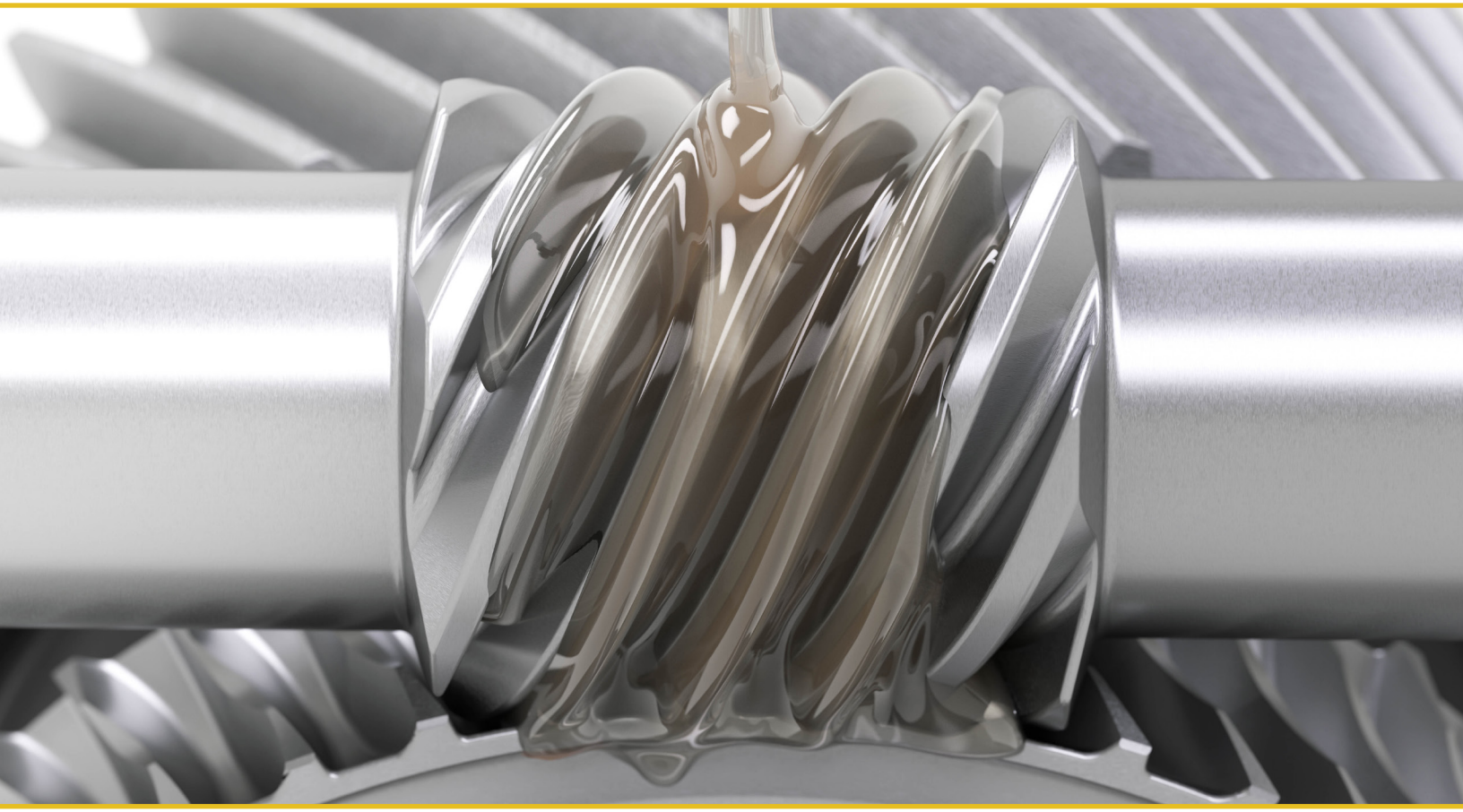
Dispensing

Caution should be taken to ensure that a bearing is not under-or over-filled. This requires a dispensing method that distributes the grease precisely. This may mean that you need a syringe for manual application or pails for automated dispensing. Nye offers referrals to companies that provide dispensing systems to help customers choose the right application procedure.

Product	Chemistry	Temperature Range	4-Ball Wear Scar	Application Notes
NyeTorr® 5200	Cyclopentane/ PTFE	-45 to 150 °C	0.59 mm	Low outgassing and particle generation grease intended for semiconductor manufacturing equipment.
Rheolube® 2000	Cyclopentane/ Sodium Soap	-45 to 125 °C	0.38 mm	Aerospace and other low vapor pressure applications.
Rheolube® 462	PAO/ Lithium Soap	-54 to 130 °C	0.51 mm	General purpose bearing grease with great oxidative stability and corrosion resistance.
Uniflor™ 8172	PFPE/PTFE	-45 to 225 °C	–	Excellent plastic and elastomer capability with resistance to aggressive chemicals.
Uniflor™ 8981	PFPE/PTFE	-65 to 250 °C	1.67 mm	Excellent plastic and elastomer capability with resistance to aggressive chemicals.

5 Things You Should Consider When Selecting a Worm Gear Lubricant

Choosing the right lubricant for your component is almost as important as picking the component itself. Lubricants play a critical role in improving the performance of our components, but not all lubricants are suitable for every application. A lubricant that cannot withstand the operating conditions of your application, such as temperature or speed, will not adequately protect your component from wear and corrosion and can even accelerate the process. Worm gear lubrication presents unique challenges to design engineers who must consider the high sliding nature of the gear assembly.



Worm gears come in a variety of sizes from power steering units to small DC motors and typically transmit higher torque ratios. Therefore, typical worm and wheel materials can vary anywhere from stainless steel, to nylon, to even some yellow metals (brass, bronze, etc.). Not all greases formulated for worm gears are created equal. Here are five things you should consider when selecting a worm gear lubricant:

Viscosity

Worm gears undergo more sliding motion than rolling motion. Rolling motions will migrate lubricant around the entire gear box to ensure that all components, including the contact zone, are sufficiently lubricated. Repetitive sliding motions will push the lubricant away from the contact zone. Lubricants with a high base oil viscosity are recommended to ensure that the lubricant can migrate effectively to all areas of the gear box under sliding conditions. PAO based lubricants offer wider temperature performance and better viscosity index than mineral oil base products. While choosing the correct base oil viscosity is paramount, temperature and loading conditions should also be considered when selecting the proper lubricant.

Temperture

The predominantly sliding contact of the worm gear generates significant friction and high operating temperatures in the assembly. This is a problem for designers who wish to maximize gearbox efficiency without giving off too much heat. When a lubricant cannot withstand high temperatures, it will oxidize and leave behind several by products such as acids. These acids attack the metal surface and lead to increased wear and corrosion of the gear. Lubricants for worm gears should be able to withstand operating temperatures of up to 125°C.

Additives

Due to the sliding contact of worm gears resulting in high friction and operating temperatures, worm gears operate predominantly under boundary lubrication conditions making extreme pressure (EP) additives a logical choice. Many engineers will not select a grease with an extreme pressure additive because they often contain active sulfur which can soften, etch, or corrode yellow metals. Many EP additives at Nye use inactive sulfur that prevents the corrosive attack of the gear surface. Inactive sulfur forms a soft slippery chemical layer on the metal surface which protects against severe wear and welding. Lubricants with EP additives have greater film strength to reduce friction and protect your gear from wear.

Material Compatibility

Many applications, such as Electric Power Steering systems, use a combination of plastic and metal components within their gear assembly. It is important to select a lubricant that is compatible with all the materials in your assembly. Incompatible lubricants can penetrate plastics and cause several adverse physical and chemical reactions that affect its mechanical properties.

First, plastic can absorb oil and swell. Second, oil can extract solubles from plastic and shrink it. Finally, chemical interactions can affect the molecular structure of the plastic where a slight chemical change may lead to loss in mechanical performance such as embrittlement.

The lower the viscosity of the oil, the greater the possibility that it can penetrate plastics. Esters should be approached with caution as they have been known to attack certain plastics and elastomers. With so many different variations of plastics and elastomers, compatibility testing is always recommended to ensure that it will work properly in your specific application.

Noise

Noise-free operation is becoming increasingly important to consumers. Lubricants reduce frictional vibration to minimize noise emissions.

Below is a partial list of the most commonly used Nye synthetic lubricants for worm gear applications:

Product	Base Oil Chemistry	Temperture Range	Base Oil Viscosity @ 40°C
Rheolube® 363F	PAO	-50 to 125 °C	51.7 cSt
Rheolube® 380-GI	PAO/Ester	-50 to 130 °C	37 cSt
Rheolube® 362HB	PAO	-40 to 125 °C	32.6 cSt
Rheolube® 462CF	PAO	-54 to 130 °C	27.1 cSt

What to Consider When Selecting a Linear Guide Lubricant

Linear guides are often used in cleanroom manufacturing and vacuum environments to facilitate linear X and Y motion in a horizontal or vertical plane. These components must operate reliably to improve yields and prevent costly downtime. How do Nye's lubricants benefit linear guide applications?

Reduce Frction & Wear

Linear guides are in constant motion and their components must be protected against friction and wear to extend the life of the system.

Control Torque

Linear guides are often used to automate manufacturing processes and torque must be carefully controlled to ensure the system operates with precision. Lubricants reduce starting and running torque by reducing friction between rolling and sliding surfaces.

Minimize Contamination

In cleanroom environments, each material sourced, including lubricants, must be carefully selected to minimize the risk of particle contamination or outgassing. When a lubricant outgasses it releases condensable material that can contaminate wafers, processing equipment, and other sensitive components. Our NyeTorr® lubricants for semiconductor and cleanroom environments are tested per ASTM E595 to determine the percent of lubricant outgassed under vacuum conditions.

Lubricants for Linear Guide Components

Linear guides are in constant motion and their components must be protected against friction and wear to extend the life of the system.

Guide rails

The guide rail must be able to move side-to-side with a smooth, controlled motion. A NyeTorr® product will reduce friction and wear, while also inhibiting corrosion to ensure long operating life. These products are recommended for use in vacuum environments, as they exhibit low outgassing.

Nye Products: NyeTorr® 5200 & NyeTorr® 6300

Ball Screws

A ball screw will facilitate precise, shifting movements in the linear guide system. The addition of a NyeTorr® product will reduce friction and allow metal components to slide

Nye Products: NyeTorr® 5200 & NyeTorr® 6300

Lead Screws

A lead screw requires greater torque in the linear guide application, leading to higher friction levels and higher operating temperatures.

Nye Products: NyeTorr® 5300XP & NyeTorr® 5350

Product	Temperature Range	Friction & Wear ASTM D5707	Outgassing ASTM E595	Low Temp Torque ASTM D1478
NyeTorr® 5200	-45 to 150 °C	CoF = 0.114 Wear Scar = 0.44 mm	TML=0.068 wt% CVCM=0.007 wt%	Start = 221 g.cm 10 min = 274 g.cm
NyeTorr® 6300	-65 to 250 °C	CoF = 0.11 Wear Scar = 0.68 mm	TML=0.036 wt% CVCM=0.006 wt%	Start = 221 g.cm 10 min = 125 g.cm
NyeTorr® 5300XP	-65 to 200 °C	CoF = 0.113 Wear Scar = 0.58mm	TML=0.075 wt% CVCM=0.018 wt%	Start = 207 g.cm 10 min = 121 g.cm
NyeTorr® 5350	-55 to 250 °C	COF = 0.14 Wear Scar = 0.652 mm	TML=0.757 wt% CVCM=0.451 wt%	Start = 221 g.cm 10 min = 118 g.cm

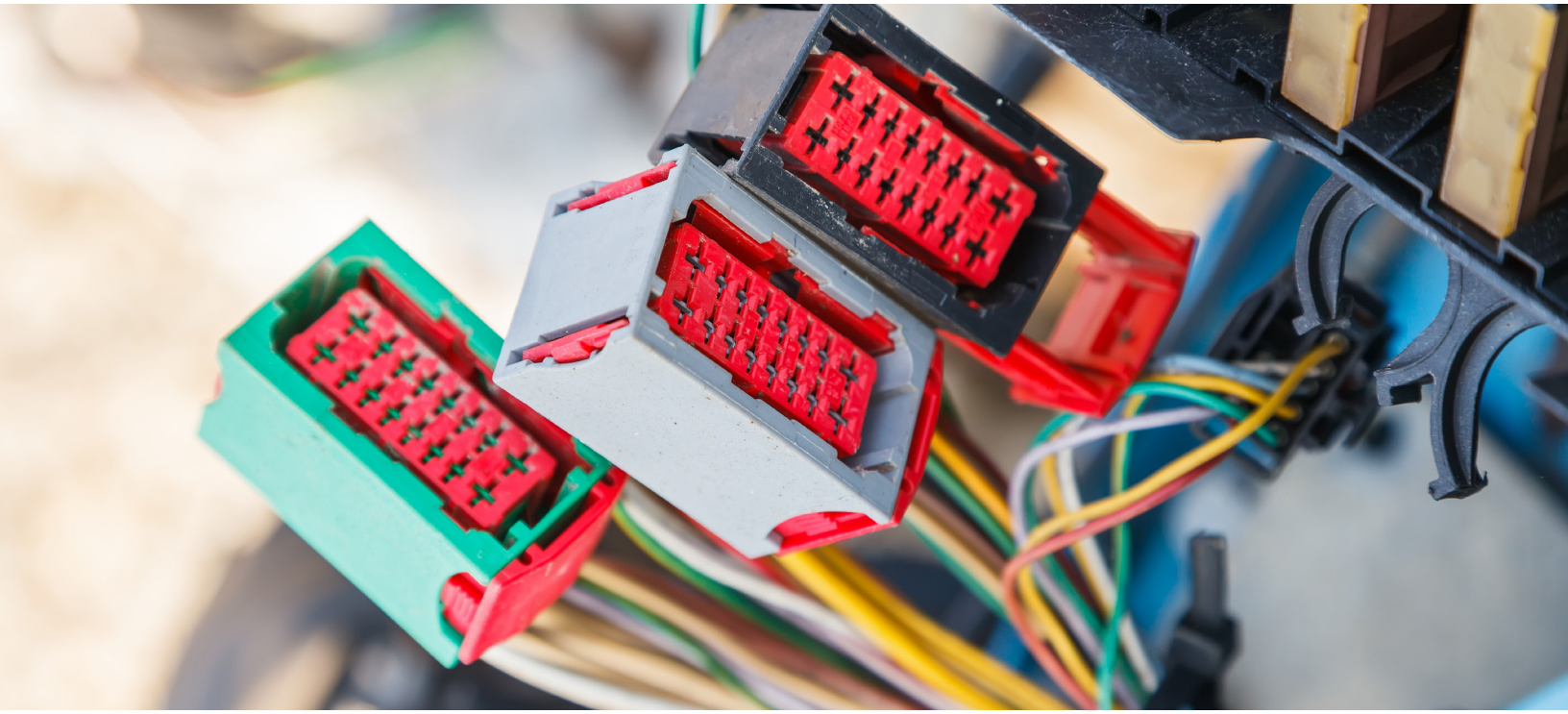
CoF= Coefficient of Friction TML= Total Mass Loss CVCM= Collected Volatile Condensable Materials

Sulfur and Connector Grease – What You Need to Know

Dr. Amanda Walcott Stubbs – Tribologist

One of the most common questions we get about our connector grease is if it contains sulfur. Engineers are concerned that a grease that contains sulfur, in any form, will interact with terminal metal plating materials, posing a risk to continuity. The short answer is yes, our connector greases contain inactive sulfur. But there is a difference between inactive and active sulfur molecules and how they can affect connector applications..

Inactive sulfur **is not harmful** to connector applications. But first, let's explore why sulfur is used in the first place.



Why is Sulfur Used in Grease?

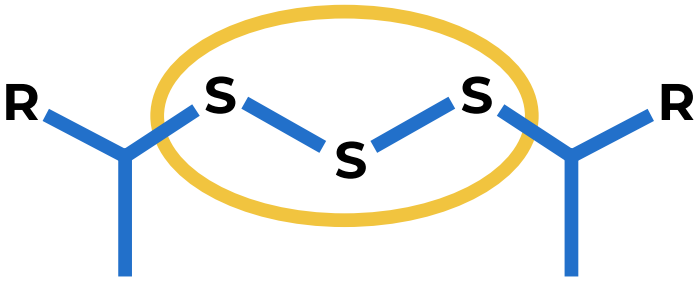
Sulfur is found in many anti-wear, extreme pressure, and antioxidant additives that enable applications to perform under extreme conditions. Sulfur additives have been known to reduce wear on metal surfaces and prevent the metal surfaces from welding together.

How Does Sulfur Affect Connectors?

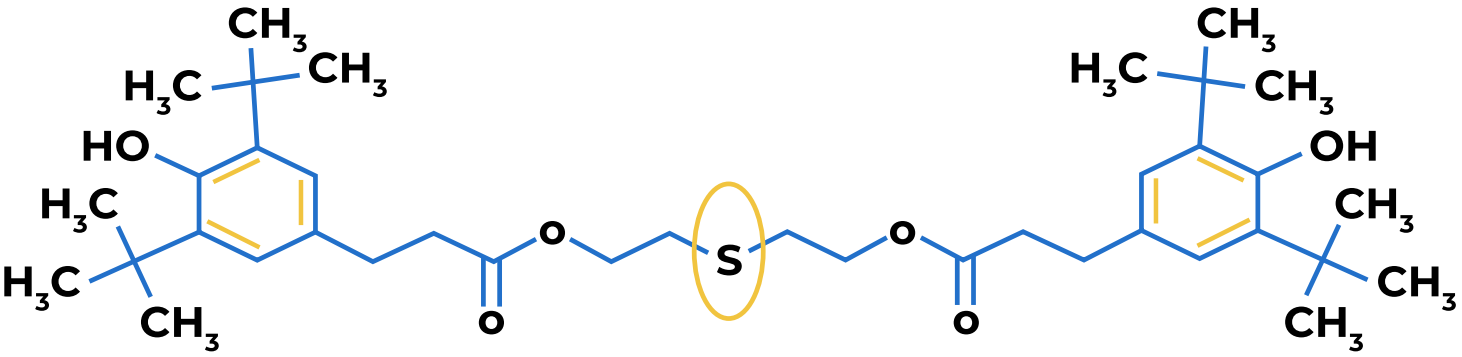
Most connectors are coated with a thin layer of a conductive metal like silver, tin, or copper-tin. These are all reactive metals. Active sulfur, when applied to a connector, reacts with the thin metal coating and creates metal sulfides, or tarnish. When these sulfides build up, they will flake off the surface of the connector and disrupt the surface morphology.

What is the Difference Between In-Active and Active Sulfur?

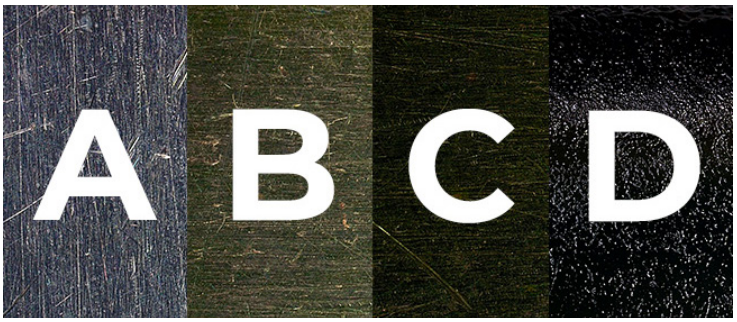
Not all sulfur is harmful to electric connectors. Active sulfur is harmful to connectors and can result in a loss of continuity, whereas inactive sulfur is not harmful.



Molecules containing active sulfur contain chains of two or more sulfur atoms in length. When sulfur molecules are connected to other sulfur molecules it creates a short chemical chain that can break easily. This break in the chain can result in those molecules interacting with other species. In other words, the chemical structure of active sulfur makes it a reactive material that attacks conductive metal coatings.



In inactive sulfur compounds, molecules contain fewer than two sulfur atoms in length. In the example shown above, sulfur is connected to carbon or oxygen, which creates a tight chemical structure. Because the structure is so tight, the sulfur molecules do not break off the chain. Thus, they cannot react with the conductive metal coating on the connector surface to create tarnish.



A - Untreated Coupon

B - Coupon Treated with Grease Containing Inactive Sulfur

C - Coupon Treated with Sulfur-Free Grease

D - Coupon Treated with Grease Containing Active Sulfur

Nye chemists ran a series of tests to illustrate the effects of inactive and active sulfur.

Image A shows an untreated silver-plated coupon. The coupon seen in **Image B** was covered with grease containing inactive sulfur and heated at 100°C for 4 weeks. In this image you can see that the grease protects the coupon surface without creating tarnish.

In **Image C**, the coupon was coated in a modified grease that does not contain any sulfur and was subjected to the treatment described above. The coupon coated in grease without any sulfur does not tarnish the coupon but is also not protected by the inactive sulfur containing additives which prevent the metal from oxidizing.

Lastly, in **Image D** a coupon was treated with another modified grease, this time containing active sulfur. The coupon containing active sulfur completely tarnishes the metal surface in just one week and created sulfides that eventually flaked off the metal surface.

These results prove that not only is inactive sulfur safer to use than active sulfur, but inactive sulfur additives improve the overall performance of your connector when compared to a grease without sulfur.

Our Verdict

Not all sulfur is bad for electric connectors! Additives containing inactive sulfur protect components against wear and oxidation without tarnishing conductive metal coatings. To learn more about the benefits of connector grease, click here.

Meet Nye - Jeremy Luchies

Meet Jeremy Luchies, Nye's newest Regional Engineering Manager and our in-house bearing expert. With more than eightteen years of experience at leading companies within the bearing industry, Jeremy has in-depth knowledge of bearing designs and their corresponding lubrication requirements. We recently sat down with Jeremy to ask him the most common questions Nye gets about bearing lubrication.

What are the benefits that a lubricant provides to a bearing?

Depending on the application and operating conditions, there are many benefits that a given lubricant may offer, but its' primary purposes are to reduce direct metal-on-metal contact between the rolling elements, raceways and cage to minimize friction and wear. Other benefits of a lubricant can include, dampening, corrosion resistance, wash out resistance, low particle generation, low outgassing, thermal conductance, electrical conductance and assembly aids. However, the ideal bearing lubricant will help a bearing achieve the calculated bearing L10 fatigue life, in hours or revolutions, before experiencing fatigue failure.

Often, lubricants are specified by the bearing manufacturer. What is the downside of this?

Many times, the bearing manufacturer's use "general purpose" greases in their sealed bearings, which may work great for many commercial / industrial bearing applications. However, general-purpose greases may not be ideal for a number of specialty applications that have unique operating requirements. In such cases, it is best to engage directly with the bearing and lubricant manufacturer to help ensure the ideal lubricant is selected. Lubricant manufacturers are always developing new formulation technologies to address unique application challenges, so by engaging with both the bearing manufacturer and lubricant manufacturer, customers will benefit from the latest lubricant technologies available for their new application to maximize bearing life and application performance.

What is one of the most common misconceptions you hear about bearing lubricants?

One of the most common misconceptions about bearing lubricants is that a few drops of oil per bearing row will provide adequate lubrication for many years of service. Service life is largely dependent on the duty cycle, number of cycles required over the life of the assembly, applied loading, operating temperature and environmental conditions.

Lubricating a bearing with only a few drops of oil, with no relubrication frequency or drip applicator, will result in the bearing(s) operating in a mixed-to-boundary lubrication regime. Operation in these lubrication regimes typically results in increased adhesive wear generation between the rolling elements and raceways, which can eventually lead to bearing performance issues and be designated as a "bearing failure".

The calculated bearing L10 fatigue life for a given bearing assumes that the bearing always maintains an adequate lubrication film thickness throughout its' life. However, most bearings fail due to improperly selected lubricants based on the application / operating conditions, contamination issues and or mounting / installation issues. An in-depth bearing failure analysis (FA) by your bearing supplier can be very beneficial in helping to identify potential causes for the bearing failures being experienced, as well as identifying possible resolutions for increased bearing life. An alternate lubricant may be part of the solution and our engineers at Nye can help point you in the right direction.

What common mistakes do people make when lubricating their bearings??

One of the most common mistakes that customers make when lubricating a bearing is not ensuring that the bearing is sufficiently cleaned to remove the preservative oils applied by the bearing manufacturer prior to lubricating the bearing with the specified lubricant. The solvent used to clean the preservative oil out of the bearing must also be compatible with the lubricant being applied. If it is not, then the applied lubricant will not sufficiently wet the bearing internal surfaces and could result in premature lubricant failure.

Another common mistake is determining how much lubricant should be applied to a bearing. The amount of lubricant that is recommended is largely dependent on the application and operating conditions. Most industrial bearings are filled approximately 33% full, whereas a bearing used in a Semiconductor wafer transfer robot may only be filled 5 - 10% full due to their respective operating condition differences. Grease volume for specialty bearings that are used in sensitive applications is typically carefully metered by weight in grams, whereas a large bearing or one that may be less sensitive to lubricant volume differences may be lubricated with a specified volume in CC's.

What is the proper way to lubricate a bearing?

Believe it or not, there is a proper way to apply lubricant to a bearing, especially for applications with very sensitive performance criteria. Lubricant is typically applied manually by a syringe or by a semi-automated lubrication system with appropriately sized tips to carefully meter the specified amount of grease into each bearing. Unless the lubricant being applied is a silicone-based lubricant, the syringe must be silicone-free. The lubricant should be forced into the rolling element path as much as possible while it is being applied because that is where the lubricant is actually needed. Once the specified lubricant volume has been applied, the bearing should be rotated a minimum of 10 to 20 full revolutions to evenly distribute the lubricant within the bearing prior to installation.

What is your favorite part about working at Nye?

As a Regional Engineering Manager at Nye I get the opportunity to work closely with customers in both their new product developments as well as working through identifying solutions to their application problems, which I greatly enjoy and is often personally rewarding. Even though I have worked closely with Nye for a relatively long period of time, I am still learning something new about Nye products and the many diverse applications that we serve every day. This would not be possible without my outstanding colleagues that are always willing to share knowledge and best practices with one another. Our technical team is second to none, and our R&D and Test Lab teams are very creative in their development of new products based on the challenges brought in from the sales team's input from our customer base.

About the Author – Jeremy Luchies

In his eightteen years in the bearing industry Jeremy worked with specialized bearings including those in semiconductor, medical, automotive manufacturing, defense and aerospace applications. Although new to Nye, he has worked closely with Nye lubricants over the past approximately fifteen years with testing and utilizing Nye's Semicon lubricant offerings to maximize specialty ball bearing life under the demanding operating conditions of Semicon robots and process equipment.

Stay tuned for more updates next month!

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