

Biobased Lubricants for Drill Rods

New Product Trends

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Introduction

Drilling Rod greases are employed in mining for drilling core samples or other down-hole drilling operations. The conditions which they are used in are: hot, cold, dry, humid or submerged in water. The lifespan of drill rods can be dramatically increased when coated with a lubricant to reduce friction. The variability in use dictates the desired lubricant properties. Since water is present during drilling, greases that have resistance to water washout are required. Also, lubricants include additives and materials that would increase the density of the product relative to water. To date a large majority of drill rod greases are barium thickened which is known for its superior water washout resistance but also has a heavy metal component. Recently, new environmental guidelines are driving users to give consideration not only to the lubricants that lubricate and protect, but that are also considerate to the environment. The fact that barium is a heavy metal component makes it undesirable in environmentally sensitive areas.



Figure 1. Examples of drill rods that when threaded end to end provide the desired length for drilling depths.

Drill Rod

A drill rod is made from high quality hollow steel pipes of different lengths with opposite male – female threads on each end so it can join other rods of the same diameter. Figure 1, shows an example of drill rods that, when threaded end to end, provide the desired length for drilling depths.

Different geological conditions and complicated underground pressures expose the rod to stresses of pulling, pressing, bending and twisting forces, which require design considerations. Drill rods come in many different diameters depending on the size of the hole being drilled and can range from a few inches to 36" or more with a variety of lengths, wall thicknesses, and threaded or plain ends. Figure 2, shows a drill rod in a hole¹.



Figure 2. Drill rod in the hole readied for the next rod to thread in¹.

Drill Rod Casing

Is special steel tubing screwed or welded together and lowered into a bore hole to prevent collapse of the hole or to prevent loss of circulation liquid coming up from the drill rod into surrounding ground. Drill rods are matched with rod casings. It is easy to visualise that the cooling and cleaning drilling fluid travels down the hollow drill rod and then comes back up from the bottom of the hole in the gap between the drill rod and casing. Thus the grease that is applied to the outer surface of the rod must be able to provide a sufficient level of lubrication, and a balance of adhesion and cohesion to resist being washed off by the fast upward flowing drilling fluid.

Drill Rod Grease Properties

As with most lubricants, drill rod grease serves several purposes. Beyond being lubricants they are secondarily designed to coat and protect the rod from corrosion while in storage. Lack of lubrication would result in high twisting forces (torque), scuffing, pitting, wear, and reduced longevity.

Drill rod greases are often formulated from products that are known to have high resistance to water washout. The components of the grease include base fluids, thickener, and performance enhancing additives. The base oil for manufacturing grease is selected based on the intended end use. For drill rod greases requiring a bodied structure, high viscosity base oils are used. Traditionally, base oils have been

petroleum based. Being of the highest concentration ingredient in the product formula, the base oil requires particular attention. There is an increasing emphasis on environment friendlier base oils derived from vegetable and synthetic oils. High viscosity fluids, such as synthetic polybutenes and PAOs are also employed.

Additives or performance enhancing chemicals are added to the lubricants to enhance desired performance properties. Common lubricant properties include friction modifying chemicals (Anti-Wear and Extreme Pressure additives), corrosion prevention, oxidation resistance, and tackiness enhancers. In addition to being a lubricating substance, the drill rod grease must resist water washout and protect the rod from rust and corrosion. Anti rust additives are designed to provide resistance to oxidation or interaction of the metal with oxygen. Anti-corrosion additives are designed to prevent interaction of chemically corrosive materials with the metal. While oxygen comes from air or process fluids, corrosive materials are often formed due to chemical reactions between various components of the grease and the metal surfaces.

Many lubricant applications are pumped to the moving parts. But, for most drill rod grease applications they are applied manually or by some mechanical means. So, the method of application is taken into consideration in formulation of the grease. Figure 3 shows grease applied to drill rod.



Figure 3. Grease manually applied to drill rod as the rod is lowered into the drilled hole.

Drill Rod Grease

Simply explained, grease is made of soap mixed with lubricating oil; along with selected performance additives. Soaps used for drill rod grease are similar to traditional grease thickener chemistry and not much different than the lye (sodium hydroxide) soap used for hygiene. The most common soaps in drill rod greases today are barium based and some include lithium thickener using lithium hydroxide. The soap portion of any grease by itself is somewhat benign, but the lubricating oil used is the components that can impact biodegradability. Soap based greases tend to harden up at extreme cold temperatures. Sometimes, non-soap greases using organo-clay or silica as thickeners have been used. Those greases may not have the water wash out resistance properties of the soap based products; which could yet be remedied by formulation. By far the most effective grease to resist waterwash out is aluminum complex grease which is often used in food processing applications. Pressure washers are used to wash equipment thus exposing the grease to extreme water washout conditions. As a result, the biobased drill rod grease made with food-grade type aluminum complex thickeners could offer the desired property and match or exceed those of barium greases while reducing the use of heavy metal components.

Due to extreme water flow passing the grease on the rod, the consistency of greases found on the market seems to range from NLGI Grade #2 to Grade #3. The Grade #3 greases are for use in temperate climates.

The following table shows typical properties of a biobased drill rod grease.

Biobased Drill Rod Grease - Typical Properties	
Appearance	Dark Brown
Base Oil	Biobased
Thickener Type	Aluminium Complex
Cone Penetration - Unworked ASTM D-217	245
Cone Penetration Worked 60 strokes ASTM D-217	250
Dropping Point (°C), ASTM D2265	295
Four Ball Wear Scar (mm)	0.4
Four Ball Weld Load (Kg)	500
Corrosion, ASTM D-1743	Pass
Water Spray Off (ASTM D4049)	Less than 5%,
Biodegradability OECD 301F	Pass
Aquatic Toxicity (<i>Daphnia Magna</i>) OECD 202	Pass
Terrestrial Plant Toxicity OECD 208	Pass

Table 1. Typical properties of Biobased drill rod grease².

The most effective biobased drill rod grease tested in the author's manufacturing facility has been a variation of an NSF registered food grade aluminum complex grease. This grease in field trials has shown to be near fully recoverable from the rods when they are pulled out of the drilled hole. In some cases by using a rod wiper, the used grease could be recovered for possible reuse.

Environmental Considerations

There are greases that are considered environmentally friendly and are called environmentally acceptable or environmentally considerate. Some claim environmental friendliness primarily based upon biodegradability performance. Today, there are guidelines by various organisations such as the European Union's Ecolabel, Germany's Blue Angel, or the Nordic Swan Ecolabel. In 2013 the U. S. Environmental Protection Agency required the Vessel General Permitting for use of non-bioaccumulative lubricants on ships. But, one of the most desired certifications in the US comes from the designation of Biobased in a program administered by the US Department of Agriculture. Under the designation of Biopreferred Program, government purchasers are required to give preference to purchasing products that meet the designation of Biobased. This designation is based on a requirement of the presence of a minimum amount of Renewable Carbon in the product. A simple carbon dating test is performed using the ASTM D6866 - 12 "Standard Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis". In this designation, the emphasis is on promoting the use of renewable products.

Conclusion

The Vessel General Permit requirements as required by the US Environmental Protection Agency, has created a new impetus for rethinking the use of conventional lubricants. There has been significant progress in developing products that are non-bioaccumulative and would meet the VGP requirements. More importantly, the VGP requirements have led to the development of other environmentally friendly greases including those for drill rods, rail curve and truck uses where product is released directly into the environment.

References

1. http://www.holeproducts.com/userfiles/files/hp_global_catalog%282029%29.pdf – downloaded April 15, 2016
2. Source: Environmental Lubricants Manufacturing, Inc. www.elmusa.com

LINK
www.elmusa.com