Significance of Grease Water Resistance in the Determination of Lubrication for Industrial Machinery

Faaiz Kamal[1,2] , Raj Shah[1], Stanley Zhang[1,2], Blerim Gashi[1]

1. Koehler Instrument Company, Inc., Holtsville, NY 11742, USA
2. Department of Materials Science and Chemical Engineering, Stony Brook University, Stony Brook, NY 11794, USA

Overview

Lubrication is a necessary component in the successful operation of industrial machinery. The two main types of lubrication are oil and grease; oil is optimal for lubricating high speed equipment that can be easily accessed, while grease is used for machinery that is not easily accessible for frequent lubrication. Grease is generally preferred as a lubricant as it can contain additives that prevent decay in environments with extreme speeds or large contact loads. However, the efficacy of grease-lubricated components depends on the ability of the grease to resist water washout. Typically, an ingress of water displaces the lubricant and meets the surface of the bearing, causing corrosion. Meanwhile, the lubrication itself is subjected to rheological and chemical changes, resulting in a degradation of grease performance and lifespan.

Figure 1

Figure 1 displays an industrial calcium sulfonate grease with differing amounts of water content: 0% (left), 1% (middle left), 10% (middle right), and 50% (right). The presence of water can spur hydrolysis, which significantly alters the composition of a grease, causing a break down in anti-wear and extreme-pressure additives, as well as decreased [1]. Thus, a decrease in grease functionality will result in bearing failure, leading to a breakdown of the overall machine. Due to the described interactions, it is imperative to consider water repellency when determining what grease to use in bearings and other containment devices, especially for equipment used in food production, aviation, and steel/paper mill industries.

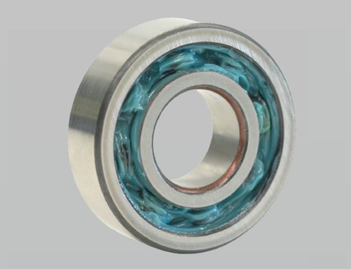

Figure 2. Typical bearing lubricated with an industrial grease.

Methodology

Regarding the water resistance of a grease, there are a variety of standardized tests that replicate grease-water interactions; among others, the water-washout test (ASTM D1264) is a common test that inadvertently tests water retention in addition to water resistance, making it optimal for discerning water resistance characteristics. The test involves initially weighting a grease-lubricated bearing, spraying it with a steady stream of water for a set period, and then recording the final weight. The percentage of grease that is lost is recorded as a characteristic of water resistance. In practical uses, the water washout method can be used as a comparison metric for greases when considering modifications to the grease to improve versatility in heavy-load, high pressure, or wet environments. Modifications may include a change in the base oil of the grease, or applying additives such as polymers, nanoparticles, or those that assist with corrosion and extreme pressure.

Instrumentation

Figure 3. Koehler's Water Washout Tester (left) and bearing housing for grease to be tested (right).

The K19201 Water Washout Tester is a device that utilizes the water washout method, conforming to ASTM standards D1264, D4950, and other related standards. The device operates by rotating a ball bearing lubricated with the grease of choice at 600rpm, while spraying a steady stream of water at the bearing. The K19201 offers the customizability to specify flow rate with an analog dial. Additionally, the bath reservoir temperature is displayed on an LED screen, included with buttons to set the desired temperature. Water washout testing can be initiated automatically with the press of a button. Thereafter, the percentage of grease washed out (by weight) over a one-hour period is recorded. The Water Washout Tester is a versatile instrument that can be used to characterize and compare water resistance characteristics for a variety of greases.

Data Analysis

Tests	Pure paraffin grease		SiO_2 doped paraffin grease	
Cone penetration (1/10 mm)	Unworked penetration	Worked penetration	Unworked penetration	Worked penetration
	358	372	361	377
Drop point (°C)	201		200.5	
Evaporation loss (%)	3.14		3.18	
Leakage loss (%)	26.85		26.40	
Water washout (%)	42.0		41.8	

Table 1. Test results for various physical characterizations of paraffin grease.

Grease Type	ASTM D217 Grease Consistency	ASTM D445 Base Oil Viscosity 40°C	Water Washout ASTM D1264 79°C	
			Polymer 1	Polymer 2
Simple Li Soap	320 cSt	8% loss	5% loss	5% loss
Li/Ca Soap Mixture	320 cSt	6.4% loss	2% loss	2.1% loss
Li Complex	320 cSt	6.5% loss	4.4% loss	4.5% loss
Ca Sulfonate Complex	320 cSt	4.29% loss	1.97% loss	2.1% loss

Grease Type	ASTM D217 Grease Consistency	ASTM D445 Base Oil Viscosity 40°C	Water Washout ASTM D1264 79°C
Simple Li Soap	274 mm/10	150 cSt	12% loss
	274 mm/10	220 cSt	9.5% loss
	274 mm/10	320 cSt	8% loss
Li/Ca Soap Mixture	276 mm/10	150 cSt	10% loss
	276 mm/10	220 cSt	8% loss
	276 mm/10	320 cSt	6.4% loss
Li Complex	275 mm/10	150 cSt	10% loss
	275 mm/10	220 cSt	8% loss
	275 mm/10	320 cSt	6.5% loss
Ca Sulfonate Complex	276 mm/10	180 cSt	6.8% loss
	276 mm/10	220 cSt	8% loss
	276 mm/10	320 cSt	4.29% loss

Table 2,3. Water washout comparison of multiple grease types with polymer additives (left) and differing base oil viscosity (right).

As discussed, the water washout method can be used as a comparative assessment of water resistance for grease additives. Rawat et al. [3] studied the effects of silica nanoparticles as an additive to paraffin grease (Table 1). Water washout percentage was used as a tribological property to assess the water resistance of pure paraffin grease versus silica paraffin grease; silica additives were found to have no significant impact on the water resistance of the grease In another study, Johnson et al.[2] tested the effects of polymer additives and base oil viscosity on water resistance, finding that the addition of polymers significantly increases the water resistance of the grease; in addition, a more viscous base oil demonstrated a greater resistance to water washout.

Conclusion

To assess the durability of grease-lubricated components, there is often a need for thorough consideration in the choice of grease. The K19201 simulates practical grease-water interactions such as those found in steel or paper mills. Thereafter, additives can be considered to amplify the desirable properties in a grease, while determining if there is any significant effect on water resistance.

References

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