Improper Lubricant Selection: A Slippery Slope

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Summary

1.0 Introduction

In an industrial setting, lubrication may seem to be a small part of a comprehensive preventive maintenance program. However, lack of proper lubrication may play a big role in equipment downtime.

Lubricants separate the working surfaces of electrical equipment. They prevent metal-to-metal contact, which reduces friction and wear. If a piece of electrical equipment fails, it is very possible the failure could have been caused by insufficient or improper selection of circuit breaker lubrication. It is estimated that as many as 60 to 80 percent of all bearing failures are lubrication-related.

Choosing and applying the correct lubricant to circuit breakers plays a key role in the proper maintenance of electrical distribution equipment. It is important to follow the OEM's lubrication specifications. If the recommended lubricant is no longer available, select a substitute lubricant based upon the specific application of the equipment.

In addition to enhancing equipment reliability, a comprehensive preventive maintenance program (that includes the proper selection and application of lubrication) promotes workplace safety. Equipment breakdowns may put workers in harm's way to troubleshoot or repair the equipment. Planned maintenance activities provide fewer opportunities for workers to improvise.

In an industrial setting, the choice of lubricants cannot be arbitrary.

2.0 Types of Lubrication for Electrical Equipment

The role of lubricant is very important for electrical equipment to function properly. Lubricants separate the working surfaces and prevent metal-to-metal contact which reduces heat-producing friction. Overheating in electrical enclosures can shorten the life of the equipment or worse, lead to costly downtime. Lubricants also shield the equipment's surfaces from contaminants and corrosive environments.

There are several types of lubricants:

• **Oils** cover a broad class of fluid lubricants, each of which has particular physical properties and characteristics. Petroleum oils (mineral oils) are made from naphthenic or paraffinic oils. Naphthenic oils contain little wax and their low pour point makes them good lubricants for most applications. Paraffinic oils, on the other hand, are very waxy, which makes them useful for hydraulic equipment and other machinery.

• **Greases** are ideal for lubricating bearings, gaskets, seals and other moving parts. They consist of oil or synthetic fluid (~80%), a thickening agent (~10%) and additives (~10%). The National Lubricating Grease Institute (NLGI) developed a scale for ranking greases by their relative hardness. The softest greases are rated at 000 (which is a flowing liquid) with higher numbers indicating harder grease. Most grease falls in the range between 1 and 4.

• **Solid lubricants** are usually fine powders, such as Molybdenum Disulfide (Moly), graphite and Teflon® (PTFE). They can be used alone or as additives in grease or dispersions, or as dry film bonded lubricants. Lubricating solids can last longer than unfortified oils and greases because of their ability to form burnished films on surfaces.

3.0 Lubrication Recommendations for Circuit Breakers

Choosing and applying the correct lubricant to circuit breakers, while often overlooked, plays a key role in the proper maintenance of electrical distribution equipment. The selection and application of lubrication should be according to the original equipment manufacturer's specification. This may be a difficult task for plant engineers trying to maintain aging equipment with recommended lubricants that have become obsolete. In such cases, you must choose based upon the application and physical properties of available lubricants.

Trying to find suitable replacements for discontinued lubricants can be time consuming, and carrying too many lubricants in stock can be costly. Lubricant manufacturers can provide technical data sheets on their products to advise you on the best applications of each type of lubricant. Schneider Electric Services has also published a comprehensive Lubrication Guide that covers electrical distribution equipment for most major manufacturers.

The OEM's recommendation (or suitable substitute) is only one factor to consider in product selection. The lubricant's characteristics must also be suitable for the operating conditions. Grease (not oil) is most often used in circuit breakers because the thickening agent and additive used in grease helps it 'stay put'. This is because circuit breakers:

1) Do not run continuously and parts can stay inactive for long periods of time.
2) Can be inaccessible for frequent lubrication; a quality grease can last for extended periods of time.
3) Are often exposed to high temperatures, shock loads or fast speed under heavy load.

Circuit Breaker Lubrication: Troubleshooting Guide

Application	Symptom	Possible Cause	Check for
Bearings: Rolling	High bearing temperature or excessive leakage Frequent bearing replacement	Incorrect product or grease incompatibility Excessive wear	Incorrect EP and/or viscosity, temperature range Incorrect EP, base oil too thin, insufficient grease
Bearings: Plain	Overheating Excessive wear	Improper distribution Incorrect grease Incorrect grease	Grease is too stiff, insufficient grease, base oil too thin Mechanical stability grease in service Incorrect EP, temperature range
Gears: Enclosed	Excessive leakage Overheating Wear and scoring	Grease too soft for application, high temperature Lack of lubricant Incorrect product	Product penetration, milling down of product, mixture of greases Grease too stiff, base oil too thin Consistency, incorrect EP, base oil viscosity
Gears: Open	Gear wear Build-up on gears or in roots	Lack of lubrication Excessive lubricant contamination	Incorrect lubricant
Sliding Surfaces	Non-uniform motion (stick-slip)	Lack of lubricant	Incorrect lubricant
Universal Joints	Excessive wear	Insufficient lubrication	Incorrect EP, high T qualities, slumpability
Couplings	Dry coupling Hardened grease Excessive wear	Excessive grease leakage Centrifugal separation Incorrect product	Grease consistency, stability Improper grease quality Grease EP
Centralized	No grease to point of application High system pressure	Depleted reservoir Grease consistency too hard	Improper lubricant Product recommendation; pressure on grease when not dispensing
High T	Noise-high wear Excessive leakage Grease hardening	Lack of lubrication, improper grease, incompatibility of greases Improper grease	Type of grease in service, thickener type. base oil viscosity, consistency of greases, mixture of grease Oxidation stability of grease, thickener type, grease mixture
Low T	Component motion restricted Difficult application Freeze-Up	Incorrect grease Incorrect grease Water in system	Grease torque quality, base oil viscosity Pumpability qualities, viscosity, consistency Lubricant ability to absorb/shed water

Source: Schneider Electric Lubrication Manual (6th Edition)

4.0 Temperature Limitations

Grease has a temperature range at which it can effectively be used. When heated, the consistency of most grease will change very slowly until a certain critical temperature is reached. At this point the gel structure breaks down, and the whole grease becomes liquid. This critical temperature - which should not be exceeded - is called the **drop point**. When heated above its drop point and then cooled, grease usually does not retain its original properties which could compromise its intended function. The **minimum temperature** is the point where the grease stiffens or becomes too hard for the bearing (or other component) to be used. The base oil of the grease determines the minimum temperature; for low temperature service the base oil should have low viscosity.

Synthetic greases can last a lifetime, making them very cost-effective. They are chemically inert, and their high thermal stability makes them useful for aerospace, electrical, automotive and other high-tech or industrial applications. Some of these lubricants keep their viscosity in temperatures ranging as high as 550° F and are nonflammable up to 1,200° F.

5.0 Consequences of Using the Wrong Lubricant

Improper (or Lack of) Lubrication Affects Equipment Reliability

To illustrate the importance of proper lubrication, consider this everyday analogy. Failure to perform the routine, inexpensive task of changing the oil in your car every 3,000-5,000 miles could lead to major, costly repairs. In an industrial setting, lubrication may seem to be a small part of a comprehensive preventive maintenance program. However, lack of proper lubrication may play a big role in equipment downtime. In his article, "What Exactly is a Lubrication Failure?" (www.machinerylubrication.com) Mark Barnes states that "as many as 60 to 80 percent of all bearing failures are lubrication-related, whether it's poor lubricant selection, poor application, lubricant contamination or lubricant degradation. Many components are failing early because lubrication best practices have not been established."

Customer's Financial Impact Due to One-Hour's Production Shutdown

Application	Loss (*)
Health establishment	Human Lives
Stock market transactions	$12,600,000
Credit card sales	$3,600,000
Petrochemical	$140,000
Plane ticket booking system	$125,000
Mobile phone network	$60,000
Automobile	$40,000
Pharmaceutical	$40,000
Food processing	$30,000
Cement	$20,000

(*) Direct and indirect costs of non-availability

Source: Contingency Planning Research & Schneider Electric

Improper (or Lack of) Lubrication Affects Workplace Safety

A common cause of accidents is workers being placed in harm's way. Consider the following scenario.

A piece of equipment breaks. The maintenance worker may have to enter a confined space, be exposed to dusty, cluttered or moist environments and may not have the proper tools to repair the equipment, i.e., improvise. Planned maintenance activities allow fewer opportunities for the maintenance worker(s) to improvise. Exxon-Mobil conducted a study on maintenance-related accidents. The findings revealed a higher incidence of accidents (5 x greater) when working on equipment failures than on planned corrective jobs.

Well-maintained equipment promotes workplace safety. One of the requirements to comply with NFPA 70E: Standard for Electrical Safety in the Workplace® (2012 Edition) is to maintain all electrical distribution system components. NFPA also recommends adopting NFPA 70B: *Electrical Equipment Maintenance* (2010 Edition). This standard provides guidelines for developing and implementing a preventive maintenance program.

Because arc flash incident energy can only be controlled by the devices in a system (circuit breakers, fuses, protective relays), the condition and maintenance of these components becomes very critical. If the device is not in good or well-maintained condition, the opening times can vary considerably from the original trip curve. In some cases, poorly maintained devices will not open for any reason and the incident energy during an arc flash event will become unpredictable. When electrical equipment is properly maintained, the electrical system study and arc flash analysis better represent the potential performance of the power system.

6.0 Conclusion

A preventive maintenance program that includes the proper selection and application of lubrication will help extend equipment life and promote workplace safety. It is extremely important to note that any specific maintenance of separate pieces of electrical equipment does not guarantee a completely coordinated power distribution system. A comprehensive preventive maintenance and testing program should incorporate all electrical power distribution equipment, regardless of the manufacturer, to ensure that all electrical equipment and components operate as originally designed and intended.

Important terms to know when selecting the proper lubricant:

Viscosity is a measure of flowability. It is the resistance to flow caused by internal friction between the lubricant molecules. In selecting a lubricant for a particular application, definition of required viscosity level during start-up and operating conditions is critically important to ensure optimum lubricant performance.

Viscosity index indicates how viscosity varies with temperature. This can be an important consideration in applications where operating temperatures vary widely, particularly when low temperatures are encountered.

Pour point is the lowest temperature at which oil flows and is most critical in low temperature applications. Wax crystals may form and cause flow failure in paraffinic oils.

Flash point is the temperature at which oil gives off ignitable vapors.

Fire point is the temperature at which oil will burn if ignited.

Drop point is the temperature when the gel structure of grease breaks down and becomes liquid. When grease is heated above its drop point and then allowed to cool, it usually does not regain its original properties.

Synthetic lubricants cover a broad category of oils, greases, and pastes of varied properties. Synthetic lubricants are more inert, generate less waste, are capable of a wider range of temperatures and have a longer life than petroleum materials.

Minimum temperature is the point where the grease stiffens or becomes too hard for the bearing (or other component) to be used.

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