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Lubrication for Industrial Collections

Introduction

Many industrial artifacts have moving metal parts such as axles, pistons, and crankshafts. Keeping these parts movable helps to preserve the objects and allows interpreters to demonstrate their mechanical movements, either by hand or under power.

Movable parts have two enemies: metal-to-metal contact and moisture. The former causes scoring and wear of the parts when they move, and the latter causes unprotected surfaces to corrode and fuse, making the machine inoperable.

What is Lubrication?

Lubrication is the introduction of a film of oil or grease between the moving parts. The lubricant separates and cushions the parts, allowing the surface irregularities to slide over each other without touching. This reduces wear and allows the parts to move smoothly. At high operating speeds, oil also helps to dissipate a certain amount of heat. Equally important, lubricants prevent corrosion: they contain corrosion inhibitors and they form a physical barrier against moisture.

Moving Parts in Contact

Moving parts are subject to either **sliding** or **rolling** contact.

Sliding contact occurs with shafts (journals) rotating in simple bearings (called *plain bearings* or *bushings*) and in reciprocating and meshing parts. Sliding parts usually involve relatively large surface areas.

Rolling contact occurs mainly with shafts rotating on ball-and-roller bearings (called *antifriction* bearings). These are more complex than plain bearings, with hardened parts that have been ground and polished to close tolerances. The surface areas involved are quite small but they can be ruined by even a small amount of corrosion. Antifriction bearings are usually protected from the environment by external coverings, or housings, that have felt or leather seals.

Oil and Grease

As a rule, **oil** is used to lubricate fast-moving parts and parts with close tolerances. Regular operation keeps the working surfaces coated

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and protected. By contrast, **grease** (which is oil thickened with metallic soap) is used on slower moving parts, often with loose tolerances and at much lower temperatures. Grease stays in place because of its heavier body and its 'stickiness'.

Problems with Oil

When a machine stops operating, two things happen:

1. the layer of oil is slowly squeezed out by the static load of the parts; and
2. the oil flows away from the areas where it is needed the most.

The latter action is aggravated by hot weather, which warms and thins the oil (making it less viscous). In both cases, metal-to-metal contact can occur. The longer the period of rest, the greater the wear when the parts are eventually moved. In addition, the thinned layer of oil offers less protection from moisture, so corrosion is more likely to occur. This is most common inside closed cavities such as engine crankcases, where the water vapour produced during operation condenses as the machine cools down.

Because oil is runnier than grease, it also tends to leak more. This is common with older machines that have antifriction bearings with imperfectly sealed housings.

Choosing a Lubricant

Selecting the right lubricant depends on how the object will be used and under what conditions. There are three common scenarios for machinery in museum settings.

1. Static display with no planned movement

Use grease or rust-preventive coatings for this type of display. Rust-preventive coatings are formulated to stay in place and are usually less tacky than oil and grease. They also serve as a lubricant until real lubricating oil can be introduced. This is important. Even static objects may have to be moved at some point: during set-up or tear-down of an exhibit; in an emergency (flood, fire, etc.); or at the hands of unsupervised visitors. A lubricant must be present to prevent wear or damage in these unexpected situations. It must also offer protection against corrosion at all times.

2. Occasional movement by hand (low speed, low temperature)

Occasional movement requires a lubricant that will stay in place during long rest periods. Use high-viscosity lubricant on sliding parts, i.e. one class higher than recommended for full running (e.g. SAE 20W-40 rather than 10W-40; see explanation under "Weather Conditions"). Thicker oil will support the load on a plain bearing for a longer period of time. With old machines, it will also provide more separation between worn and rough surfaces. Although higher-than-recommended viscosity could cause overheating of the parts at full operational speed, this will not occur with machines operated in slow motion by hand.

With antifriction bearings, a soft grease will offer more protection than an oil because it will stick to the metal surfaces longer. It will also leak less than oil if the bearing seals are not tight. At low speeds, substituting grease for oil will not interfere with the movement of the bearings.

Note: Intermittent, slow-motion operation of machines in museums is not a normal operating situation. As such, it has never received much attention from manufacturers or mechanical engineers. There is no clear evidence that it either benefits or harms the moving parts. It may eventually lead to wear, simply because the lubricants are cold and they are not distributed as efficiently as in full operation.

3. Fully operational (regular running at high speed, high temperature)

Full-speed operation demands constant and thorough lubrication. Follow the instructions in the machine's original trade literature or the manuals for a similar machine. These will indicate which parts should receive the most attention while assuming the operating conditions are severe. Update the recommendations with modern products, i.e. substitute petroleum products for vegetable or animal-based oils and greases such as tallow or lard (which can become rancid and acidic, leading to corrosion).

Do not skimp on fresh oil and grease — these are much cheaper than repairing or replacing worn parts. With any machine, try to limit cold starting, extended periods of idling, and periods of inactivity longer than 5 days.

Weather Conditions

It is common knowledge that cold weather makes a lubricant thicker and hot weather makes it thinner. Try to balance these tendencies with the operation of the machines, especially in transitional periods like spring and fall. For example, a bitterly cold morning in fall will be hard on a machine that is lubricated for summer conditions. It would be better to delay running the machine until mid-afternoon.

Motor oil is rated for how smoothly it flows in different seasonal temperature ranges. Low-viscosity (thin) oil is recommended for cold conditions to make starting easier and to spread the film quickly. High-viscosity (thick) oil is recommended for warm conditions to minimize the flow of lubricant film away from hot metal parts.

Oils are classified by the Society of Automotive Engineers (SAE) to indicate viscosity, or thickness. The lower numbers such as 5W and 10W indicate the oil will flow at low starting temperatures (the 'W' stands for 'winter'). Higher numbers such as 20W indicate thicker oil. Most motor oils are now multigrade, meaning they operate over a wide range of temperatures. They have SAE numbers such as 10W-30, meaning they are appropriate for cold starting and hot running temperatures.

Industrial greases are classified according to the average operating temperature of the bearing and the speed of the revolving journal. If the artifacts will only be operated slowly, e.g. by hand, select the lubricants based on low operating speed (RPM) and medium operating temperature (30–60°C). Avoid low-temperature lubricants (0–30°C range) in warm weather; they will be too soft and will flow away from the bearings.

The best all-purpose grease for both plain and antifriction bearings is lithium soap grease. It has good resistance to water and oxidation and it is stable over a broad temperature range.

Oil Additives

Since the late 1930s, motor oils have contained various chemical additives, e.g. corrosion inhibitors, antioxidants, and detergents. These are intended to slow down oxidation and carbon build-up in engines operating at high temperatures. They have little effect on objects that operate at low speeds or temperatures. Detergents are included to keep carbon and sludge in suspension, but some operators believe they attack the gaskets and seals of vintage machines (pre-1930s). If this is a problem, non-detergent oils are available. These are virtually pure mineral oil, with no additives; however, because no corrosion inhibitors are present, non-detergent oils offer less protection against corrosion.

Applying Lubricants

Before applying fresh lubricants, it is important to flush out all traces of dirt, rust, hardened grease, and contaminated oil. The best approach is to disassemble the machine and clean the parts thoroughly by soaking and brushing them in a solvent-based parts washer. The next best procedure is to bathe and brush the parts in place with solvent, keeping a drip-pan underneath.

Remove all grease pressure fittings (Zerk or Alemite), flush them thoroughly, and re-install them. With unsealed housings, force new grease into the fittings until all the old grease is squeezed out and clean grease appears. Apply fresh grease to open parts such as gears and ball bearings with a clean paintbrush, spatula, or gloved fingers.

Warm weather helps to distribute the lubricants. In cool conditions, consider using a hot-air gun or hair dryer to warm up the parts first.

Deterioration of Lubricants

Under normal operating conditions, lubricants such as motor oil are attacked by heat and contamination. The contaminants in this case are combustion products such as water, acids, carbon, and unburned fuel. These factors do not apply in static conditions, where deterioration is mainly the result of very slow oxidation.

The lubricants in open bearings and gears can be contaminated with dust and dirt, which mix with the oil or grease to form an abrasive paste that rapidly wears away the contacting surfaces.

Maintaining Lubricants

Maintaining lubricants requires ongoing vigilance and labour. As suggested above, use the machine's operating instructions as a guide. These instructions were written for severe operating conditions, and will provide a wide margin of safety for museum operations. Turn down the grease cups and check the oil levels regularly. Keep a record of lubrication, especially if there are frequent changes in staff or volunteers who operate the machines.

Above all, monitor the condition of the lubricants. Make it part of a daily routine. Look for dirt particles in the grease, and contaminants and sludge in the engine oil. Listen to the machine for squeaks, chattering, or grinding sounds when it moves. Watch for leaks or excessive oil consumption. Make a note when parts start to resist movement or become excessively hot. All of these observations indicate a serious problem with the lubricants that must be remedied. An ounce of prevention goes a long way. By the time you hear the noise or feel resistance to movement, some damage may already have been done.

Conclusion

Choosing and applying the correct lubricants can be a challenge, especially when occasional movement or static display is involved. The key is to apply fresh lubricant liberally and often. Do this, and your operation will run like a well-oiled machine.

Additional Information

For more information about lubricants, refer to the following Web sites.

Shell Lubricants
http://www.shell-lubricants.com/

Dixon Industrial Graphite Lubricants
http://www.dixonlube.com/

Alemite Corporation
http://www.alemite.com/

Copies are also available in French.

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