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Filtration Plays Vital Role in Oil Cleanliness

Introduction

Cleanliness of lubricating oil is imperative to the reliable operation of many types of lubricated components such as bearings, gears and hydraulics. Clean oil can enhance the reliability and service life of equipment, while dirty oil can lead to problems such as wear, corrosion, sluggish operation or even failure. This Techni-Tips publication explains the important role that filtration plays and identifies different methods to effectively keep lubricating oil clean.

Particle Contamination

Typical contaminants include dirt, process material and water. To avoid abrasive wear, the film thickness of the lubricating oil needs to be greater than the particle size. Table 1 shows typical film thicknesses for various equipment components.

Typical Film Thickness for Various Equipment Components

Component	Film Thickness
Rolling Bearings	0.1 to 1 µm
Gears	0.1 to 1 µm
Gear Pumps	0.5 to 5 µm
Piston Pumps	0.5 to 40 µm
Servo Valves	1 to 60 µm
Journal Bearings	5 to 50 µm
Actuators	50 to 250 µm

Table 1

In general, OEM filters are not designed to remove sufficient particles due to concerns with restricted flow and pressure drop across the filter via in-line systems. For that reason, it is often beneficial for end users to install an off-line kidney loop type filtration system using dedicated filter carts or permanent filtration units. They are either connected by quick-connect fittings or hard-piped into the lubricant reservoir or return line. These filtration methods are effective at preventing contamination ingression because they limit exposure of the lubricant to atmospheric conditions.

Filters selected to remove the majority of fluid film thickness sized particles are usually the most beneficial. A beta rating of at least 200 for the desired particle size is usually sufficient. It must be kept in mind, however, that too fine of a filter may not be cost-effective because of the possibility of clogging, which requires frequent filter changes. The viscosity of the oil must also be kept in mind when selecting filtration elements because it can have a drastic effect on the flow rate of the lubricant across the filter, especially at cold temperatures. Filtration elements that allow practical flow rates should be selected in order to allow the sump to circulate several times through the filter.

A good rule of thumb is to circulate the reservoir volume through the filter seven to 10 times for efficient removal of particles. When using an oil analysis program, particle counts should be trended and results recorded over multiple test periods in order to show patterns and better determine action plans. Warning and action limits should be established on critical pieces of equipment to develop appropriate filtration schedules. Table 2 shows typical cleanliness targets for various types of equipment.

Water Contamination

Water contamination in the oil promotes both rust and sludge by reacting with oil additives and metal surfaces. It can also accelerate wear by reducing the film strength of the lubricating oil in the load zone.

In order to prevent moisture ingression, desiccant breathers should be installed on storage tanks or equipment reservoirs to prevent them from breathing in wet air. Dry air headspace purges can also be an effective method of preventing moisture ingression. Sight glasses with petcock valves can be installed to remove moisture as it settles to the bottom of the reservoir.

In addition, water removal filtration elements are available for installation on filter carts and permanent filtration systems.

Recommended Target ISO Cleanliness Codes

Component	Pressure		
Pumps	**< 2,000 psi**	**2,000-3,000 psi**	**> 3,000 psi**
Fixed Gear/Vane	20/18/15	19/17/14	18/16/13
Fixed Piston	19/17/14	18/16/13	17/15/12
Variable Vane	18/16/13	17/15/12	n/a
Variable Piston	18/16/13	17/15/12	16/14/11
Valves			
Check Valve	20/18/15	20/18/15	19/17/14
Directional	20/18/15	19/17/14	18/16/13
Flow Control	20/18/15	19/17/14	18/16/13
Proportional	17/15/12	17/15/12	16/14/11
Servo	16/14/11	16/14/11	15/13/10
Actuators			
Cylinders, Vane Motors, Gear Motors	20/18/15	19/17/14	18/16/13
Piston Motors, Swash Plate Motors	19/17/14	18/16/13	17/15/12
Hydrostatic Drives	16/15/12	16/14/11	15/13/10
Bearings			
Journal	17/15/12	n/a	n/a
Industrial Gearboxes	17/15/12	n/a	n/a
Ball Bearings	15/13/10	n/a	n/a
Roller Bearings	16/14/11	n/a	n/a

Table 2 | Source: www.hydacusa.com

Top-Off Containers

Improper dispensing of new oils into top-off containers is one of the primary sources of contamination. Proper techniques and tools must be used to ensure your new filtered oil is transferred to the top-off container with minimal exposure to atmospheric conditions. If proper techniques are not used in this area, all of the other filtration and contamination control efforts to ensure storage and in-service lubricant cleanliness would have been wasted. However, if proper techniques are followed, equipment and fluid reliability and service life should be significantly increased.

Best practice guidelines are that oil should be filtered as it is transferred from bulk storage containers to handheld portable top-off containers. There is more than one way to accomplish this. Some storage systems have dedicated pumps and filters for each tank that allow oil to be filtered as it is dispensed. When transferring oil from a drum, the best practice is to use a drum adapter kit and either a filter cart or drum topper filtration unit. Options for filtering oil out of totes include tote dispensing racks and fluid handling carts using quick connects to assure minimal exposure to atmosphere. Both of these options include their own pumps, filters and hose reels for quick and easy filtered oil transfer. Further, the fluid handling cart can be used to filter the oil during filling and during dispensing, and can be used as a kidney loop filter. These options make it simple to filter the oil as it is transferred from storage into different pieces of equipment, and can be color coded and labeled to ensure accurate lubricant identification.

Summary

Lubricants should be treated as assets. When managed and maintained properly, lubricants can help improve any maintenance program. Several methods of contamination control are available; the right combination of these solutions can dramatically enhance equipment reliability, lengthen service life, and increase lubricant performance. The reduction and elimination of particle and water contamination and increased reliability of equipment translates to less unscheduled downtime, improved maintenance efficiency, and overall increased profitability.

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