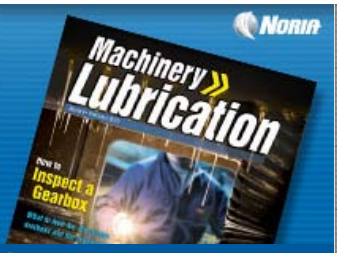
A Noria Publication
Machinery Lubrication



How to Flush Gearboxes and Bearing Housings

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Tags: oil flushing

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Gearboxes and bearing housings periodically need a thorough flushing rather than a simple drain and fill. Several signs point to this requirement, such as overheating of the sump, gross liquid or solid contamination, and development of a severe wear pattern. Material evidence in the form of sludge, rust, moisture, wear metals, gel or other viscous residue that is present at the beginning of the drain should confirm to the technician that a flush is in order. A thorough flush is also useful for removing construction and assembly contaminants from equipment sumps prior to commissioning.

With these factors in mind, what constitutes a thorough sump flush? Are there any particular problems that the operator should be careful to avoid? What equipment can or should be used for this purpose? Finally, what items should be included in a detailed flushing procedure?

Flushing

Flushing is a clean fluid circulation process designed to remove water, chemical contaminants, air and particulate matter (not fixed to surface) resulting from construction, normal ingression, internal generation or component wear.

Flushing can be useful in many different circumstances, such as the following:

For new or rebuilt machines to remove contamination resulting from manufacture, service or overhaul. The fluid system can be contaminated due to dirty assembling elements, corroded surfaces, water, oxidation products and incompatible elastomers such as seals, sealants and coatings. Also, during the assembly process, dirt is ingested and debris is generated due to threading, joining, welding, etc.

For in-service machinery after an oil change due to heavy fluid contamination, component failure, extremely degraded lubricant (oxidation), or if a system flushing has not been performed in the past three years.

For gearboxes and bearing housings that are not fitted with filtration, flushing is required to remove contamination and sediment. Water, rust, excessive wear debris, sludge, varnish or lacquer, and hard-to-open drain ports suggest system contamination and indicate the need for a thorough flush. Ten percent of the old contaminated or depleted lubricant may be enough to use up most of the additives of the new oil.

What Flushing Removes

Material attached to contact or noncontact surfaces that may be harmful to lubricants or critical working surfaces is generically called soil. Soil may be composed of material that is generated internally, such as varnish, carbon deposits, chemical residues, sludge and rust; or material that is generated externally, such as scale, welding slag, rust, machining swarf and

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metal debris.

Soils may be mechanically or chemically removed. Flushing is a type of high-pressure, high-flow fluid circulation used to generate physical movement of contaminants. As the pressures/flow is used for flushing, circulating clean fluid in the system cannot clean rust and scale from the piping, deburr machined elements or remove flux or weld slag.

Flushing Methods

Three levels of system flushing are practiced, depending on the machinery internal conditions and type of contaminants compromising the system. Figure 1 provides a summary of different flushing approaches that may be used and various circumstances and criteria associated with each method.

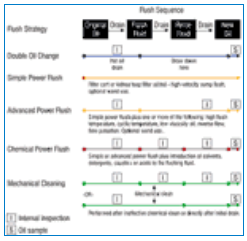

Figure 1.

Recirculation cleaning – The recirculation of clean fluid at a high velocity to achieve a turbulent flow helps remove contamination from the fluid system.

Power flushing - A variation of recirculation, where the oil level in the sump is reduced and a high-velocity fluid is applied to mechanically dislodge, lift and entrain particulate debris. Power flushing suspends and transports particles; absorbs air, chemical products and water from the system; and releases the contaminants to a filter.

Wand flushing - A wand attached to one of the cart hoses is used to discharge at high pressure (kicking up adherent debris). The flow is then reversed and the wand vacuums the sediments.

Solvent cleaning – The use of solvents to remove organic deposits that cannot be removed by recirculation. Solvent cleaning may incorporate the use of organic (hydrocarbon-based) halogenated, nonhalogenated and blends solvents (type A-1 cleaners such as kerosene, or A-2 cleaners such as naphtha and Stoddard solvent are common) to dissolve heavily crusted or layered carbon residues.

Organic solvents tend to be blends of aliphatic and aromatic hydrocarbons and dissolve soil as opposed to emulsifying soil. These materials may be warranted if evidence of heavy carbonaceous residue exists.

Chemical cleaning – The use of chemicals that can dissolve inorganic components. Chemical cleaning may incorporate the use of aqueous alkali or acid solutions to accomplish the desired result.

Regardless of the flushing compound/fluid selected, unless it is identical to the lubricant used following the flush, it is important that all of the flushing fluid be removed from the sump prior to final fill. Some petroleum solvents with a concentration of five percent can create an appreciable thinning effect on the lubricant viscosity.

Factors for Effective Flushing

Fluid Properties. Fluid solubility and hygroscopic characteristics influence removal efficiency of water, air and chemical contaminants. Most oil companies supply special flushing fluids (rust-inhibited oils with good solvency power) that demonstrate the following desirable properties:

- compatible with system components and lubricating fluid
- noncorrosive to machine components
- low viscosity (lower than the lubricating oil used in the system)
- high density to suspend particles

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Poll

Does your plant use extreme pressure (EP) oils to lubricate worm gears?

- Yes
- No

Vote

- low surface tension to eliminate air
- high solvency
- hygroscopicity (for water removal)
- nonflammable
- economical
- reclaimable

Fluid Turbulence. To remove particles, the flushing process depends on the lift forces, drag forces and the depth of the laminar sublayer in the stagnant fluid next to the conduit wall.

As seen in Figure 1, turbulence can have a significant influence on loosely attached solid debris lingering in crevices or in the sidewall perimeter low-flow area. Turbulence in the system shortens the time and improves the quality of the flushing activity.

To properly achieve particle removal, the fluid must be turbulent. The indexless Reynolds number measures turbulence. In general, a number greater than 4,000 represents turbulent flow, and a number less than 2,000 represents laminar flow. Hydraulic and circulation system designers strive to create laminar flow conditions. For gearbox and bearing housings fed with a central system, turbulence is necessary. For stand-alone housings, the effect of turbulence and the ability to direct the force of the fluid facilitates movement of soil.

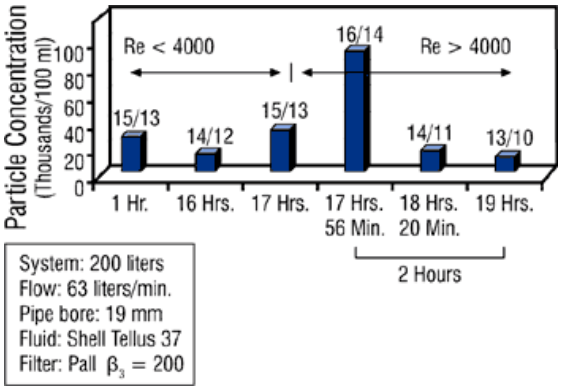

Figure 2

The Reynolds number can be calculated by:

*Nr = 3160*GPM/CS*D*

Where GPM = flushing fluid flow rate in gallons per minute

CS = flushing fluid viscosity – centistokes at 40°C

D = pipe/tube inside diameter – inches

There is some risk associated with the high-velocity flush. Circulation of a fluid at high velocity with particulate contaminants can damage sensitive components (pumps, heat exchangers and valves). Also, such high pressures and flow can affect system filters. It is necessary to bypass flow- or contaminant- sensitive components.

Filter housings can be left in place if filter elements are removed. Components that restrict the flow rate, and thereby increase the pressure drop, should be isolated from the flushing circuit and cleaned individually.

Flushing Equipment

The flushing equipment required depends on the size, location and installed devices on the machinery. A mobile filtration unit is helpful if the pumps are capable of providing a flow rate at least twice that normally used in the fluid system or the flow requirements for the proper Reynolds number. An air breather is required to prevent dirt ingression during flushing.

Use large duplex filters (Beta 3= 200 or higher) with differential pressure indicator to allow filter changing without interrupting flushing. If water removal is desired, include a filter with water-absorbing capabilities.

A heater should be required in case of low ambient temperature to maintain or reduce fluid viscosity and achieve the flow requirements. Permanently installed quick-connectors are beneficial for flushing or filtration if the connector and piping are large enough to facilitate flow. In some cases, a reservoir other than the machinery sump is needed to contain the high volume of fluid required for the appropriate flushing.

A sampling port should be included upstream of the filter to analyze the fluid to establish when system cleanliness is achieved. An in-line, flow decay-type particle counter is the best option. If particle counters are not available, the use of an optical filter patch can help to determine system cleanliness.

Flushing Procedure

The flushing procedure depends on the specifics of machinery, plant conditions and flushing equipment. To obtain the best results, follow these guidelines:

- Drain the used oil while hot, so the viscosity is low and contaminants remain suspended and can be drained within the oil.
- Inspect the drained oil and drain ports for contamination that may indicate the need for power flushing or wand flushing.
- If drain port is not located at the lower point, heavy solid particles, water and/or emulsions will stick to the bottom of the reservoir. Wand flush is required.
- Remove oil filters from system.
- Block or bypass sensitive components.
- Block or bypass components that can reduce fluid velocity.
- If necessary, divide the system in sections.
- Connect the flushing equipment to gear box or bearing housing.
- Install air breather.
- Circulate and heat the fluid if necessary to reduce viscosity and pressure drop.
- Flush at specified Reynolds number to achieve turbulent condition.
- Monitor the contamination level (in-line particle counter readings or sample fluid and optically inspect filter patch).
- Circulate fluid an additional 15 minutes after cleanliness level is achieved.
- Drain and blow the system with dry, filtered air.
- Remove flushing connectors.
- Empty and clean filter housings and install new filter elements.
- Refill the system with filtered specified lubricant.
- Circulate (filter) new oil at least seven times before operating the equipment. Use a filter cart in systems without filtration.
- Label and store flushing fluid.
- Analyze flushing fluid for suitability.

Flushing Cleanliness Targets

For gearboxes and bearings, the target cleanliness level for flushing should be at least one number below the cleanliness level for the operating fluid. A maximum of 16/14/12 (ISO 4406.99) is recommended for critical gearboxes and element bearings.

The flushing process may be perceived to be an expensive, complicated and time-consuming extra task for an oil change. However, some conditions justify the effort. Highly contaminated reservoirs on critical systems warrant additional attention to assure a high state of reliability.

Flushing is justified for new and rebuilt equipment prior to commissioning to sustain high levels of reliability. A proactive maintenance approach of deploying flushing for in-service

bearings and gearboxes helps to increase lubricant life and equipment durability. Generally, the flushing efforts and costs are well compensated with increased reliability related to system cleanliness.

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