TECHNICAL BULLETIN

MAINTAINING EQUIPMENT AND LUBRICANTS DURING EXTENDED SHUTDOWN

Due to the current situation, various facilities are going through extended shutdowns. Castrol has created this technical bulletin to help our customers avoid problems associated with lubricated equipment during extended shutdowns or slowdowns. This document will provide recommendations to maintain equipment and lubricants for an extended time period in order to put our customers in a better position when returning to normal production.

Take Care of Your Lubricants

Did you know that 70-80% of hydraulic failures and 40-60% of gear failures are due to contamination? Clean oil is critical not only for the life of your equipment but for the life of oil as well. Now, during the extended shutdown, is a good time to take care of lubricants.

Contamination can be in the form of solid, liquid, or gas:

- Solid – Solid particles may come from numerous sources including metal chips, sand, dirt, slag, or sealing material. The most damaging particle sizes are equal to or slightly larger than equipment clearances. Particles are also additive strippers - additives attach to particles and are carried to the filter or settle to the sump floor. Solid particles will greatly accelerate the speed of oil oxidation and reduce the service life of the oil.
- Liquid – Water is the most common and could come from heat exchanger leaks, seal leaks, condensation of humid air, inadequate reservoir covers, and temperature drops. It may contaminate oil in 3 forms including dissolved, emulsified, and free. In addition to commonly known rust and corrosion, water contamination causes fluid breakdown, such as additive precipitation and accelerated oil oxidation.
- Gas – Air gets naturally entrained in the oil as it is pumped through the system. Splashing in the reservoir can also lead to entrained air. Air in oils results in acceleration of oil oxidation and reduction of oil service life. Clean oil releases entrained air much faster.

In summary, your oils continue to deteriorate when your equipment is not running; when you are ready to return to normal production, your oil may not be ready.

What to do?

- Filter your oils to remove solid particles using permanent kidney loop filters. If your system does not have kidney loop filtration, now is a good time to install it. To be effective not only during shutdown but during normal operations, kidney loop pump should be sized about 20% of the main system pump.
- If your oil is contaminated by more than two ISO cleanliness codes above target, use a filter cart. Filter carts usually have larger, more efficient filters with higher dirt holding capacity and will be more cost effective to remove solid contamination. The filter cart running time should be at least 8 times the oil reservoir capacity. For example: if your oil reservoir capacity is 150 gallons and GPM of filter pump is 5 gal/min, the running time should be: 150 gal / 5 GPM x 8 = 240 minutes (or 4 hours minimum).

- Setup filter cart to pull oil from one side of tank and return on the opposite side for maximum efficiency. To do so, accessorize your lube systems and install quick-connects for filter cart as shown below:

Filter Cart

Sight glass added with oil sample port combo. Desiccant breather with stainless piping and top-off plug between gearbox and breather.

Quick-connect on gearbox for filter cart

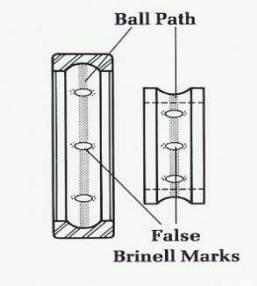
- Use hygroscopic breather/vent filters. When your equipment is not running, lube system reservoirs are continuing to breathe. Protect your oil from atmospheric contamination and moisture by installation of desiccant breathers. Desiccant type breather features will provide the following benefits:

- Eliminates Moisture and Contamination in the System
- Reduces Speed of Oil Oxidation
- Extends Life of Oil and Filters
- Prevents Rust and Corrosion
- Allows Optimum System Performance

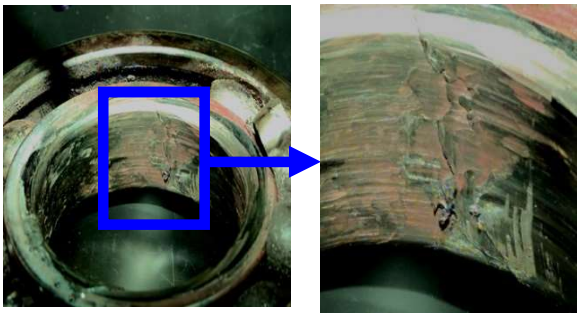
Prevent Fretting Wear When Equipment Is Not Running

What is fretting wear? It is also called "False Brinelling and "Fretting Corrosion" due to the hard-red oxides it forms as a by-product of wear. Fretting wear is caused by loose fit and vibrations between mechanical components in contact. Small relative motion between non-rotating parts occurs due to external vibration. When equipment is not running, an oil film cannot be formed to prevent wear. Vibration is our natural background. Sometimes we can feel it and sometimes we can't, but it is always present. Fretting occurs on the inner ring of bearings where they meet the shaft, between rolling element of the bearing and outer or inner rings. Fretting is also very common for open and enclosed gears. Fretting wear is working when your equipment is not.

What does it look like? Please see examples below. Typical appearance of a bearing which is subject to fretting wear includes wear marks at roller spaced intervals on the raceways. Loose fit between shaft and bearing bore can also cause fretting. Unused gears in storage can have fretting in locations where the gear teeth contact each other.



Typical appearance of a bearing subject to fretting wear



Fretting can occur on the inner ring of bearings where they meet the shaft

Unused gear with fretting wear

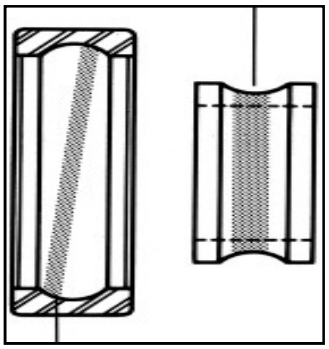
What can you do to prevent (reduce) fretting corrosion during extended shutdown?

- Lubricate equipment using greases containing solid film additives such as molybdenum disulfide (moly). Solids-containing lubricants will better resist being squeezed out, prevent metal-to-metal contact, and reduce fretting wear. Castrol Molub-Alloy Paste White T is a high solids paste that prevents fretting and protects against corrosion. All Castrol Molub-Alloy greases contain solid lubricants for maximum protection.
- Try to isolate parts from external vibration and/or correct source of vibration. For example, the pump of a gear oil circulating system can be a source of external vibration caused by cavitation from damaged seals or hoses. Replacement of damaged seal or hose will reduce vibration and fretting wear.
- Check fits between mechanical components. Make sure they meet OEM specifications. Tighten internal fits. For example, loose fit between shaft and bearing bore can cause fretting as shown above.
- Maintain proper oil levels in gearboxes and other reservoirs.
- Incorporate periodic turning of shop equipment into PM Schedule. This will supply lubricant where needed most – the point of contact between two parts. Lubricant will function as a cushion and reduce effect of vibration and fretting wear.
- Store bearings well lubricated and on their side to minimize the effect of bearing weight on the amount of fretting wear.
- Try to reduce load on bearings in storage by properly supporting equipment or by keeping bearings separate from assembly.
- Secure large bearings during transportation to reduce vibration and fretting wear.

Alignment of Rotating Equipment

If you have experienced atypical patterns of bearing wear during production but were unable to identify the root of the problem due to time constraints, now is a good time for deeper investigation. Usually atypical patterns of gear and bearing wear, and uneven wear of the couplings is caused by shaft or housing misalignment and/or shaft deflection.

Wear patterns of bearings and gears with misalignment are shown below.



Typical wear pattern of bearing with misalignment. Bearing will have wider path or wear path running from one side of race to the other.

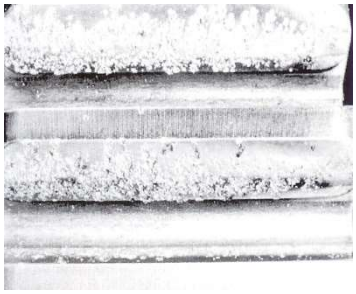
Significantly higher wear on one side of the gear is an indication of misalignment

What to do?

- Check dimensions and squaring of shaft and housings.
- Ensure proper bearing installation and shaft alignment.

Prevent Electric Arcing and Electric Discharge Wear

Common practice is for facilities to complete significant equipment repair, including welding, during extended shutdown. Please remember that individual arcs can melt metal surfaces. Current sparkover can lead to the formation of craters in the raceway of bearings and gears. Examples of electrical discharge wear on bearings and gears are shown below.



Current sparkover craters in the raceway of a bearing and on a gear surface

What to do?

- Insulate bearings and gearboxes with nonconductive material if possible.
- Ground bearings and gearboxes. Connect ground cable of welding apparatus as close to the equipment as possible.
- Check insulation of wiring and welding apparatus.

Take Care of Equipment in Storage

Whenever possible, the storage should take place in an enclosed site to protect the equipment from the roughness of weather.

What to do?

- In the case of gearboxes, if the storage is going to be prolonged, they must be filled with appropriate oil to the correct level and have a desiccant breather installed.
- Once a month, the input shaft of the gearbox in storage should be rotated by hand until the output shaft rotates at least one full rotation.
- Protect equipment with rust preventatives. Use rust preventatives with VCI (vapor-phase corrosion inhibitor) additives such as Rustilo HL 01 or Rustilo 66 VCI. Both are very effective at protecting closed systems such as gearboxes.
- The main challenge in storing electrical motors is to protect the coils from humidity. The coils absorb humidity even in apparently favorable conditions.
- The motors must be stored in a building with a clean and dry atmosphere; the temperature must not be less than 5°C. Best practice is to place a bag of desiccant crystals in the terminal box to absorb humidity.
- Equipment in storage must be covered at least with a roof.

Careful planning before the shutdown and utilizing the above recommendations will certainly extend the life of critical plant equipment and facilitate a more successful restart.

Industrial Technology Deployment