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1. When is Flushing Required?

A flush generally means the internal cleaning up process of a machine by using a fluid as the cleaning medium. A successful flush is to clean pipes, hoses, and system components efficiently and a cost-effective manner -with as minimum of time and effort as possible-

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

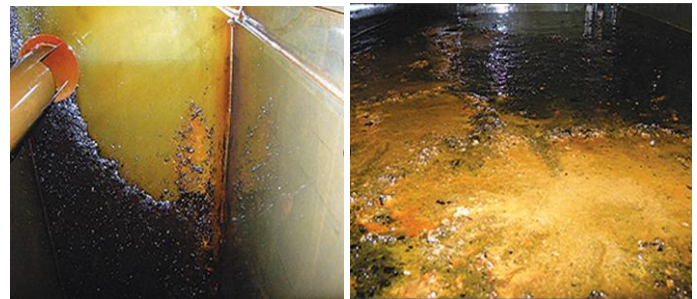
- Oil degradation
- Filter failure
- Aftercooler failure
- New, overhauled, or repaired machine
- Mixed with wrong lubricants
- Microbial contamination
- Machine standby for a long period of time

2. What Flushing Removes?

Flushing can remove dirty assembling elements, corroded surfaces, scale, welding slag, rust, machining swarf and metal debris, oxidation products, chemical residue, and incompatible elastomers such as seals, sealants and coatings after manufacturing or repair processes.

Sludges, water, and carbon deposits generated internally in the system also require flushing to maintain system health and eliminate premature failure which can impact to the productivity.

In many cases, the need to flush is first observed during an inspection or the appearance of sludge in a sight glass, on a used filter, or on the bottom of a sump. This can be confirmed by oil analysis and further inspection to determine the severity and complexity of the flushing procedure to use.



Picture 1: Sludge and sediments in sump tank

3. Factors for Effective Flushing

In general, effective flushing is affected by:

a) Flushing fluid properties

Oil with lower viscosity, higher solvency, high hygroscopicity, high density while non-corrosive and keep on compatible with the system and lubricating fluid is recommended. Using the same lubricating oil as a flushing oil is also possible to be done.

b) Fluid Turbulence

Turbulence can have a significant influence on shed attached solid debris lingering in crevices or in the pipe sidewall. Turbulence in the system shortens the time and improves the quality of the flushing activity. In general, Reynold number greater than 4,000 represents turbulent flow.

c) Filter Micron Size and Beta Ratio

Depending on the system the correct Filter micron size and Beta ratio should be selected carefully, as this is correlated directly to the dirt and particulate removal effectiveness.

Replace the filter as necessary when the filter blocked as indicated by differential pressure sensor. Using large duplex filters (Beta 3 = 200 or higher) with differential pressure indicator is preferable to allow filter changing without interrupting flushing.

If water removal is desired, water separator or vacuum dehydrator will also be required.

d) Heater and Cooler

The temperature of the oil should be controlled in order to facilitate the turbulence flow, but is maintained not to be over as it will significantly accelerate oxidation when the oil temperature is more than 60°C.



Picture 2: Flushing Rig

4. Shell Lube Optimizer – Flushing

In Shell Lube Optimizer we utilize the flushing rig consists of pumps, reservoir, filters, thermometer, particle counter, hose connections, and water sensor. Some of the critical parts to set-up are:

- The adjustable relief valves are set at a pressure above that required to pass the full pump flow through the system which is to be flushed.
- The filter size should be selected to pass the specified pump delivery at a low pressure drop. Select a filter size to meet the requirements of the system to be flushed with high dirt holding capacity.

Step by step procedures are:

1. **Identification** of the system
2. **Preparation**, pipe layout/drawing
3. **Looping**, connecting the flushing rig to the system
4. **Pre-circulate**, clean up the flushing oil
5. **Flushing**, the execution
6. **Drain** the flushing oil
7. **Air Purging**, when required
8. **Inspection**, to check the final result

The Flushing equipment consists of hydraulic pile unit, data logger and flow meter. In addition to that, pressure sensor and temperature sensor are also installed.

During flushing, contamination level is measured using an online laser particle counter, while water contents is being measured online by water sensor.

5. Flushing Cleanliness Target

Contamination level should not exceed ISO 4406 1999: 18/16/13 (NAS 1638 class 7)

The water content shall be < 0.1% or < 0.05% for industrial applications with higher performance demands for service life.

Approximate Equivalent						Type of Hydraulic System
ISO 4406:1999 Cleanliness Class			SAE AS 4059 Cleanliness Class			
> 4µm	> 6µm	> 14µm	> 4µm	> 6µm	> 14µm	
13	11	8	3A	3B	2C	Highly reliable control system, sensitive to sludge accumulation
14	12	9	4A	4B	3C	High performance servo systems and high pressure systems with long service life; e.g. for aerospace and machine tooling.
16	13	10	6A	5B	4C	
17	15	11	7A	7B	5C	High quality, reliable systems; general machinery
20	17	12	10A	9B	6C	General machinery and vehicles; medium capacity
23	19	13	>12A	11B	7C	General machinery and vehicles; low pressure systems in heavy machinery