**HOW IMPORTANT IS OIL CLEANLINESS FOR YOUR EQUIPMENT?**

**MH Hydraulics FZC**, **a leading hydraulics solutions provider in the Middle East talks** about the importance of cleanliness of hydraulic oil with the recommendation from their partner **DES-CASE RMF Systems** from USA and the Netherlands.

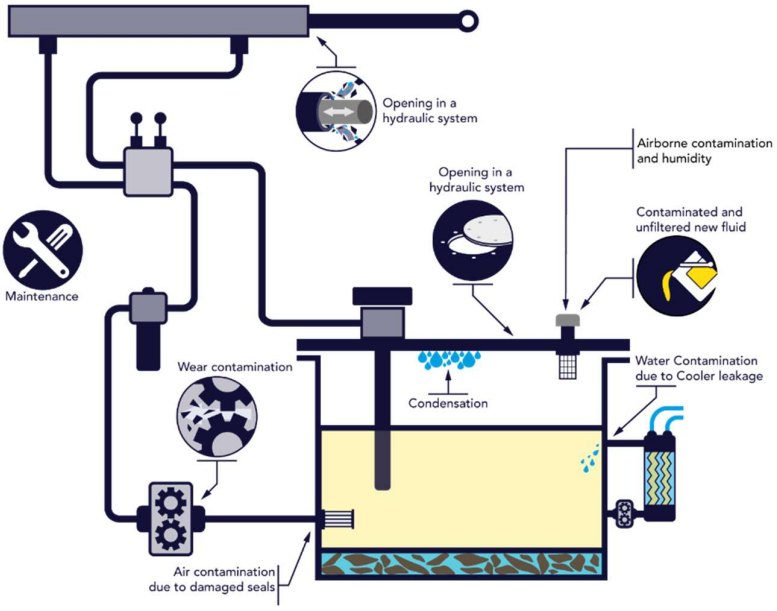
In industries where high value and production focused equipment operate, it's all about maximizing uptime, productivity & efficiencies.

Oil is still too often seen as a consumable and doesn't receive the attention it deserves & requires as it is one of the most important components of an industrial system. Without a lubricant your gearbox would get damaged within no time and without oil a hydraulic system doesn't even work.

Contaminants such as particles and water can and will have negative consequences on the functionality of your systems.
At first, you'll see the performance and productivity decline and efficiencies of your machines and assets decrease and thereafter unexpected component breakdowns will occur.

Approximately 70% of the machine failures are causes by surface degradation, also known as mechanical and corrosive wear.
It's known that mechanical wear such as abrasion, erosion and fatigue cause decrease of production, machine efficiency and eventually component breakdowns and costly downtimes.

**Contamination Sources in Hydraulic Systems.**




Also, water shouldn't be underestimated as it is a serious contamination type that leads to issues like fluid oxidation, internal surfaces corrosion, additive depletion and many more fluid failures. These failure modes will cause acceleration of the degradation process of the oil.
These contaminants can also cause secondary contamination such as acids. sludge, varnish by-products.

Contamination: where does it come from?

- New systems / components are usually contaminated from manufacturing processes.
- New oil is dirty oil, in almost all cases above the target cleanliness levels required for the systems/assets
- Contamination ingress through (damaged) seals
- Contamination (particles & moist) ingress through filling cap/port / breather
- Internally generated contamination – friction / wear / abrasion / erosion / oxidation

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To be able to measure the particle contamination level in a fluid there are two most used norms in the industry, the ISO 4406 and the NAS 1636.

Developed by the International Organization for Standardization, the ISO Range Code is the commonly used cleanliness code. The ISO 4406 code records the cleanliness level of a liquid by three numbers. These numbers correspond with the number of particles respectively larger than 4, 6 and 14 microns per 1ml or 100ml.

**NAS 1636**

| Class | Maximum Particles/100mL in Specified Size Range (µm) | | | | |
|---|---|---|---|---|---|
| | 5-15 | 15-25 | 25-50 | 50-100 | >100 |
| 00 | 125 | 22 | 4 | 1 | 0 |
| 0 | 250 | 44 | 8 | 2 | 0 |
| 1 | 500 | 89 | 16 | 3 | 1 |
| 2 | 1,000 | 178 | 32 | 6 | 1 |
| 3 | 2,000 | 356 | 63 | 11 | 2 |
| 4 | 4,000 | 712 | 126 | 22 | 4 |
| 5 | 8,000 | 1,425 | 253 | 45 | 8 |
| 6 | 16,000 | 2,850 | 506 | 90 | 16 |
| 7 | 32,000 | 5,700 | 1,012 | 180 | 32 |
| 8 | 64,000 | 11,400 | 2,025 | 360 | 64 |
| 9 | 128,000 | 22,800 | 4,050 | 720 | 128 |
| 10 | 256,000 | 45,600 | 8,100 | 1,440 | 256 |
| 11 | 512,000 | 91,200 | 16,200 | 2,880 | 512 |
| 12 | 1,024,000 | 182,400 | 32,400 | 5,760 | 1,024 |

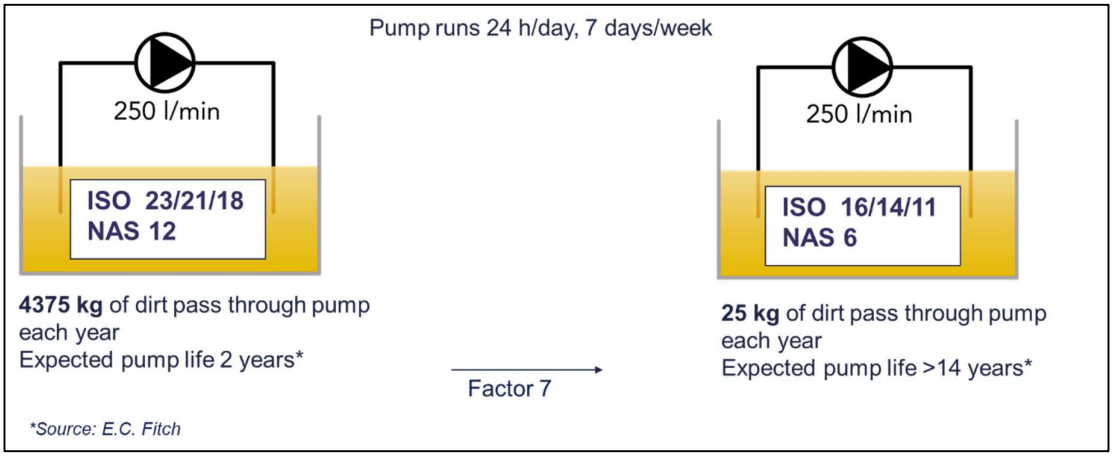
**ISO 4406**

| Number of particles (per 100 ml) | | ISO-Code |
|---|---|---|
| from | to | |
| 1.000.000 | 2.000.000 | 21 |
| 500.000 | 1.000.000 | 20 |
| 250.000 | 500.000 | 19 |
| 130.000 | 250.000 | 18 |
| 64.000 | 130.000 | 17 |
| 32.000 | 64.000 | 16 |
| 16.000 | 32.000 | 15 |
| 8.000 | 16.000 | 14 |
| 4.000 | 8.000 | 13 |
| 2.000 | 4.000 | 12 |
| 1.000 | 2.000 | 11 |
| 500 | 1.000 | 10 |
| 250 | 500 | 9 |
| 130 | 250 | 8 |
| 64 | 130 | 7 |
| 32 | 64 | 6 |
| 16 | 32 | 5 |

**Classification of all particles**
≥ 4 µm(c), ≥ 6 µm(c) and
≥ 14 µm(c)

**Example from ISO 18/16/11:**
190.000 particles ≥ 4 µm(c)/100 ml
58.600 particles ≥ 6 µm(c)/100 ml
1.525 particles ≥ 14 µm(c)/100 ml

**Visualizing Contamination**



What you want to achieve is that the oil and your system stays in optimal conditions as long as possible as this will directly result in:

- extended machine reliability,
- less breakdowns,
- less oil changes,
- longer remaining life of components & oil.

-> Ultimately resulting in a Higher Return on investment

Although inline full flow filters are an essential part of a system, most of the time they are not capable to keep the oil at or below the target cleanliness & moisture levels.
The solution here is to adopt additional micro filtration to achieve these targets as these units continuously improve the oil quality by reducing contamination levels.

Implement a contamination control strategy:
1. Set target -> Every component has a manufacturer specified ISO cleanliness and recommended target moisture levels
2. Take action -> install desiccant breathers that will absorb particles and moist, install adequate additional filtration.
3. Measure - Take samples on a regular basis to measure / evaluate effectiveness of your actions.

**Component required cleanliness by manufacturer**

| Vickers Recommended Cleanliness Code Chart | | | |
|---|---|---|---|
| **PUMPS** | | | |
| **Pressure** | **< 2000 PSI < 140 Bar** | **< 3000 PSI 210 Bar** | **< 3000 PSI > 210 Bar** |
| Fixed Gear | 20/**18/15** | 19/**17/15** | 18/**16/13** |
| Fixed Vane | 20/**18/15** | 19/**17/14** | 18/**16/13** |
| Fixed Piston | 19/**17/15** | 18/**16/14** | 17/**15/13** |
| Variable Vane | 19/**17/15** | 18/**16/14** | 17/**15/13** |
| Variable Piston | 18/**16/14** | 17/**15/13** | 16/**14/12** |
| **VALVES** | | | |
| **Pressure** | | **3000 PSI 210 Bar** | **> 3000 PSI > 210 Bar** |
| Directional (solenoid) | | 20/**18/15** | 19/**17/14** |
| Pressure (modulating) | | 19/**17/14** | 19/**17/14** |
| Flow Controls (standard) | | 19/**17/14** | 19/**17/14** |
| Check Valves | | 20/**18/15** | 20/**18/15** |
| Cartridge Valves | | 20/**18/15** | 19/**17/14** |
| Screw-in Valves | | 18/**16/13** | 17/**15/12** |
| Prefill Valves | | 20/**18/15** | 19/**17/14** |
| Load-sensing Directional Valves | | 18/**16/14** | 17/**15/13** |
| Hydraulic Remote Controls | | 18/**16/13** | 17/**15/12** |
| Proportional Directional (throttle) Valves | | 18/**16/13** | 17/**15/12*** |
| Proportional Pressure Controls | | 18/**16/13** | 17/**15/12*** |
| Proportional Cartridge Valves | | 18/**16/13** | 17/**15/12*** |
| Proportional Screw-in Valves | | 18/**16/13** | 17/**15/12** |
| Servo Valves | | 16/**14/11*** | 15/**13/10*** |
| **ACTUATORS** | | | |
| **Pressure** | **< 2000 PSI < 140 Bar** | **3000 PSI 210 Bar** | **> 3000 PSI > 210 Bar** |
| Cylinders | 20/**18/15** | 20/**18/15** | 20/**18/15** |
| Vane Motors | 20/**18/15** | 19/**17/14** | 18/**16/13** |
| Axial Piston Motors | 19/**17/14** | 18/**16/13** | 17/**15/12** |
| Gear Motors | 21/**19/17** | 20/**18/15** | 19/**17/14** |
| Radial Piston Motors | 20/**18/14** | 19/**17/15** | 18/**16/13** |
| Swashplate Design Motors | 18/**16/14** | 17/**15/13** | 16/**14/12** |
| **HYDROSTATIC TRANSMISSIONS** | | | |
| **Pressure** | **< 2000 PSI < 140 Bar** | **3000 PSI 210 Bar** | **> 3000 PSI > 210 Bar** |
| Hydrostatic Transmissions (in-loop fluid) | 17/**15/13** | 16/**14/12*** | 16/**14/11*** |
| **BEARINGS** | | | |
| Ball Bearing Systems | 15/**13/11*** | | |
| Roller Bearing Systems | 16/**14/12*** | | |
| Journal Bearings (high speed) | 17/**15/13** | **>400 RPM** | |
| Journal Bearings (low speed) | 18/**16/14** | **<400 RPM** | |
| General Industrial Gearboxes | 17/**15/13** | | |

*Requires precise sampling practices to verify cleanliness levels.

**Typical clearance of different components**

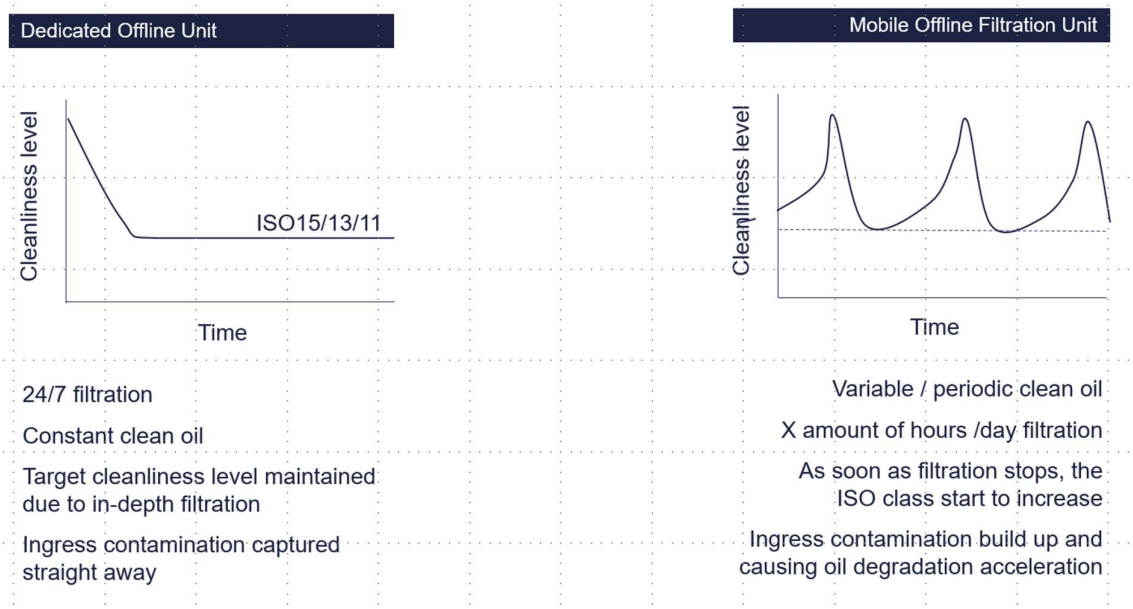
| Component | Details | Clearances |
|---|---|---|
| Valves | Servo | 1 - 4 µm |
| | Proportional | 1 - 6 µm |
| | Directional | 2 - 8 µm |
| Variable Volume Piston Pumps | Piston to Bore | 5 - 40 µm |
| | Valve Plate to Cylinder Block | 0.5 - 5 µm |
| Vane Pumps | Tip to Case | 0.5 - 1 µm |
| | Sides to Case | 5 - 13 µm |
| Gear Pumps | Tooth Tip to Case | 0.5 - 5 µm |
| | Tooth to Side Plate | 0.5 - 5 µm |
| Ball Bearings | Film Thickness | 0.1 - 0.7 µm |
| Roller Bearings | Film Thickness | 0.1 - 1 µm |
| Journal Bearings | Film Thickness | 0.5 - 100 µm |
| Seals | Seal and Shaft | 0.05 - 0.5 µm |
| Gears | Mating Faces | 0.1 - 0.1 µm |

Ref. ASME (American Society of Mechanical Engineers) Wear Handbook

There are two ways to implement the contamination control strategy using additional filtration: mobile and dedicated.

**Mobile offline filtration:**
Also known as periodic filtration, is a good start to remove/degrease the contamination levels in the oil in a system.
It's an economical way to filter multiple assets with the same filtration unit, especially when you want to filter but have budget restrictions. It's Ideal choice/solution for pre- filtering new oils as they arrive at your plant or facility. Often used for periodic filtration of less critical assets or where contamination build-up is less expected.

**Dedicated:**
Dedicated filtration is especially used in critical applications where downtime and the high associated costs have a significate impact on the productivity and performance of the machines.
Keeping the contamination levels as low as possible is essential for the proper functionality of the system components.




**Conclusion:**
Machines/systems require certain cleanliness levels to operate properly. Micron size particles and very small amounts of water cause most of the failures in assets like hydraulic systems, gearboxes, reducers and pumps. Therefore, it's of utmost importance to keep the contaminants out of the lubricants as much as possible. Implementing the right contamination control strategy will result in:

- Increase of overall equipment RELIABILITY,
- Reduction of downtime & maintenance costs, (thus saving MONEY),
- DECREASE our clients' FOOTPRINT on the environment