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**Y2K WHITE PAPER**

# Water Mitigation In Hydraulic & Gear Lubricated Systems

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# WATER MITIGATION IN LUBRICATED SYSTEMS

## Executive Summary

Water Contamination in Hydraulic and Gear Lubricating fluids has long been an issue. Matter of fact, every fluid that has any type of temperature change or water as part of the operational process is susceptible to water and many other types of contamination in their system. Not to minimize the importance and impact in other applications, but the effects of water and Gaseous process by-products are particularly damaging, have the most impact, and are massively disrupting and expensive to critical systems. (I.e.. Turbine Lube Systems in Power Generation and the roller bearings in Pulp and Paper equipment and machines) The challenge is, first, understanding realistically how dry your system should be as a standard, and what options you have to keep that system within that specification.

## **How to choose the best water removal system based on the application, volume, and fluid type?**

## Introduction

The majority of Power Generation, Pulp & Paper, and many other markets all over the world utilize some form of hydraulic or gear fluids as the primary source of lubrication or energy to power machinery and equipment. This fluid provides not only lubrication and cooling properties to critical friction or rotating based systems, but can also be used to provide power to high tonnage presses or to move a boom on an excavator. In a turbine lube system, the power generated is critical to our power grid and everyday life! Have you ever been at home, work or an event where the power went out? I would bet we all have experienced that at some point in our life and it is very disruptive and can be very dangerous depending on the circumstances surrounding the power outage. The fact is that we depend on power to keep the engine of life moving forward. Likewise, another dependent market is the Pulp & Paper industry providing us with paper products from toilet paper (Apparently in short availability due to the Coronavirus) to printer paper and an unimaginable amount of other products necessary for our comfort and survival. Just as we rely on the power generation segment, we equally rely on paper products and many other markets. These systems, critical or not, are all susceptible to contamination in many forms. However, for the sake of this subject, I will be specifically focusing on water contamination, the damaging effects, and possible solutions to mitigating and reversing the effects that is caused on these systems. Water is among one of the highest contributors to failures in these systems and can account for a majority of the wear that leads to corrosion, breakdown, and mechanical failure.

# WATER MITIGATION IN LUBRICATED SYSTEMS

## Problem

The ingress of moisture is unavoidable in any type of equipment or machine that utilizes hydraulic or lube oil. Although certain types of fluids make it harder for the water to become emulsified or dissolved into, it is still a big issue that needs to be dealt with before it has the chance to cause irreversible damage and ultimate degradation in the life cycle of the system. It is known to be significantly easier and at a lower cost to mitigate water ingress from the start than it is to dry or repair a system that is already saturated and damaged. Different applications, conditions, and environments pose additional challenges in choosing the correct way to handle water in your system and should be applied properly to limit not only the effects on the life cycle of the equipment but also to handle the different forms of water in oil such as free, emulsified and dissolved states. There are several filtration systems for different purposes, and there is no one solution that fits all applications. Water and particulate contamination can cause great strains on these systems including physical and chemical changes in the oil that decreases the effective lubricity and additive properties. This change causes pre-mature wear on moving components, lower productivity, and result in early or consecutive failures. Focus on water contamination control can be a powerful and important part of a proactive maintenance strategy.

## Definition of Different Forms of Water

### **Dissolved Moisture:** <sup>1</sup>

The lowest level of moisture contamination in lubricant oils. This moisture is derived from ambient air humidity slowly interacting with the lubricant oil overtime. Usually, the more additives the oil contains, the more hygroscopic (water attracting) the oil will become. Acceptable levels of dissolved moisture typically range from 50-300 ppm (or 0.0050% – 0.0300%). [2] This level of moisture does not greatly affect the compressibility or viscosity of the oil but is the most chemically reactive water species since it is dispersed throughout the oil.

### **Emulsified Moisture:** <sup>1</sup>

If left unchecked, the dissolved moisture will continue to increase within the oil sample until it reaches a saturation point. At this point, any added water will precipitate out as cloudy emulsified micro droplets. Like the mayonnaise you would put in your sandwich, this form of moisture is created by the continuous churning, heating and high pressurization of water into oil. The saturation point varies for different lubricants. Mineral oil has a saturation level of 100 ppm (0.0100%), while some hydraulic fluids have a saturation level as high as 5000 ppm (0.5000%). As some oils age, the saturation point may increase depending on the type of oil and the additives used in the lubricant.

# WATER MITIGATION IN LUBRICATED SYSTEMS

## Definition of Different Forms of Water (cont'd)

### Free Moisture:<sup>1</sup>

Free moisture is water that is neither dissolved nor emulsified within an oil sample but remains in a distinct and separate aqueous liquid phase. This form of moisture will never incorporate into the oil and usually originates from condensation or leaks. The free moisture is denser than the oil and will settle to the bottom of most engines or create a thin film covering all available polar metal components.

<sup>1</sup>Source: <https://www.azic.com/moisture-in-oils-the-three-headedbeast/>

## Sources of Water Contamination

- Running systems typically breath using the oil reservoir Breather or desiccant when the volume of fluid is being used and returned to the tank this causes displacement of the fluid in that space and that volume movement creates a vacuum and pressure cycle in the system causing the system to pull air in and push it out and moisture can be ingressed in this process, higher amounts of water will be ingressed with a standard non-Filtered breather cap versus a Desiccant type breather.
- The Heating and cooling of a running or an idle system creates a differential in pressure that can condense outside moisture into the fluid in the tank.
- Water Cooled Oil Heat exchanger system leaks.
- System maintenance practices.
- Piping, Fittings, and Connections can allow ingress into the system.



# WATER MITIGATION IN LUBRICATED SYSTEMS

## Solutions: How to Minimize & Monitor Water Ingression

- 1 Install desiccant breathers on all tanks.
- 2 Minimize exposing the system to the environment.
- 3 Monitor the oil, take samples frequently to check for the presence of water in your oil, and determine what actions to take.
- 4 Implement a water removing element, membrane or vacuum dehydration system based on the amount of water ingression into your system .
- 5 Filter or dehydrate new oil.
- 6 Use sound application processes to lower the chance of water ingression.
- 7 Upgrade or repair seals/leaks in your water-cooled heat exchangers.
- 8 Utilize non-invasive inspection/sampling methods to verify the presence of water.
- 9 Use routine filtering/dehydrating practices for new or recently serviced equipment.
- 10 Practice good fluid storage and management.

## Solutions: Methods to Control Water Contamination

### Water Removal Systems & Processes

- Portable off-line/Online Membrane Dehydration
- Vacuum dehydration
- Water absorbing filters
- Air stripping
- Depth Media Filters

## Solutions: Selecting the Appropriate Filtration System

### Things to Consider

- Determine the type of water in your system to apply the right product
- Filter water at regular and routine intervals
- Consider the availability of power requirements for different systems
- Space restrictions
- Flow rate vs. water removing efficiency
- Amount of water in PPM to be removed

# WATER MITIGATION IN LUBRICATED SYSTEMS

## Solutions: Spin-On Type Filters

### Mobile Two-Wheel Filter Carts or Stationary Systems:

These carts can be fitted with water-absorbing filter elements and are only designed to assist the system in maintaining a typically dry system and have the lowest capability of water removal in comparison to other systems for water mitigation. This is important when sizing, not only the correct level of water removal the system requires, but also how fast or efficiently they can remove the water to keep up with the ingress rates. Keeping the system running and removing contaminants and water, will keep your oil in an ideal condition promoting the health of your system and a direct result to longer life cycles and increased productivity.

### Filter Cart Options:



D Series Filter Cart

M Series Filter Cart

D Series Tandem Filter Cart

M Series Tandem Filter Cart

# WATER MITIGATION IN LUBRICATED SYSTEMS

## Solutions: Depth Type Filtration Systems

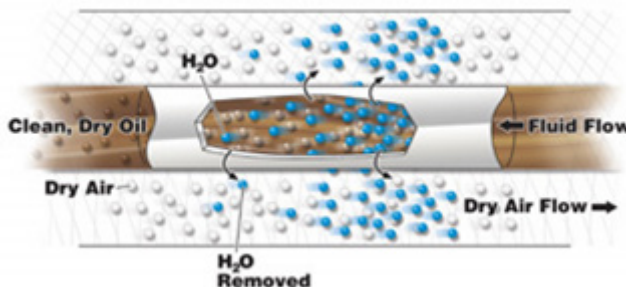
Depth media can come in many forms from point of use inline solutions with or without pressure and flow regulating valves to mobile and stationary plug and play systems. The benefit of using this type of system is the low cost high dirt and water absorption capabilities of the tightly wrapped large surface cellulose media. The dirt holding and water absorbing capacity of the element provide specific benefits to certain applications where the oil sump is severely contaminated or an ingress of free water is an issue. Where typical spin on elements don't have the capability and are not from a cost point of view economically feasible this would be the next step up.



## Solutions: Membrane Technology (Water Removal)

Membrane water removal technology is very new to the market and will slowly be introduced to more applications in the coming years. The concept behind membrane technology is an oil impermeable membrane inside an opposing directional dry/clean air path to which there is a less populated cluster of dry air molecules causing the air molecules to permeate through the membrane and attached to the dry clean air. This is exhausted out as a pure invisible air/water mist. This type of unit is unique in the fact that it can act like a vacuum dehydrator and remove free, emulsified and dissolved water and gasses from the oil, this differs from spin on and depth media because these absorbent types are only designed to capture mainly free water molecules.

When the membrane technology is coupled with high efficiency filters the ability to clean the particulate in addition to moisture from the system provides an extension of the wear components and overall useful life of the equipment.

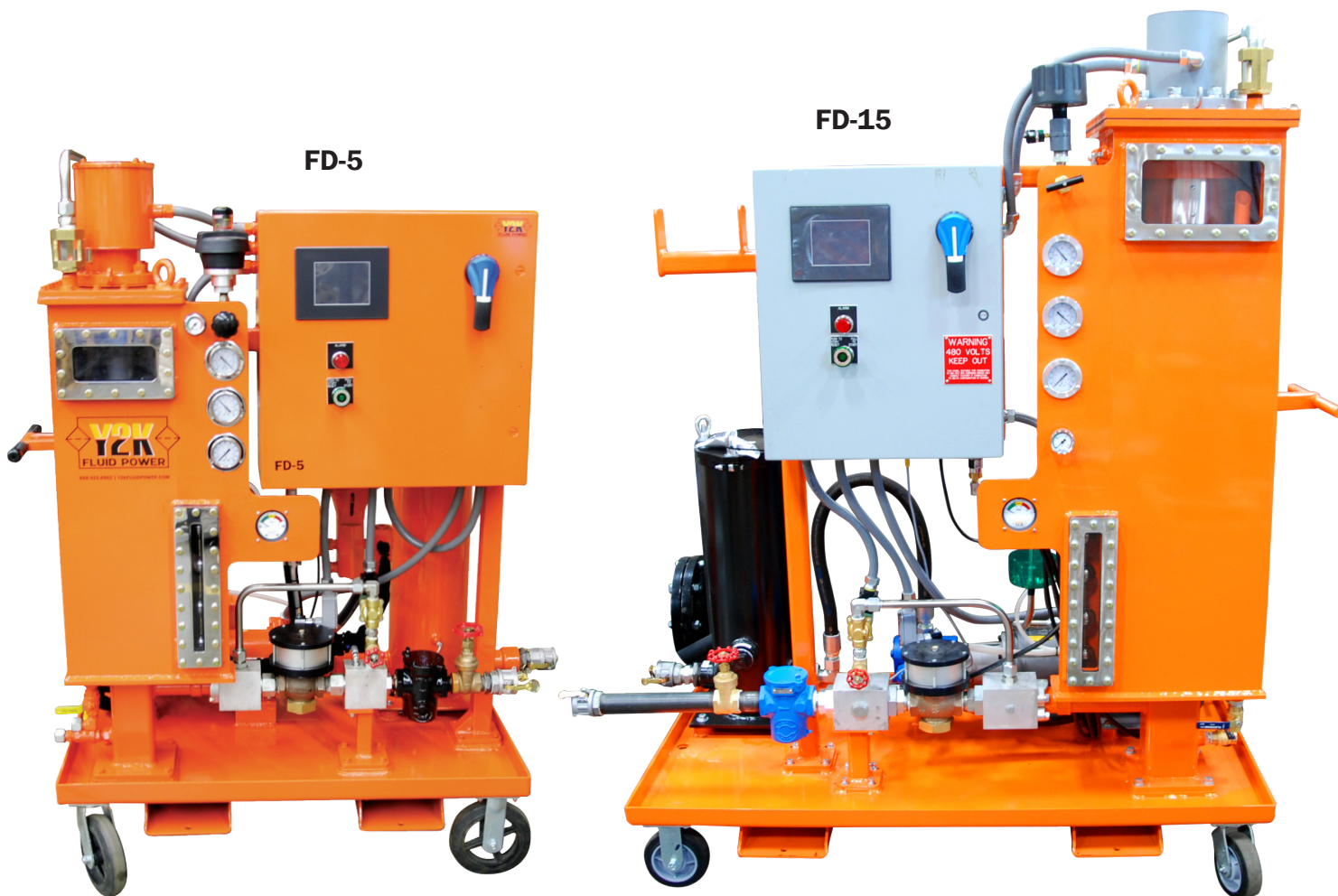


Portable Membrane Dehydration System

# WATER MITIGATION IN LUBRICATED SYSTEMS

## Solutions: Vacuum Dehydration

Vacuum Dehydration is by far the most effective at rapid water removal these systems also typically contain some form of particulate removal before returning the oil back to the sump. Vacuum Dehydration is used in critical high cost components or systems that cannot be easily shut down for maintenance or where the cost of breakdowns exceeds the presumable cost to prevent an unexpected shut down. Some markets include Power Generation, Pulp and Paper and mining industries. The concept behind operation is to use a vacuum pump to lower the effective boiling point of water from the 212 Deg. to a much lower temperature between 130-150 Deg. Which allows under vacuum and heat the transition of the liquid free water, emulsions, Dissolved water and gasses to be exhausted out of the dehydration system as pure gas or steam. The goal of this process is to eliminate or lower the water (PPM) and contamination (ISO Cleanliness Level) in the oil to an acceptable level so that the characteristics of the oil maintain their lubricity properties and allow for an extension of useful life of the machine or equipment.





# WATER MITIGATION IN LUBRICATED SYSTEMS

## Conclusion

In short, no matter what type of water is in your system, one thing stands true, it is damaging to components and the life of the system whether you can see the damage or not. If there is water or contamination present you are starting the clock on the failure of that system. Use the appropriate water removing system for your application and in the case of Power Generation and Pulp & Paper the solution is typically the high water removal properties of a Vacuum Dehydration system in varying flows. The value benefit and adverse effects of water in these systems significantly outweighs the cost to implement these systems.

## Additional Resources

For a look at Case Studies in relation to filtration please visit the link below:

<https://www.y2kfiltration.com/media/case-studies>

For a look at more White Papers in relation to Filtration and Oils please read some of our other published White Papers in the link below:

<https://www.y2kfiltration.com/media/white-papers>

## Inquiries/Contact

**For additional inquiries, questions, comments or to find out how Y2K Filtration can help you with your Contamination needs and solutions please contact us:**

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