FLUIDMATIX

HYDRAULIC OIL – THE UNSUNG HERO OF HEAVY MACHINERY

A Look at the World of Hydraulic Oil Contamination

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AN AUTHORITATIVE REPORT

A LOOK AT THE WORLD OF HYDRAULIC OIL CONTAMINATION

HYDRAULIC OIL - FOR THOSE OF US THAT ARE NOT MECHANICALLY INCLINED, THOSE TWO WORDS MAY MEAN NOTHING TO US. AND IF THAT IS THE CASE, THEN WHAT IS IT, WHY IS IT NECESSARY, OR HOW DOES IT WORK; DEFINITELY DID NOT CROSS YOUR MIND.

You may have been driving and seen a bulldozer on a construction site and not given a thought as to how the machine actually works. If we peel back the onion layers – there are enormous amounts of (underappreciated) physics and engineering working together in meticulous fashion to make large machines responsive to commands.

A bulldozer is comprised of major parts that require fluid power to move and work in unison. If we wanted to draw an analogy, we can think of the human body as a fluid power machine. The main pump is your heart, the pressure lines are the arteries, the filter is your kidneys, cylinder and flow controls are your muscles, the instrumentation is comparable to our senses, and all of this controlled by our brain, something similar to a PLC (programmable logic controller) system. To ensure there is minimal friction between the various bones and joint cartilage when we move, the body produces lubricin or a natural lubricant to facilitate everything moving smoothly. Similarly, in a complex machine, hydraulic oil is required to transfer power and to keep all the pieces of the machine moving smoothly. As you can imagine, large machines have enormous amounts of pressure, weight, and power all working in a fine balance to react to commands or directions. Hydraulic oil is the fluid used to transfer power and provide lubrication to an asset.

Common large assets that use hydraulic oil include presses, forging machines, plastic injection molding machines, forklift trucks, log splitters, automotive lifts, aircraft jacks and hangar doors, tractors, excavators, bulldozers, steering and transmission systems, lifts, pumps, motors, and other industrial machinery. Given the demand for hydraulic oil in a variety of construction and heavy assets, the global hydraulic monitoring market is enormous; new sales, and an installed base, yield ~$500B+ in assets. Pumps and motors in this space regularly have price tags of ~$500K+.

HYDRAULIC OIL – A QUICK PRIMER

SO, WHAT IS HYDRAULIC OIL?

Hydraulic oil is a fluid that is generally made up of one base liquid and then other elements to improve performance. Additional elements include mineral oil, glycol, silicon, esters, and other elements to give the oil the desired characteristics to optimize the performance of the asset based on external factors such as where the asset is being used, temperature, weather conditions, or other factors which may impact the asset.

While hydraulic oil itself possesses properties similar to other lubricants, in addition to the elements noted above, additives are then often added to the oil based on expected use. Additives such as anti-foaming, anti-air release, anti-oxidation, hydrolytic stability, anti-wear performance, and improved filterability are all additives that can improve the performance of hydraulic oil.

WHAT DOES HYDRAULIC OIL ACTUALLY DO?

Beyond power transfer and lubrication, hydraulic oil plays four key additional roles in enabling large assets to perform optimally:

1. Heat transfer.
2. Sealing of moving parts.
3. Energy transmission medium.
4. Lubrication of internal moving parts.

It is important to note that hydraulic fluid actually provides the sealing within the internal components of pumps, valves, and motors. The sealing lubrication is essential to protect internal parts from wearing, breaking, or melting as a result of high friction.

DIRTY OIL IS INCREDIBLY COMMON

AT THE HIGHEST LEVEL, PARTICLE CONTAMINATION IS GENERALLY BROKEN INTO TWO CLASSES:

1. Hard Particles – Silica, Carbon, Metal
2. Soft Particles – Rubber, Fibers, Microorganisms

As you can imagine, with oil flushing around various parts and moving in a rapid manner of a large machine – small particles are bound to be introduced into a system. Fluids are being constantly exposed to water and other contaminants while being handled, stored, or while working within a machine. Think of the weather elements in an outdoor storage drum or a windmill, the condensation in the air in a logging plant, or the dirty conditions present when excavating a mine.

These examples don't include more common variables like a dirty workstation, improper flushing techniques, wear and tear on tools and components, wrong additives, cavitation, or less than pristine ports, plugs, or rags used when interacting with a machine.

As noted above, while additives can be added to oil to minimize contamination, additives can also break down in the presence of water, acids, or extreme conditions. Contamination opportunities are everywhere, it is impossible to eliminate contamination in these conditions.

Contaminated (dirty) hydraulic oil.
Photo credit: mobilehydraulictips.com

SMALL CONTAMINATIONS LEAD TO BIG PROBLEMS

TO THINK ABOUT IT SIMPLY, SURFACES WITHIN A COMPONENT ARE NOT DESIGNED TO HIT METAL ON METAL BUT RATHER BE SEPARATED BY AN OIL FILM.

In many components, mechanical loads are so extreme that they squeeze the lubricant into a very thin film, less than 1 micrometer thick. For reference, milled flour is about 25 micrometers, the average human hair is about 70 micrometers, and red blood cells are 8 micrometers in width!

When this microscopic gap is bridged by contaminants, wear will start to occur and quickly accelerate as small particles are further ground into even finer particles. Degradation in a pump will quickly pass to the motor, and contamination, no matter how small, can accumulate quickly in the motor, which is generally the most expensive and complex part of an asset.

Contaminated hydraulic oil results in enormous costs:

1. Loss of asset production (uptime).
2. Component replacement/maintenance costs.
3. Frequent fluid monitoring and replacement.
4. Costly disposal/scrapping.
5. Catastrophic equipment failures.

75% OF ALL FAILURES IN A HYDRAULIC SYSTEM ARE DUE TO CONTAMINATION.

Particle contamination is the leading culprit. Putting this into dollars:

- A large asset can easily cost $50K in hourly downtime.
- We estimate that the annual maintenance market is ~$50-100B.
- The installed base of hydraulic equipment is well over $500B of assets.

UPPER-RIGHT: Catastrophic hydraulic motor failure due to contamination.
LOWER-LEFT: Failed rotary group from hydraulic piston pump due to contamination.

CURRENT SOLUTIONS ARE ANTIQUATED AND REACTIVE

OIL CONTAMINATION IS NOT A NEW PROBLEM.

Yet, what can we do to reduce contamination that enters into the hydraulic ecosystem? Filtration techniques have been created to minimize the number of particles that enter into a motor. A properly sized, installed, and maintained filtration system plays a key role in preventative maintenance planning. While the function of a filter is to maintain clean oil, the purpose is to reduce machine operating costs.

Users of hydraulic systems have worked together to establish acceptable levels of contamination in which particular systems will continue to operate satisfactorily. These systems use information that:

1. Specify the degree of filtration required;
2. Define the contamination sensitivity of a system; and
3. Establish the contamination tolerance levels of a system.

Current method of oil sample extraction from hydraulic equipment.
Photo credit: machinerylubrication.com

Due to the important role clean oil plays in the optimization of assets, the maintenance and management of hydraulic fluid is of high importance. However, this maintenance has not kept up with technology.

In its current state, if there is a perceived oil contamination issue, an asset owner calls a technician. While this is generally done on a schedule, due to time and costs, the sampling is inconsistently completed. A technician draws a sample of the oil to ensure that the oil is within a defined set of parameters. To take this reading, a technician uses a particle counter. A particle counter is an expensive equipment ranging in cost from inexpensive versions at $500 to highly sophisticated versions at $20,000+.

If the oil is within an agreeable level of contamination, minimal adjustments can be made. If the oil is not within an acceptable parameter, the technician may shut down the machine to minimize the probability of asset failure.

To really understand the details of the dirty oil, the analysis required includes size spectrum and concentration (i.e., particle count), the weight of the contaminant per unit of volume of fluid (i.e. gravimetric reading), and the geometric and material properties of the contaminants. It is almost impossible to make accurate on-site assessments of contamination levels, so fluid samples are sent to the laboratory.

CURRENT SOLUTIONS ARE ANTIQUATED AND REACTIVE (CONT'D)

The sample itself then must be closely monitored and protected in order to get a representative and accurate sample. The time between sample draw and analysis can be days, sometimes weeks. All the while the asset is not being utilized, and also importantly without real analysis being completed on why the contamination occurred and how to prevent it in the future. Furthermore, the data that a technician or lab specialist documents generally sits in a log somewhere, and is not put into a 'smart' system where root cause analysis can be completed.

This current process to manage and monitor contaminants is inefficient, costly, and most importantly post facto. The particle counter reading from the particle counter itself is simply a snapshot of a point in time, it does not provide any insight into why or when. Once the contamination occurs, none of the actions noted above do anything preventative, even if there are sensors (like vibration or temperature) installed on the machine, they simply report an issue that has already occurred.

A PROPERLY SIZED, INSTALLED, AND MAINTAINED FILTRATION SYSTEM PLAYS A KEY ROLE IN PREVENTATIVE MAINTENANCE PLANNING.

Particle counter displaying ISO codes; cleanliness levels of hydraulic oil.

FLUIDMATIX IS PREVENTATIVE

FLUIDMATIX LOOKS AT THIS WORLD VERY DIFFERENTLY.

First, we are focused on alerts and failure prevention. Second, we are deeply interested in the data; looking at the interplay, and correlation, of various sensors data to predict, and prevent, equipment deterioration and catastrophic failures.

With over 5 decades of hydraulic experience, Mr. Nick Nesland, partnered with Mr. Shirish Pareek, Founder and CEO of the world's leader in Hydraulic remanufacturing (Hydraulex Global) to create FluidMatix - the world's first smart, IoT enabled, hydraulic oil monitoring system. FluidMatix has developed a prototype system which divides the process into three key categories:

1. Use of a variable pump speed motor to moderate the flow of hydraulic oil in a kidney loop system that takes dirty oil out of the asset and pumps clean oil directly back into the asset.
   - There is no asset downtime.
2. Development of IoT technology to remotely monitor the performance of complex hydraulic systems.
   - Monitoring is now live 24x7, not on scheduled intervals.
3. Application of 50 years of hydraulic experience with sensor data to identify key causes of contamination, mitigate asset failure, and understand the impact of various internal and exterior variables on hydraulic oil contamination.
   - We are focused on why assets fail to prevent failures

We believe sensors/hardware, and even software, are not true value differentiators, they can be replicated with ease, and are sometimes even given away for free. What cannot be easily replicated is the deep subject matter expertise regarding the root cause and effects of contamination on asset performance that the FluidMatix team possesses.

As more assets come on-line, we will compile and analyze the data from these assets to understand what factors, or combination of factors when working together, cause asset failures. We are a data science company specializing in hydraulic particle contamination.

FluidMatix solutions are purpose built for the hydraulics industry.

THE CURRENT & FUTURE STATE OF AFFAIRS

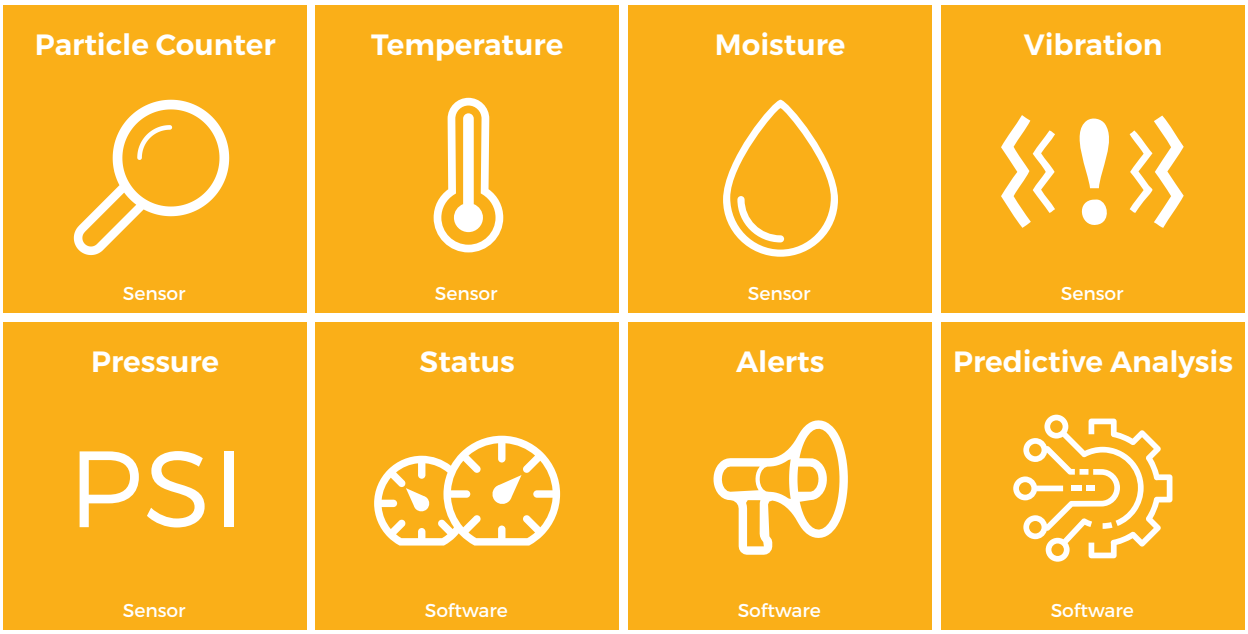
CURRENT STATE OF AFFAIRS

The system described above is in proof of concept stage and ~10 units have been successfully deployed in a range of industrial environments displaying machine performance to a centrally located server. Trial customers have proven the ability to access their data from any location in the world and review alerts on customer-defined performance or contamination parameters.

We currently provide monitoring and analytics platforms to end-users, maintenance companies, OEMs, and machine builders. Our solution is focused on serving the hydraulics industry and the nuances associated with the industry, including a variety of environmental conditions or remote and underground connectivity needs.

FUTURE STATE OF AFFAIRS

We currently are focusing on three key inputs (particle counter, temperature, and moisture) as the major inputs regarding oil contamination. In the future state, as our technology enables more sophisticated analysis, we will be expanding our scope to holistic equipment health monitoring and predicting and preventing failures using machine learning on current and additional sensor inputs such as vibration, pressure, viscocity, sound,, equipment historical performance, and environmental or exterior environment variables such as: temperature, air particle count, or other potential influential factors.



We have built an end-to-end IoT enabled solution that does not focus on predictive, but rather preventative.

MEET THE TEAM

With almost 100 years of hydraulics experience, the team at FluidMatix are hydraulic experts. We believe we are entering a unique time where manufacturing will embrace new technology, and are at the forefront of driving technology innovation into the advanced manufacturing economy.

SHIRISH PAREEK

Shirish Pareek is a tried and true manufacturing visionary. Shirish was the CEO and Founder of Hydraulex Global, which he grew into the largest re-manufacturing business in America. Under Shirish's stewardship Hydraulex global achieved ~$90MM in revenue, exported to 50 countries, employed over 300, and managed 5 manufacturing plants. Mr. Pareek was previously a business strategy consultant with McKinsey and Company. Mr. Pareek also served two-terms on President Obama's Manufacturing Council, and is currently on the Leadership Council of mForesight, America's foremost manufacturing think tank. Shirish earned a B.S. with University Honors in Mechanical Engineering from the Indian Institute of Technology Kanpur, India and an MBA with a specialization in Operations and Strategy from Carnegie Mellon University.

NICK NESLAND

With over 50 years of hydraulic remanufacturing and repair experience, Nick was the CEO of Hydraulic Repair and Design. A premier hydraulics facility he built from the gound up that specialized in the remanufacturing and repairing of hydraulic components ranging from pumps, motors, valves, cylinders and power units; for mobile and industrial applications. He now spends his time innovating in the field of hydraulic oil filtration and monitoring.

GAUTAM BAZAZ

Gautam has worked at Fortune 500s and launched numerous tech startups in the health care, financial, and social connectivity spaces. Prior to FluidMatix, Gautam served as the lead Portfolio Manager at a multi-billion Single Family Office. His corporate work experiences include Vanguard, J.P. Morgan, and Booz Allen Hamilton. Gautam earned his B.S. from Carnegie Mellon University and his MBA from Duke University.

ELIMINATING HYDRAULIC SYSTEM FAILURES

With The World's Most Sophisticated Hydraulic Oil IoT Enabled Platform

FLUIDMATIX

Want to learn more about FluidMatix? **Contact Us!**

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