PERFORMANCE UNDER PRESSURE: HOW TO PREVENT PARTICLE CONTAMINATION FROM IMPACTING YOUR HYDRAULIC SYSTEM

We know what you're up against. Hydraulic systems are critical to keeping your operation running. Yet today's equipment designs and operating conditions mean higher temperatures and loads, more stress on components and lubricants, and more potential for costly failures.

This whitepaper will explore common problems and misconceptions surrounding hydraulic oils and what can be done to keep systems running efficiently.

Are you relying on your equipment filters to clean up your oil?

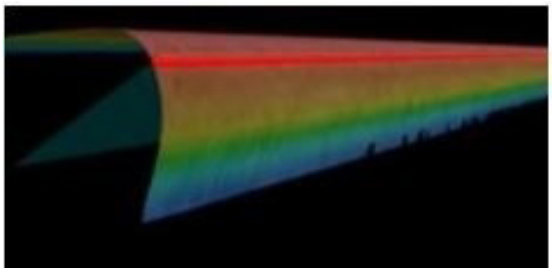
No matter how much is written on the importance of clean oil, a common question we hear in the field is still, "Why do I need to start with a certified clean oil if my equipment filters will protect my equipment?"

To help answer this question, Chevron's Research Scientist, Dr. Nathan Knotts, completed a study utilizing an industry standard hydraulic system developed for measuring hydraulic fluid performance.

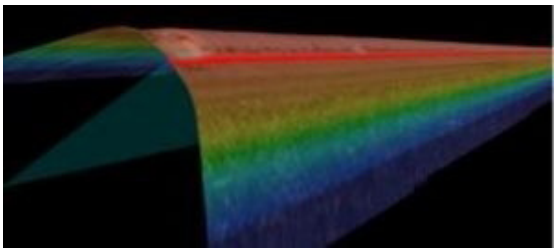
Equipment filters can help reduce the level of contaminants over time; however, during this time, damage can occur to equipment parts. As you can see from the chart below, the equipment filter gradually reduced the contamination level of the typical hydraulic oil AW 32 over the 50-hour operating interval. In the second test, the hydraulic system was started with a certified clean Chevron Rando® HD 32 ISOCLEAN® Certified hydraulic oil. The level of cleanliness was maintained from the start of the operating interval to the end.

Test	Operating Time	ISO 4406 Cleanliness Code	ISO 4406 Cleanliness Code	ISO 4406 Cleanliness Code
Stage 1	0 Hours (Fresh Fluid Fill)	22/21/19	15/14/12	17/15/12
	10 Hours	20/15/8		17/15/12
	25 Hours	18/13/6		17/15/12
	50 Hours (Drain Fluid)	16/14/11	15/14/11	17/15/12
Stage 2	51 Hours (Fresh Fluid Fill)	22/21/16	16/13/9	17/15/12
	100 Hours (Drain Fluid)	17/14/10	16/15/10	17/15/12
Stage 3	101 Hours (Fresh Fluid Fill)	22/20/14		17/15/12
	150 Hours (Drain Fluid)	18/14/11		17/15/12

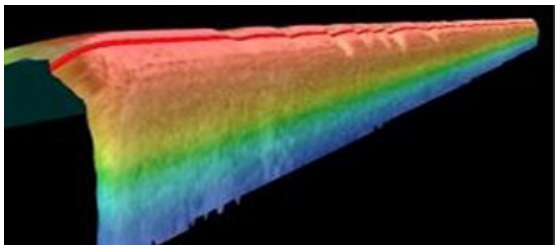
The hydraulic system parts were inspected after the 150-hour test. As shown in the hydraulic vanes below, the level of wear was more severe in the system using the typical hydraulic oil AW 32 compared to the system using the Chevron Rando® HD 32 ISOCLEAN® Certified hydraulic oil.



New Vane



Chevron Rando HD 32 ISOCLEAN® Certified (150 hours)



Typical Hydraulic Fluid B ISO 32

While system filters can help reduce the contamination level of new typical lubricants, damage can occur during this time. It is always recommended to start with certified clean new lubricant that meets the equipment manufacturer cleanliness requirements.

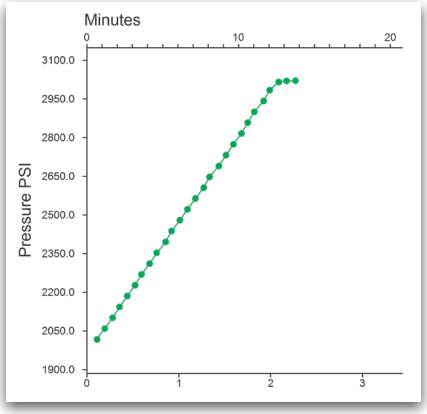
Can oil cleanliness affect pressure efficiency in hydraulic systems?

Based on the previous tests, we can draw one conclusion: starting with a Chevron ISOCLEAN certified clean hydraulic oil will result in much lower wear compared to a typical hydraulic fluid over the same time period, even with the system filter operating efficiently. With a typical hydraulic fluid, it may take a while for the wear generated by lubricant contamination to result in equipment failure, but during that time it will most certainly degrade equipment performance.

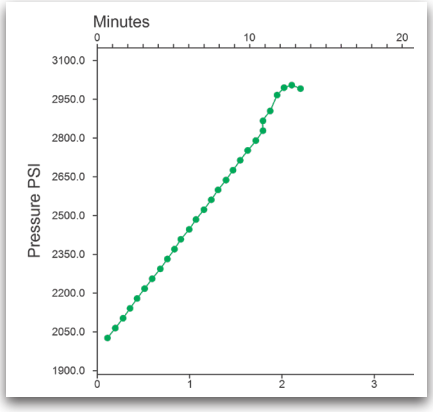
Another question we explored was whether oil cleanliness has an impact on hydraulic system pressure. Again, we compared three types of lubricants in an Eaton high-pressure vane pump: a Chevron Rando HD ISOCLEAN® Certified hydraulic fluid with a system filter, a typical hydraulic fluid with a system filter and a typical hydraulic fluid with a system filter in bypass.

You can see the difference quite vividly by looking at the pressure control curve that measures the pressure in pounds per square inch (PSI) over a period of between 10 and 15 minutes.

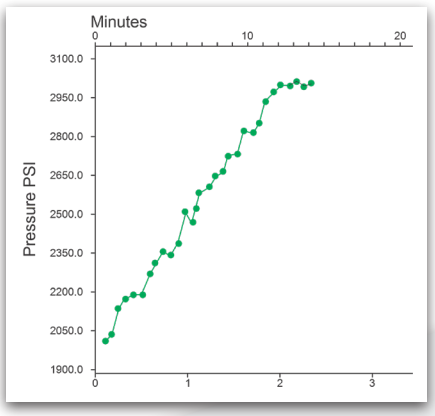
Chevron Rando HD® 32 ISOCLEAN® Certified



Typical Hydraulic Fluid B ISO 32



Typical Hydraulic Fluid C ISO 32 (Filter Bypass)



The typical hydraulic fluid with the system filter in bypass resulted in an extremely volatile pressure curve. These are signs of interruption of the pressure control valve caused by particle contamination or damage. This finding corresponded to a highly visible wear on the valve cylinder and piston.

Even with a typical hydraulic fluid running through the system filter, we see a somewhat jerky pressure control curve, indicating interruptions of the hydraulic system performance. Upon examination, the valve cylinder and piston showed signs of wear, which was less pronounced than with the unfiltered fluid, but visible nonetheless.

With typical hydraulic fluids, the pressure control valve loses its ability to provide stable, smooth pressure. In contrast, the Chevron Rando® HD ISOCLEAN® Certified hydraulic fluid produced a very smooth pressure curve, indicating no interruptions to the pressure control valve. We saw no wear on the valve cylinder or damage to the piston.

So can lubricant contamination have an impact on hydraulic pressure? The answer is clearly yes, meaning that the equipment you operate will not perform as efficiently as needed, reducing production and possibly increasing product defects, causing your equipment to wear out sooner rather than later.

Can switching to a clean lubricant can restore hydraulic pressure efficiency?

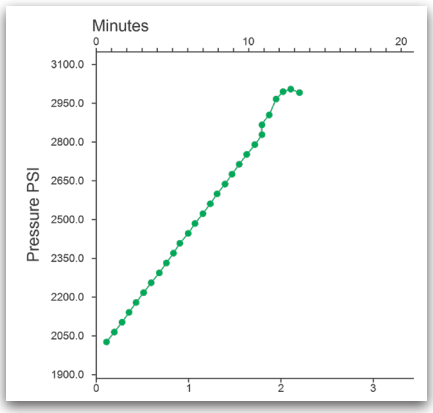
When we talk to our industrial customers about the importance of lubricant cleanliness in improving equipment performance and extending its life, we sometimes hear this response: "If my equipment is already damaged, what is the point of putting clean oil in it?"

The answer may surprise you. In the previous section, we looked at the impact of oil cleanliness on hydraulic system pressure efficiency. Specifically, we shared test results showing that a typical hydraulic fluid that is not certified to the equipment manufacturer's ISO cleanliness standards can have a jarring effect on system pressure and overall system performance. Using a certified clean hydraulic fluid, however, can result in smoother pressure and efficient performance.

In the course of our testing, we took apart a high-pressure Eaton vane pump to examine the relative wear caused by typical contaminated hydraulic fluids versus a Chevron Rando HD ISOCLEAN® Certified hydraulic fluid. We then put back together a pump that had experienced significant wear from a typical hydraulic fluid over a period of 150 hours, and refilled it with a Chevron Rando HD ISOCLEAN Certified hydraulic fluid.

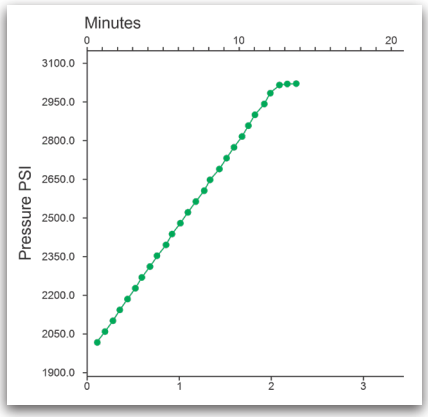
The results were fairly dramatic. With the typical hydraulic fluid, the pressure control valve had exhibited instability, as shown by a somewhat shaky pressure control curve. With the Chevron Rando HD ISOCLEAN Certified hydraulic fluid, the exact same valve exhibits a very smooth pressure control curve.

Typical Hydraulic Fluid B ISO 32 (System Filter)



Chevron Rando HD® 32 ISOCLEAN® Certified

Using End of Test (150 hrs.) Damaged Parts from Typical Hydraulic Fluid B ISO 32



What this tells us is that you actually can stabilize a hydraulic system's fluid pressure and gain operating efficiency by putting a certified clean oil into a previously damaged system. Whether you're operating an excavator on a construction site or a plastic injecting molding machine, you're going to get much more efficient performance, higher production and improved quality by changing out a typical hydraulic fluid for a certified clean lubricant. You might even get many more hours of useful life out of the equipment that would otherwise have been cut short by sticking with a typical contaminated hydraulic fluid.

Our advice, of course, is always to "start clean." Our testing found a clear correlation between initial hydraulic fluid cleanliness and the amount of wear on hydraulic system components. We further concluded that fluid contamination can have a negative impact on system fluid pressure and efficiency.

Hydraulic leaks: A telltale sign of particle contamination

When lubricant sales representatives discuss hydraulic failures with maintenance managers, the conversation typically focuses on extending the life of the hydraulic systems (valves, cylinders, pumps, hoses). Since it is widely accepted that particle contamination found in new lubricants is one of the major causes of component failure, there is great validity in the fact that failures can be delayed or even avoided when lubricant cleanliness is properly addressed.

When a customer decides to proceed with a clean oil program, it begins by determining the correct ISO 4406 cleanliness for the component. To simplify the target for the system, use the specification for the component with the tightest ISO cleanliness specification as the standard for new oil being delivered. This is what we call validating the third specification for your lubricant, as everyone knows how important the viscosity grade and performance properties are. Overlooking this third lubricant specification, however, has dire consequences. While new, pre-filtered oil costs an incremental amount more, it offers a greater cost savings overall – through increased valve, cylinder, pump, hose and seal life.

Multiple OEMs have reported the benefits of clean lubricants, which are reduced component wear and extended rebuilds, leading to decreased downtime and reactive maintenance tasks. That said, asking for an increase in operating budgets can be challenging. First, maintenance personnel may not be tracking their failures or identifying RCAs (Root Cause Analysis) as to why failures are occurring. Rather, maintenance staff become accustomed to changing out the failed parts on a more regular basis and come to expect this status quo as the norm for their operation.

Also fueling the status quo, many industries that employ maintenance and repair workers must deal with frequent turnover. Employees who are exposed to an unsafe environment, or at a shop that can't stay on top of its tasks, are more likely to leave. Thus, reducing unscheduled activities not only has a direct impact to the bottom line, it can also improve shop morale. But even if you aren't convinced that lubricant cleanliness can save money or improve morale, as a maintenance manager the thought of a critical hydraulic system failure will keep you awake at night. Whether in-plant, on a construction site, or in an underground mine, if you have hydraulic equipment, you have plenty of maintenance tasks to think about, both scheduled and unscheduled.

Another common frustration with hydraulic systems is leaks. This too has some shops thinking it is normal and unpreventable. As maintenance personnel will attest, most of those leaks occur at rigid-to-flexible fittings where O-rings have simply failed. What many don't take the time to quantify is that small leaks add up quickly. Looking at the chart below, one drop in 10 seconds doesn't seem to add up to a significant amount, but imagine this was occurring with 25 out of the 100 hydraulic systems on site, which would add up to 1,000 gallons a year. Multiply that loss by the cost of your hydraulic oil, let's say $10/gallon for example, that would mean a $10,000 annual loss. Does it make sense to take that $10,000 annual loss and reinvest it in a clean lubricant program?

Leakage Rate	Gallons Per Day	Gallons Per Month	Gallons Per Year
1 drop in 10 seconds	0.112	3.38	40
1 drop in 5 seconds	0.225	6.75	81
1 drop in 1 second	1.125	33.75	405
Three drops per 1 second	3.38	101.3	1215
Drops break into stream	24	720	8640

During an evaluation to uncover the cause of one customer's high fluid leak rate, Chevron's team of Industrial Specialists discovered a customer was leaking nearly 800 gallons of oil per day. Instead of addressing the root cause issue - contamination - the location opted to collect the leaked oil, attempt to reclaim it and use it again. This was costing the company $150,000 in maintenance practices.

Although there is limited test data available linking the shortened life span of O-Rings to higher levels of particulate contamination, we have customers who have seen firsthand that such contamination is responsible for the abrasive destruction of the elastomer material degrading its ability to seal effectively. Constant abrasive activity essentially sand blasts the system and degrades the softer O-Ring material leading to seal deterioration, leaks and premature component failure.

Of course, a leaky O-Ring may or may not be considered significant, depending upon which hat you're wearing. The engineer might point out that an O-Ring is designed to be replaced and probably costs only a few dollars. But the maintenance manager is thinking about how many man hours the repair will take, what parts must be disassembled to access the failed seal, the opportunity cost associated with the down time of an entire line, and finally the lockout tagout process to isolate potential energy so that the necessary human-machine interaction can be accomplished safely. On top of that, they must balance their workload with their budget.

Overall, it is safe to say particle contamination wreaks havoc on components which can lead to extreme leaks, headaches, and not to mention exposure to safety issues (like slips, trips and falls). If you want to calculate the cost of your fluid leaks, check out Parker Hannifin *Corporation's Oil Leak Calculator*.

Conventional wisdom would suggest that preventive maintenance is a proactive approach, in which cost is justified as it will reduce premature equipment failure when done properly. Perhaps a more innovative approach is to aim to improve your equipment life from the very beginning, by ensuring your lubricants start clean and implementing the correct tools to maintain their cleanliness.

To learn more about Chevron hydraulic oils and ISOCLEAN® Certified Lubricants, visit ChevronLubricants.com