Cat® Hydraulic Systems



Management Guide

- Prevention
- Detection and Cleanup
- Inspection





CATERPILLAR®

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Elements of hydraulic systems management

Prevention

Many hydraulic system problems can be prevented with attention to the system's number-one enemy: fluid contamination. By learning to control contamination, you can help maintain system efficiency, extend component life and correct problems before they lead to costly repairs and unscheduled downtime.

Detection/Cleanup

Hydraulic systems are closed systems, which means much of what you need to know is happening internally. To detect wear and other problems that can occur inside the system, we recommend regular use of our S·O·S℠ Fluid Analysis Services. One of these services, Particle Counting, is especially important for hydraulics. It identifies excessive contamination levels that can be brought under control through high-efficiency filtration, "kidney looping" and other means.

Inspection

Daily hydraulic system inspections performed by you and your operators can catch leaks and other small problems before they result in unscheduled downtime. Efficiency loss is not easily detected and silently robs your machine of performance. That's why we also recommend technical inspections performed by our trained technicians. These periodic inspections include checks of system pressures, cycle times and more—which can identify problems and help us recommend corrective actions.

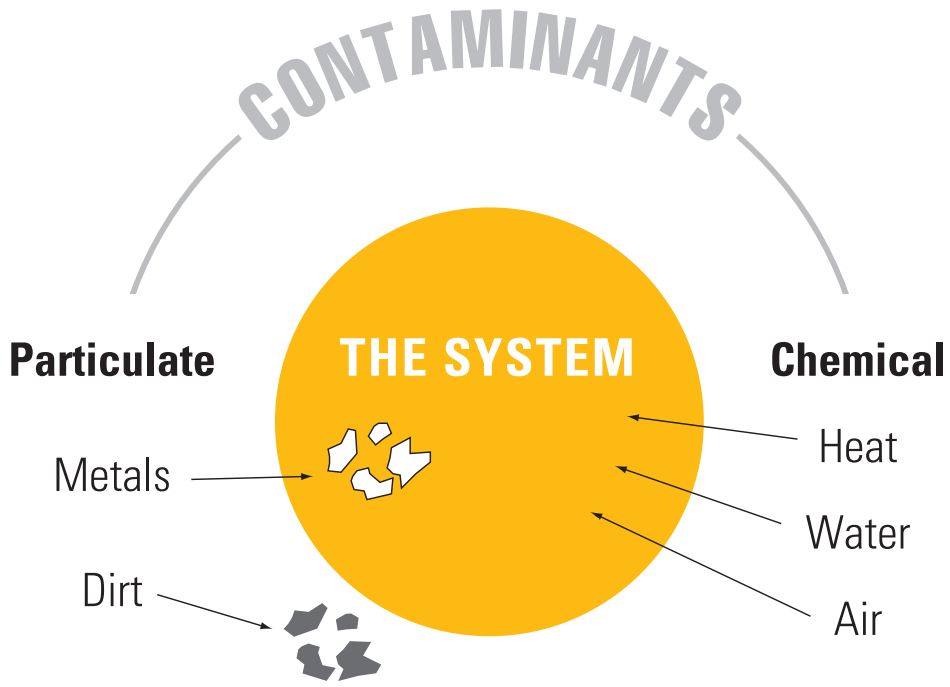




Know what contaminants are

Preventing hydraulic system problems begins by addressing fluid contamination. Contaminated oil is the primary threat to today's hydraulic systems. Understanding what contamination is, why it's harmful, how it gets in and how to control it can go a long way in improving machine performance, extending component life and lowering your costs.

Contamination is anything foreign in the hydraulic system. There are two types of contaminants: particulate and chemical.



Particulate contaminants

Particulate contaminants are the most common, measurable and controllable. They can be built in at the factory, transferred in through new oil, generated internally or taken in during maintenance, attachment changes and machine operation. Examples of particulate contaminants include dirt, sand, paint and metal or rubber wear particles.

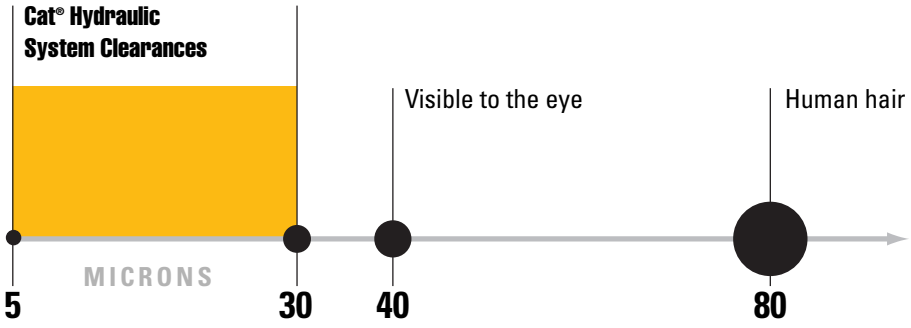
Chemical contaminants

Chemical contaminants include heat, water and air. These combine to break down the oil's chemical composition, producing contamination in the form of oxidation and acids. Like particulate contaminants, chemical contaminants can originate inside or outside the system.

Know the effects of contamination

Fluid contamination damages a hydraulic system in two ways. First, it **reduces system efficiency**. Machine productivity and efficient hydraulics go hand in hand. If a hydraulic system isn't performing at peak efficiency, it's robbing the machine of performance. Efficiency losses usually occur slowly and can reach 16 percent to 20 percent before the operator detects a loss in performance. These "invisible" efficiency losses also can increase fuel consumption.

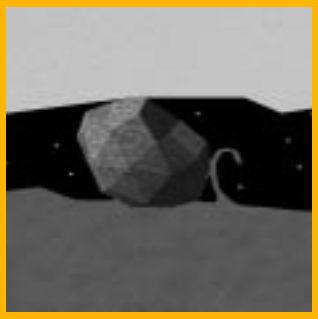
Contamination also **accelerates component wear**—75 percent to 85 percent of hydraulic pump, motor, cylinder and valve failures can be traced to contamination. Due to the extremely small clearances in today's hydraulic systems, even particles you cannot see can damage pumps, motors, cylinders and valves in the form of abrasive, adhesive and fatigue wear.



Typical metal-to-metal clearances in Cat® hydraulic systems are 5-30 microns (one micron is one millionth of a meter). Therefore, even particles too small to see can do big damage.

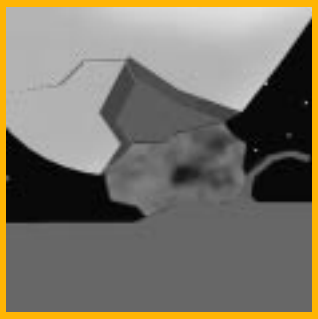
Abrasive wear

Abrasive particles scrape metal from hydraulic components. Wear metal is created, multiplies and travels to other parts of the system to do more damage.



Fatigue wear

Repeated high-pressure stress loads cause metal to chip or break from components and contaminate the hydraulic system.



Adhesive wear (Silting)

Small particles build up on metal surfaces and clog the flow of fluids. The result is jamming and sticking of valves and reduced system efficiency.

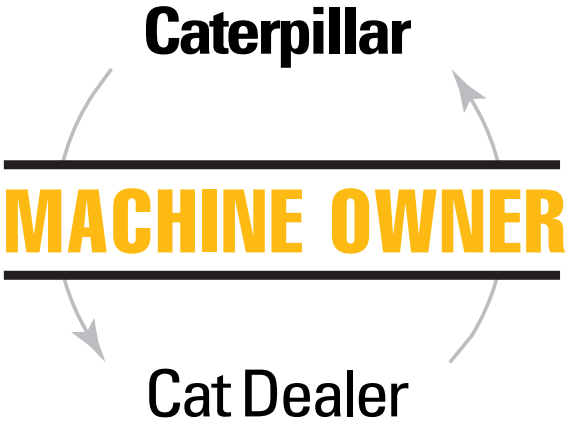


Know when your systems are exposed to contamination

Because contamination can have many sources throughout the life of a machine, controlling it must be a joint effort.

Caterpillar is committed to shipping clean machines and components. As a result, in-plant process reviews and employee education are ongoing efforts. Caterpillar also is working to educate its dealers and customers on ways to keep Cat products clean once they leave the factory.

Let's look closely at some of the things you can do to minimize contamination. You'll be surprised how many are simply common sense.



Control contamination during housekeeping

If you have a service shop, housekeeping is the best place to initiate contamination control. Each technician needs to understand the importance of contamination control and practice it daily. Here are some tips:





Keep floors and work areas clean

Sweeping floors daily and maintaining uncluttered work benches with surfaces that won't mar parts or add contaminants are good ways to jump-start contamination control efforts.

Put someone in charge

Making someone responsible and accountable for results will help ensure contamination control becomes an ongoing effort.



Manage spills correctly

Oil spills should be cleaned up promptly and properly. Absorbent pads, mops and scrubbers are recommended over granular methods that tend to pollute the air with contaminants.



Protect work "in progress"

When possible and at the end of each shift, make sure in-process repairs are protected from airborne contaminants. Ask us about other repair processes that can be implemented to control contamination.

Control contamination during oil and filter changes and oil storage



Select the right oil

Cat Hydraulic Oil contains the needed additives, like oxidation and foam inhibitors, to help prevent contamination. It also has more than twice as much zinc as standard industrial oils to provide maximum protection to pumps, motors, cylinders and valves. Be familiar with the additives in your oil, and don't compromise quality to save a small amount of money.



Change oil regularly and always filter oil stored in bulk

Caterpillar has extended the oil change interval for hydraulic systems to 4,000 hours, providing certain conditions for monitoring the oil are met. We also recommend changing oil when it's warm and agitated, and always filtering new oil from barrels or other bulk systems before installation.



Use tight-fitting barrel covers

Tight-fitting covers, such as our 1U6156, can help prevent dirt, water, airborne particles and other contaminants from entering oil barrels. It's also wise to store barrels inside.

Control contamination during hose assembly

Precautions you take when assembling and storing hoses can go a long way in minimizing fluid contamination.





Besides maintaining a clean facility, paying attention to the hydraulic oil is important. The oil you select and how you store and transfer it all have an impact on contamination and component life. Filter and fluid changes also present contamination control opportunities. Here are a few tips:



Change filters regularly and carefully

Hydraulic filters should be changed at least every 500 hours. It's also important to keep new filters and other parts packaged until they're ready to install and to remove old filters carefully.



Use quality filters between system invasions

Using inadequate filters can compromise performance. To maintain the highest levels of cleanliness and performance, we recommend installing genuine Cat Fluid Filters.



Use High Efficiency Filters after maintenance and service

Contaminants invade the hydraulic system any time it's open for maintenance or repair. We recommend Cat High Efficiency Filters at 250 service meter hours following any system invasion. Be sure to change High Efficiency Filters before 250 hours if the bypass indicator goes on.

Clean hoses properly during assembly

The cutting and assembly of hoses introduce many contaminants that need to be removed before installation. We recommend use of the Cat Hose Cleaner Group, which fires a foam projectile through hoses, tubes and couplings. This air-powered tool takes only seconds to strip out metal and rubber contaminants traditional cleaning methods leave behind.

Protect stored hose and assemblies

Bulk hose in storage and assemblies that have been properly cleaned should be protected from airborne contaminants. Installation of caps and plugs is a low-cost means of delivering this protection.



Control contamination during general maintenance

Earlier we discussed the importance of following recommended oil and filter change intervals. A few other prevention tips include:



Perform daily inspections

When performing the daily inspections, check for leaks and promptly fix any you find. Look especially for worn cylinder wiper seals and pitted rods that may be giving dirt and other contaminants a free pass into the system.



Keep hydraulic tanks filled

Always keep the hydraulic tank between “Full” and “Add.” Insufficient fluid levels are the leading cause of pump cavitation, leading to pump failure and contamination of the entire system. Low fluid levels can also result in high oil temperatures, causing oil to degrade.



Maintain valves

Maintain oil cooler and relief valves properly. Relief valve settings should be adjusted only by our trained technicians. If a pressure loss is detected, it’s important to find its source and repair it.



Replace worn fan belts

Inspect fan belts, radiators and oil coolers regularly. Maintaining fan speed and cleaning debris from radiators and oil coolers will help keep the system operating at acceptable temperatures.



Control contamination during equipment operation

A variety of contaminants can be introduced into your hydraulic system on the job site. Here are a few ways to guard against contamination:

Monitor hydraulic system temperatures

Excessive heat in hydraulic systems thins the oil, increases fluid oxidation, bakes seals and blisters hoses. It is important to monitor system temperatures and, if equipped, watch temperature gauges and sensor lights.

Use rod protectors

In extremely dry applications and others where banked rock, corrosive material and debris are common, we recommend protective covers for the exposed portions of hydraulic cylinder rods. Ask us for details.

Use care when changing work tools

With today's machines, operators frequently change work tools that are hydraulically driven. If not maintained, these tools can contaminate each machine they're attached to. Always inspect quick couplers and wipe off dirt from flush-face disconnects before coupling. Protect nipples and couplers with caps and plugs.

Listen to your operators

An often-overlooked opportunity for contamination control is listening to your operators. Day in and day out, these individuals live with your machines and can alert you to excessive drift, noises and other signs of possible contamination.





Know what is happening inside your hydraulic systems

Helping to prevent contamination is important, but you also must know what is occurring inside your hydraulic systems. Regular use of our S·O·S Services is the best way to detect component wear and contamination so you can head off problems early.

Take samples regularly

Taking hydraulic oil samples regularly—every 500 hours—is critical because it allows for accurate interpretation. When samples are taken regularly, a baseline is established so trends can emerge. We need this information to make proper service recommendations. How you take a sample is also important. For more information, ask us to see video PEVN5514 (VHS tape) or AERV5514 (CD), both entitled "S·O·S Services Oil Sampling Techniques."

The cleaner the system, the better!

Caterpillar recommends a cleanliness target for optimizing component life in Cat hydraulic systems of ISO 18/15 or cleaner.

Understand our S·O·S℠ Services

S·O·S Services for hydraulic systems is composed of four complementary tests:

- Component Wear Rate Analysis evaluates the wear taking place inside the lubricated compartment.
- Oil Condition Analysis determines if the oil has degraded.
- Oil Contamination Tests determine if anything harmful has entered the oil.
- Oil Identification confirms use of the correct oil.

S·O·S interpreters use these tests to evaluate hydraulic system health and, if needed, recommend maintenance.



Use the correct method to take samples



Using an oil valve probe

- Set the engine at low idle after it reaches normal operating temperature. Remove the dust cap from the valve of the compartment you are sampling.
- Insert the probe into the valve and collect about 100 ml (4 fl oz) of oil into a waste container. Dispose of the waste oil and tube properly.
- Insert the probe with a new piece of tube into the valve again and fill the sample bottle about three-quarters full—do not fill to the top.
- Withdraw the probe and secure the cap on the bottle. Place the bottle with the completed label into the shipping cylinder.

NOTE: Oil valve probe should be used on pressurized compartments only. Retrofit valve kits are available for models not equipped with valves.



Filling out label accurately

Providing complete information on the sample label makes processing your sample easier. Make sure you include important information like:

- Machine model and serial number
- Service meter units on equipment and oil
- Whether or not the oil was changed when the sample was taken



Using vacuum extraction

- Turn off the engine after it reaches normal operating temperature. Measure and cut new tubing to the length of the dipstick. If the compartment you are sampling does not have a dipstick, cut the tubing so that it reaches about halfway into the oil depth.
- Insert the tubing through the head of the vacuum pump and tighten the retaining nut. The tubing should extend about 4 cm (1 in) beyond the base of the vacuum pump head.
- Install a new sampling bottle onto the vacuum pump head and insert the end of the tubing into the oil—do not allow the tube to touch the bottom of the compartment.
- Pump the vacuum pump handle to create a vacuum. Fill the bottle about three-quarters full—do not fill to the top.
- Withdraw the tubing, remove the bottle from the vacuum pump and secure the cap on the bottle. Place the bottle with the completed label into the shipping cylinder.



Address elevated contamination levels promptly

When interpretation of S·O·S data verifies you have a contaminated system, it's important to respond promptly. The longer you operate a contaminated system, the faster components wear, system efficiency erodes and oil properties break down.

Besides identifying and correcting the cause of elevated contamination levels, it's important to clean up the system. High Efficiency Filters, "kidney loop" filtration, oil changes or complete system flushing may be appropriate, depending on contamination levels. We'll be glad to discuss this topic and the Caterpillar Filter Carts available with you in more detail.

Follow these recommended hydraulic system service intervals

10-hour or daily inspection

- Check hydraulic fluid level
- Check hydraulic cylinders and pumps for leaks
- Check hoses, lines and hydraulic tank area for leaks or damage

250-hour or monthly inspection

- Perform 10-hour preventive maintenance checks
- Check hydraulic oil cooler for leaks or plugging
- Check all hydraulic lines for damaged, missing or loose connections

500-hour or quarterly inspection

- Perform 10- and 250-hour preventive maintenance checks
- Perform S·O·S Services of hydraulic oil
- Change hydraulic filter
- Check hydraulic pumps and mountings for loose or missing hardware

1,000-hour or six-month inspection

- Perform 10-, 250- and 500-hour preventive maintenance checks
- Check pump weep holes for leaks

2,000-hour or annual inspection

- Perform 10-, 250-, 500- and 1,000-hour preventive maintenance checks
- Check hydraulic system pressure
- Check hydraulic system cycle times and drift rates





Call our service department for more information on Custom Hydraulic Service and to inquire about other hydraulic system maintenance programs that may be available.

The final element in hydraulic system management involves inspecting and "listening to" your equipment. You can help maintain system performance and catch problems early by:

- Following the inspection and maintenance schedule shown on this page
- Enrolling hydraulics-intensive machines in our Custom Hydraulic Service Program
- Paying attention to the repair indicators listed on page 15

Custom Hydraulic Service (CHS)

Once a year or every 2,000 hours, we recommend having your hydraulic systems inspected by our trained service professionals. During these CHS inspections we:

- Conduct a detailed visual walkaround inspection of the hydraulics, engine compartment, cab, power train and ground engaging tools
- Drift test all hydraulic cylinders
- Perform complete checks of cycle times and system pressures
- Stall test the hydraulic system
- Take a sample of the hydraulic oil and perform S·O·S Services

After interpreting the inspection and fluid analysis results, we'll meet with you to deliver a complete report. If service is necessary, we'll also provide a quote. We offer a variety of repair options and can help you decide on the one best for you.

Pay attention to repair indicators!

Repair Indicators	Possible Causes	Cat Dealer Service Options
Leaks	System pressure too high Scored or bent cylinder rod Failed or incorrect seals Improperly torqued hose connection Worn or damaged hoses, tubes and fittings Missing guards	Hose service Thorough visual machine inspection Maintenance and diagnostic services S·O·S Services Custom Hydraulic Service
Excessive cylinder drift	Valve adjustment needed Scored cylinder Failed seal or seals Scored valve Contaminated oil	Identification and measurement Diagnostic services S·O·S Services Custom Hydraulic Service
Slow cycle times	Engine performance Faulty valve Low fluid level Worn system components Contaminated oil	Machine measurements compared to specs Diagnostic services S·O·S Services Custom Hydraulic Service
Noisy operation	Engine performance Low fluid level Restriction in system Aeration Worn system components Faulty relief valve	Thorough visual machine inspection S·O·S Services Custom Hydraulic Service
System overheating	Faulty oil cooler Low fluid level Plugged filter Worn system components Faulty relief valve Wrong viscosity or contaminated oil Restriction in system Poor operator habits	Thorough visual machine inspection Maintenance and diagnostic services S·O·S Services Custom Hydraulic Service
Loose cylinder joints	Worn rod or cylinder eye/trunnion Poor lubrication Improper preventive maintenance schedule	Component inspection/repair Custom Hydraulic Service
Blisters or abrasions in hose	Pinhole leaks in liner material Poor hose routing External damage System overheating	Thorough visual machine inspection Hose service Custom Hydraulic Service
Excessive hose movement	Improper clamping or routing of hose Aeration/cavitation	Hose service
S·O·S Services	High levels of wear elements, dirt and other contaminants in oil will accelerate component wear and erode system efficiency	Preventive maintenance schedule consultation Custom Hydraulic Service
High service meter hours	Talk with us to determine what high-hour service is appropriate for your systems	Consult with dealer Custom Hydraulic Service

Comprehensive service and support

More and more of your operating costs are tied to hydraulic systems. We are committed to helping you lower those costs—as well as maximize efficiency, productivity and machine availability—through ongoing attention to contamination control and the other system management elements.

Ask us how we can incorporate a hydraulic system management program into a Customer Support Agreement to achieve these results.

For more information about our hydraulic products and services, call us today or visit the Caterpillar website at www.cat.com.

CAT® DEALERS DEFINE WORLD-CLASS PRODUCT SUPPORT.

We offer you the right parts and service solutions, when and where you need them.

The Cat Dealer network of highly trained experts keeps your entire fleet up and running to maximize your equipment investment.



PEGP6028-05
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