

## **Detecting and Managing Hydraulic System Leakage**

**Kevan Slater, Trico Corporation**

It is unfortunate, however, that many leaks that have been identified in our hydraulic systems are left to drip away the profits of a company: Profits lost with unnecessary energy consumption, reduced equipment performance, decreased reliability, increased lubricant costs, increased house keeping cost, etc...

Even more leaks are not identified due to the fact that there are no visual indications of the leak until system performance has been severely affected. The components with these leaks are then typically repaired in an unplanned fire-fighting mode of breakdown maintenance.

Identifying and controlling hydraulic system leakage requires an in-depth approach to record keeping and surveillance based on monitoring leakage within our hydraulic systems. Also, a dedication to perform repairs and/or modifications aimed at the root causes of the leaks along with a method of monitoring to ensure the repairs performed have being effective.

### **INTRODUCTION**

The vast majority of hydraulic systems in operation today have leaks; leaks that are planned. They are designed with a specific function in mind and in many cases documented by the Original Equipment Manufacturer (OEM) as the amount of acceptable leakage under normal operating conditions. Internal planned leakage is typically small orifices or pathways that allow a lubricant from a higher pressurized side of a system to a lower pressurized area to lubricate, clean and cool a specific component or area. These planned internal leaks do not allow the lubricant to exit the hydraulic circuit so there is no visual indication of their presence.

Excessive internal leakage can be the result of system design, incorrect component selection, poor quality control tolerances during the manufacturing of a component, incorrect overhaul of rebuilt components and the most common, excessive wear of a component during designed operation. System performance, reliability and increased operating temperatures are the first visual signs of excessive internal leakage.

The major power loss in hydraulic systems usually is the result of internal leakage on pumps and motors. This leakage is the result of excessive clearances within the pumping mechanisms of the pumps and motors resulting in reduced efficiency. Slippage is a common term used to describe the volumetric loss of a pump/motor. This slippage is typically identified when the input energy remains the same or higher except less work can be performed in the hydraulic circuit.

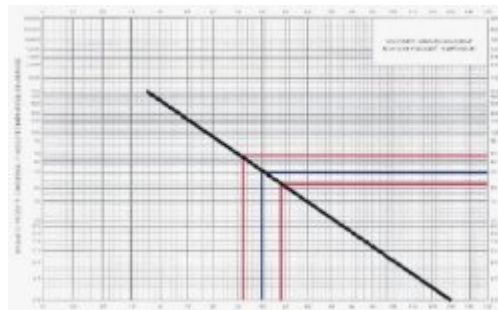
In hydraulic cylinders, cylinder rod drift or creep and the cylinder's inability to hold the designed load would be identified by increased leakage. The excessive leakage is the result of the lubricant bypassing a piston seal either through a worn seal or a worn cylinder barrel.

In spool valves, excessive internal clearances between the spool and the valve body decreased control and stability of the hydraulic circuits and their functions. Profit robbing energy loss is the result of energized fluid that is allowed to escape back to the reservoir through a spool valve that has an out of specification clearance problem. Relief valves or other spring offset valves that have a weak spring or a jammed open condition will have the same effect of fluid energy loss by allowing the pressurized fluid into by-passing the working circuit.

Incorrect lubricant viscosity or excessive heat resulting in the reduction of the effective viscosity of a lubricant will also produce excessive leakage rates. The result of this form of internal leakage reduces system performance and decreases lubricant film strength, which will also result in premature degradation of the equipment and the lubricant.

Eventually, all of these conditions will affect hydraulic system performance and ultimately company profits. Detection of unplanned internal leakage in most cases would rely on specific tools to examine the location and quantity of the leak. Performance issues or the inability of a circuit to perform its designed function typically triggers craftsmen to install flow meters in various locations (e.g. case drains on pumps) which allow for the detection of excessive leakage resulting from unacceptable clearances in mating surfaces. Many companies install flow meters on the case drains of pumps and motors to determine when to overhaul these components before performance is severely affected. In critical automated positioning systems both the control valves and the hydraulic cylinders could require periodic bench testing to ensure an acceptable leakage rate is maintained. At this point all components that fall outside the acceptable standards would require an overhaul ensuring that OEM minimum standards are achieved.

OEM's recommend an optimum operating viscosity required by their equipment to perform within the design parameters. Selection of a lubricant and maintaining an operating temperature that achieves the OEM recommended viscosity becomes in many cases the responsibility of the end user. Temperature measurement at the critical components ensures that equipment is operating within that optimum range. Use of a Viscosity-Temperature Standard Charts (ASTM D341) assists in determining these variables.



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Non-contact infrared thermometers are very useful for non-obtrusive measurement of operating temperatures of equipment. An abnormal temperature increase at a relief valve could indicate that the valve is in a bypassing condition. This by-pass condition will generate heat locally in the component and in many cases the anomaly would have gone undetected by monitoring the system reservoir temperature because of system coolers or dissipation of heat throughout the system.

Ultrasonic detection has proven to be another effective method of determining high pressure or high velocity leaks in various locations of valve and cylinder leakage. This method allows for detection of a specific location of the internal leakage but similar to temperature reading, the results are not quantifiable into the amount of leakage. The only quantifiable method is to measure the flow or quantity of fluid loss in a given time frame using a flow meter or other associated test equipment.

External leakage is the most recognizable type of leakage. Even the untrained eye can easily spot a broken hose spewing oil like a Texas geyser. These types of leaks will typically be repaired quickly as the equipment and production will soon come to a quick halt if we do not. The constant drip or drop is not always repaired due to the fact that system performance and production are not usually affected. The location and/or quantity of lubricant leaked is in many cases like "Waldo", hard to find and we consider the repair really not worth the effort!

Many companies spend ten of thousand of dollars a year on replacement top-up fluids not really understanding the financial impact of a drip. Reports show that the true replacement cost of lubricant can result in a cost 5 times the cost of the new lubricant. Two areas that are not

represented in the lubricant replacement costs and should be to renew our interest in repairing leaks are:

1. Safety Issues
2. Environmental Issues

Both of these areas have personal and financial implications when leaks are allowed to exist without competent efforts exerted into eliminating them.

Detection and quantification of the fluid consumption is the first step in external leak control. Competent up-to-date reservoir management records must be maintained to determine when, by whom and how much lubricant was required to top-up a reservoir. These records should be used along with visual inspections to determine the location and the leak rate of any detected anomalies.

SAE J1176 Leak Classification Tables allow for a method that quantifies leaks once they have been located. Quantification of the leakage rate and location will allow for the opportunity to prioritize the repairs. In many cases the source and quantity of the leaks cannot be determined, as they are very difficult to see visually. The best practice would recommend cleaning an area and fully wiping down equipment to examine the leaks. The practicality of performing these actions in an operating production facility becomes almost an impossible task.

To alleviate this problem, dyes that are sensitive to black light have been formulated to assist in the location and identification of these types of leaks. This liquid dye is formulated to be compatible with the existing hydraulic lubricants. The dye is mixed into the reservoir and the mixture will emit a bright green/yellow glow when struck by the rays of a black light. This method of visual detection helps in determining whether the oil being viewed is from an active leak from the system in question.

SAE CLASS	LEAKAGE TERM	LEAKAGE DESCRIPTION
0	DRY	No indications of moisture
1	WEEP	Any non-recurring fluid
2	SEEP	Recurring fluid not forming a droplet
3	DROPLET	Recurring non-falling droplet
4	DRIP	Recurring falling droplet
5	FLOW	Recurring stream forming volume
<b>PER SAE J1176 Recommended Practice</b>		
(Under Dust Free Conditions)		
SAE CLASS	LEAKAGE TERM	LEAKAGE DESCRIPTION
0D	DRY	No indications of moisture
1D	WEEP DUST	Dry collection, Non Propagating
2D	MOIST-A	Moist thin dust layer
3D	MOIST-B	Moist thick dust layer
4D	WET	Recurring fluid and drip
5D	WASHED	Recurring fluid forming a stream
<b>PER SAE J1176 Recommended Practice</b>		
(Under Dusty Conditions)		

## SUMMARY

The changing workplace, the environment and the need for equipment reliability requires a concerted effort to monitor and maintain all unplanned leaks. This effort or program must exist from the original equipment design throughout the life cycle of the equipment to preserve system viability and system integrity. Commitment to this program must create increased awareness by supplying training and equipment to quantify, characterize, analyze and assess all types of leaks. This collect information will allow the maintenance professionals an opportunity to perform leakage control activities by planning, organizing, managing and implementing corrective solutions to achieve leakage stability.

Managing and achieving hydraulic system leakage stability reduces energy consumption, reduces waste, increasing up time, improves equipment reliability and increases company profits.

## References:

Proactive Maintenance for Mechanical Systems- "Leakage Stability" (1992) Dr. EC Fitch, Stillwater, OK Annual Book of ASTM Standards 2000– Volume 05.01 "ASTM D341-Viscosity-Temperature Charts for Liquid Petroleum Products" (2000) ASTM West Conshohocken, PA SAE Sub 4 "External Leakage Classifications for Hydraulic Systems" SAE J1176, (1977) SAE Warrendale, PA