HYDRAULIC AND PNEUMATIC CYLINDER FAILURES , THE EFFECT OF FLUID CLEANLINESS ON COMPONENT LIFE

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Abstract:

This article reviews the situation of hydraulic and pneumatic failures of cylinders. It also identifies the various component malfunctions that may lead to these failures. Furthermore, the effect of fluid cleanliness on cylinder component life cycle was examined.

Keywords: Hydraulic, Pneumatic, Failures, Cleanliness Life

1. Introduction

The application of cylinders may allow fluids such as cutting fluids, wash down fluids, etc to come in contact with the external area of the cylinder. These fluids may attack the piston rod wiper and or the primary seal and this must be taken into account when selecting and specifying seal components.

Dynamic seals will wear. The rate of wear will depend on many operating factors.

Wear can be rapid if a cylinder is miss-aligned or if a cylinder has been improperly serviced. Seal wear is very important in the application of cylinders and could lead to failure.

Piston-rods: Possible consequences of piston-rod failure or separation of the piston rod from the piston include but are not limited to.

- Piston rod or attached load thrown off at high speed
- High velocity fluid discharged
- Piston rod extending when pressure is applied on the piston retract mode

Piston rods or machine members attached to the piston may move suddenly and without warning as a consequence of other conditions occurring to the machine such ass:

- Failure of the pressurized fluid delivery system (hoses, fitting, valves, pomp, compressors) which maintain cylinder position
- Catastrophic cylinder seal failure leading to sudden loss of pressurized fluid

The use of cushions should be considered for cylinder applications when the piston velocity is expected to be over 4inches/second. These cushions are normally designed to absolve the energy of a linear applied loud.

A rotating masse has considerably more energy than the same masse moving in a linear mode.

All these could lead to hydraulic and pneumatic cylinder failure.

Proper alignment of the cylinder piston rod and it's matting components on the machine should be cheeked-in both the extended and retracted positions.

Improper alignment will result in excessive rod stand and/or cylinder bore wear.

Another source of failure is internal leakages. Piston seal leak (by-pass) 1-3 cubic inches per minute is considered normal for piston ring construction. Virtually no static leak with lip seal seals on piston should be expected. Piston seals wear is a usual course of piston seal leakage and eventual cylinder failure.

Contamination in a hydraulic system can result in a pored cylinder bore, resulting in rapid seal wear which may lead to cylinder failure.

2. Effect of fluid cleanliness on component life

This is an important factor for consideration in cylinders operating in an environment wear air drayed materials are present such as : fast draying chemicals paint or weld splatter or other hazardous conditions such as excessive heat should have shields installed to prevent damage to the piston rod and piston rod seals.

Many factors can reduce the service life of hydraulic components. Contamination of hydraulic fluid by insoluble particles is one of these factors. To prevent particle contamination from cutting short component life, an appropriate fluid cleanliness level must first be defined and then maintained on a continuous basis. [5]

Particle Contamination And Its Consequences

Particle contamination in hydraulic fluid accelerates wear of system components. The rate at which damage occurs is dependent on the internal clearances of the components within the system, the size and quantity of particles present in the fluid and system pressure. Typical internal clearances of hydraulic components are shown in table 1.

Table 1.

COMPONENT TYPE	TYPICAL INTERNAL CLEARANCE IN MICRONS
Gear pump	0.5 – 5.0
Vane pump	0.5 – 10
Piston pump	0.5 – 5.0
Servo valve	1.0 – 4.0
Control valve	0.5 – 40
Linear actuator	50 - 250

Particles larger than a component's internal clearances are not necessarily dangerous. Particles the same size as the internal clearance cause damage through friction. But the most dangerous particles in the long-term are those that are smaller than the component's internal clearances. Particles smaller than 5 microns are highly abrasive. If present in sufficient quantities, these invisible 'silt' particles cause rapid wear, destroying hydraulic components.

Quantifying Particle Contamination

Some level of particle contamination is always present in hydraulic fluid, even in new fluid. It is the size and quantity of these particles that we are concerned with. The level of contamination, or conversely the level of cleanliness considered acceptable, depends on the type of hydraulic system.[5] Typical fluid cleanliness levels for different types of hydraulic systems, defined according to ISO, NAS and SAE standards, are shown in table 2.

Table 2.

TYPE OF HYDRAULIC SYSTEM		**MINIMUM RECOMMENDED CLEANLINESS LEVEL**		**MINIMUM RECOMMENDED FILTRATION LEVEL IN MICRONS (βχ ≥ 75)**
ISO 4406		**NAS 1638**		**SAE 749**
Silt sensitive	13/10	4	1	2
Servo	14/11	5	2	3-5
High pressure (250–400 bar)	15/12	6	3	5-10
Normal pressure (150-250 bar)	16/13	7	4	10-12
Medium pressure (50 -150 bar)	18/15	9	6	12-15
Low pressure (< 50 bar)	19/16	10	-	15-25
Large clearance	21/18	12	-	25-40

ISO 4406 defines contamination levels using a somewhat complicated dual scale numbering system. The first number refers to the quantity of particles larger than 5 microns per 100 milliliters of fluid and the second number refers to the number of particles larger than 15 microns per 100 milliliters of fluid.
The complicated part is that the quantities of particles these numbers represent are expressed as powers of the numeral 2. For example, a cleanliness level of 15/12 indicates that there are between 214 (16,384) and 215 (32,768) particles larger than 5 microns and between 211 (2,048) and 212 (4,096) particles larger than 15 microns, per 100 milliliters of fluid.

Defining A Target Cleanliness Level

As an example, let’s assume that we have a normal-pressure system and using table 1.2 we define our target cleanliness level to be ISO 16/13. Having established the minimum fluid cleanliness level required for acceptable component life in this type of system, the next step is to monitor the actual cleanliness of the fluid to ensure that the target cleanliness level is maintained on a continuous basis. This involves taking fluid samples from the system at regular intervals and testing them for cleanliness.

Testing Fluid Cleanliness

There are two ways of testing fluid cleanliness. The first involves sending a fluid sample to a laboratory for analysis. The lab results contain detailed information on the condition of the fluid. The information normally included in a fluid condition report, along with typical targets or alarm limits, are shown in table 3.

Table 3.

CONDITION CATEGORY	RECOMMENDED TARGETS OR ALARM LIMITS
Fluid cleanliness level	Within targeted range chosen for the system or recommended by the manufacturer (ISO 4406)
Wear debris level	(Al) 5 ppm, (Cr) 9 ppm, (Cu) 12 ppm, (Fe) 26 ppm, (Si) 15 ppm
Viscosity	± 10 % of new fluid
Water content	< 100 ppm
Total Acid Number (TAN)	+ 25% of new fluid
Additive level	− 10% of new fluid

The second way to test a fluid's cleanliness level is to use a portable, electronic instrument designed for this purpose. This method is convenient and results are almost instant, however it shouldn't be considered a total substitute for lab analysis because the results do not include wear debris levels, viscosity, water content and other useful data. But when the two methods are used in combination, the frequency of lab analysis can be reduced.
Whichever method is employed, it is important that the equipment used to capture and contain the sample is absolutely clean. If you are taking multiple samples from different systems, take care not to cross-contaminate one fluid sample with another, and never take samples from drain plugs or other low lying penetrations in the system, otherwise the results will be unreliable. Ideally, samples should be taken from the return line, upstream of the return filter, with the system working at operating temperature.

3. Conclusion

Monitoring and maintaining fluid cleanliness involves a continuous cycle of testing and corrective action in order to reduce component failure .Cleanliness is also an important factor hence cylinders should be protected from contaminants entering the ports. Also before making connections to cylinder ports, piping should be thoroughly cleaned to remove all chips or burns which might have resulted from threading or flaring operations.

4.References

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