SURFACE VEHICLE RECOMMENDED PRACTICE

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Hydraulic Cylinder Leakage Test

RATIONALE

This Standard is revised to clarify definitions and incorporate ISO 4406 as reference for fluid cleanliness

1. SCOPE

Applies to hydraulic cylinders which are components of Off-Road Self-Propelled Work Machines defined in SAE J1116.

1.1 Purpose

To provide a laboratory method for determining the capability of a cylinder to seal fluid under specified cycling or holding conditions.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J1116 Categories of Off-Road Work Machines

SAE J1176 External Leakage Classifications for Hydraulic Systems

SAE J1276 Standardized Fluid for Hydraulic Component Tests

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

2.1.2 ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 4406 Hydraulic Fluid Power – Fluids -- Method for coding the level of contamination by solid particles

3. DEFINITIONS

3.1 CYCLE

The movement of the piston and rod from it's starting point and return to it's original position for a specified test stroke length.

3.2 CYCLE RATE

The number of cycles per unit of time.

3.3 DRIFT

Rod movement while holding a constant load.

3.4 DYNAMIC LEAKAGE

The volume of fluid leaking past a seal under cycling conditions.

3.5 DYNAMIC LEAKAGE COEFFICIENT

A measure of dynamic leakage volume per unit of swept area.

K_a = Dynamic leakage coefficient for piston end to rod end leakage
K_b = Dynamic leakage coefficient for rod end to piston end leakage
K_c = Dynamic leakage coefficient for external leakage

3.6 EXTERNAL SEAL

A seal or seal set configuration which restricts leakage flow to the outside of a cylinder.

3.7 INTERNAL SEAL

A seal or seal set configuration which restricts leakage flow when pressurized fluid is applied on either side of the piston.

3.8 "N"

The number of cycles measured to determine dynamic coefficients K_a, K_b, or K_c.

3.9 RATED PRESSURE

The continuous duty operating pressure specified by the manufacturer.

3.10 STROKE LENGTH

The total distance traveled by the piston in completing one-half cycle.

4. TESTING CONDITIONS

4.1 Accuracy of Measurement

The accuracy of measurements unless otherwise stated shall be: Temperature ± 3 °C (± 5 °F), Pressure ± 2%, Leakage ± 2%, Time ± 2% and Length ± 2%.

4.2 Test Fluid

The test fluid shall be per SAE J1276 unless otherwise specified.

4.3 Fluid Test Temperature

The fluid test temperature, measured in the supply line, shall be one or both of 50 °C (122 °F) and110 °C (230 °F) or as agreed between user and supplier.

4.4 Test Pressure

Operational test pressure shall be the manufacturer's rated pressure and measured at the cylinder work ports. A 10% transient overshoot is permissible.

4.5 Contamination Level

Test system shall have a contamination level not to exceed ISO 4406 Code -/17/14.

4.6 Test Stroke Length

The length of stroke for the operational test shall be equal to at least 15% of the maximum stroke length of the hydraulic cylinder.

4.7 Cycle Rate

The cycle rate shall be as specified by the manufacturer unless agreed upon between supplier and manufacturer based on cylinder rating.

5. TEST EQUIPMENT

5.1 Use a suitable test fixture, for example, an oscillating beam type, a conventional in-line beam type, or similar fixture, in which the test cylinder can be loaded or driven in either direction under both static and dynamic conditions by means of a second cylinder.

5.2 Use a suitable control filter capable of maintaining the required fluid cleanliness level and use coolers or heaters as required to maintain specified test temperatures.

6. TEST PROCEDURE - INTERNAL SEAL

Either one, or both, of the following tests may be conducted, as agreed upon between user and supplier, however, the drift rate test is recommended (see caution paragraph 6.2).

6.1 Drift Rate Test

6.1.1 Cycle cylinder until the fluid and cylinder temperatures are stabilized. Stop cylinder within 20% of mid stroke.

6.1.2 Block the cap end port and insert a pressure gage. Leave rod end port open to atmosphere.

6.1.3 Apply an external load to the cylinder sufficient to produce a minimum pressure, 20%, 60%, and 100% of rated pressure at cap end of cylinder or as otherwise agreed upon by the parties concerned.

6.1.4 Hold at specified pressure and record rod travel. After initial compression travel, read and record movement for 5 minutes at one minute intervals. Maintain the temperature of the cylinder within 1 °C (2 °F) or errors due to oil volume change could result.

6.1.5 Repeat test at rod end of cylinder (see paragraph 6.1.1).

NOTE: Drift is the accumulation of leakage of both the internal piston seal and the external seal, expressed as rod travel.

6.2 Dynamic Leakage Test

CAUTION: Some seals can be damaged during the internal seal dynamic leakage test due to the seal running drier than normal. Consideration should be given to seal material and construction before using this dynamic leakage test.

6.2.1 Retain piston end port connection and arrange valving to provide pressure in either one or both directions alternatively as specified. Disconnect line from test cylinder rod end to allow measurement of leakage from cap end to rod end.

6.2.2 Using the loading/driving cylinder to provide the return stroke, resume cycling at specified temperature and adjust valving to obtain rated pressure on the test cylinder.

6.2.3 Continue cycling the test cylinder for a minimum of 100 cycles, then measure and record: (1) any leakage from test cylinder return line for "N" complete cycles of the moving element and (2) the pressure in the piston end during both extension and retraction.

6.2.4 Using the leakage volume obtained in paragraph 6.2.3, calculate the internal dynamic leakage coefficient, K_a, according to the following expression:

$$K_a = \frac{\text{Leakage Volume (mL) Accumulated in “N” Cycles}}{\text{“N” [Sealed Circumference (m)] [2 x Stroke Length (m)]}} \quad \text{(Eq. 1)}$$

6.2.5 Repeat the above steps, for leakage from the rod end to the piston end, by reversing connections. (This step may be omitted if agreed upon by the parties concerned.)

6.2.6 Using the leakage volume obtained in paragraph 6.2.5 calculate the internal dynamic coefficient, K_b, according to the following expression:

$$K_b = \frac{\text{Leakage Volume (mL) Accumulated in “N” Cycles}}{\text{“N” [Sealed Circumference (m)] [2 x Stroke Length (m)]}} \quad \text{(Eq. 2)}$$

7. TEST PROCEDURE - EXTERNAL SEAL

7.1 Cycle the test cylinder at specified temperature with valving arranged to provide rated pressure at the rod end port in either direction, as specified. Record pressure in both directions.

7.2 Continue cycling test cylinder for a minimum of 100 cycles, then measure and record the accumulated leakage for "N" complete cycles of the moving element.

7.3 Calculate the external dynamic leakage coefficient, K_c, using the following expression:

$$K_c = \frac{\text{Leakage Volume (mL) Accumulated in “N” Cycles}}{\text{“N” [Sealed Circumference (m)] [2 x Stroke Length (m)]}} \quad \text{(Eq. 3)}$$