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SAE J1195 MAR86

Cylinder Rod Wiper Seal Ingression Test

SAE Recommended Practice
Reaffirmed March 1986

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RATIONALE:

Not applicable.

RELATIONSHIP OF SAE STANDARD TO ISO STANDARD:

Not applicable.

REFERENCE SECTION:

ANSI B93.19-1972

SAE ARP 785, Procedure for the Determination of Particulate Contamination in Hydraulic Fluids by the Control Filter Gravimetric Procedure

APPLICATION:

This SAE Recommended Practice provides a method for determining the capability of a wiper seal used on hydraulic cylinders, to withstand cyclic movement of the sealing surface in a contaminated environment and restrict the passage of particulate contaminant under conditions of zero side load.

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CYLINDER ROD WIPER SEAL INGRESSION TEST

INTRODUCTION: In fluid power systems, a hydraulic cylinder wiper seal is required to restrict the passage of particulate contaminant from the external environment into annular clearance spaces exposed to the environment. The configuration and materials used in the design of the wiper seal are critical factors influencing its function. The service life of a wiper seal is an important parameter in its application.

1. **SCOPE:** To provide a method for determining the capability of a wiper seal used on hydraulic cylinders, to withstand cyclic movement of the sealing surface in a contaminated environment and restrict the passage of particulate contaminant under conditions of zero side load.
2. **PURPOSE:** To verify whether or not a wiper seal will exhibit a given service life in a contaminated environment and maintain its capability of restricting the passage of particulate contaminant.
3. **DEFINITIONS:**
 - 3.1 **Cycle:** One full extension and one full retraction of the cylinder rod.
 - 3.2 **Cycling Distance:** The total distance traveled by the cylinder rod in completing one cycle multiplied by the accumulated cycles.
 - 3.3 **Service Life:** The cycling distance during which the wiper seal is capable of maintaining a given performance under specified operating and environmental conditions.

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- 3.4 Eccentricity Ratio: Unit of total indicator runout per unit seal inside diameter.
- 3.5 Stroking Distance: The distance traveled by the cylinder rod while completing one-half cycle.
- 3.6 Contaminant Ingression: The action resulting from material in an external environment being carried around the wiper seal by the reciprocating motion of the cylinder rod.

4. TEST CONDITIONS:

- 4.1 Wiper Gland Temperature: Shall be 66°C (150°F) unless otherwise specified.
- 4.2 External Contaminant Environment: A circulating air-dust zero visibility consisting of 0.1-1.5 g/m³ (30-45 mg/ft³) of "AC" Coarse Test Dust.
- 4.3 Failure Criterion: A fluid gravimetric level of 140 mg/l or greater.
- 4.4 Test Duration: 12 200 m (40 000 ft) of cycling distance or seal failure.
- 4.5 Cycle Rate: The time required to make one complete cycle shall produce a rod speed of 15 m/min (50 ft/min).
- 4.6 Stroking Distance: The stroking distance shall be 0.6 m (2 ft).
- 4.7 Oil Spray Temperature: Same as the wiper gland temperature.
- 4.8 Initial Cleanliness Level: The gravimetric level of the circulating fluid shall be less than 5 mg/l.

5. TEST EQUIPMENT:

- 5.1 Use a test fixture per Fig. 1 capable of reciprocating the moving element in contact with the wiper seal at the rate specified for a stroking length of 0.6 m.
- 5.2 The environmentally exposed side of the wiper seal gland area must not allow the buildup of fluid or mud. It is essential that the wiper/rod interface be maintained dry at all times. Directing the spray from the spray ring away from the wiper seal accomplishes this requirement.
- 5.3 Use a low pressure 700 kPa (100 psi or less) circulating system for spraying the cylinder rod and maintaining specified temperature.
- 5.4 Use a controlled air-dust environment, and a means for verifying the concentration level must be provided. (See Figs. 1 and 2.)
- 5.5 Use MIL-H-5606 as a test oil.
- 5.6 Use a turbidimeter which has been calibrated with MIL-H-5606 and AC Test Dust to measure gravimetric level in mg/l or conventional gravimetric measuring equipment per SAE ARP 785.

- 5.7 Use an eccentricity ratio of less than or equal to 0.005.
- 5.8 Use a reservoir having a conical shaped bottom. The cone of the reservoir shall have a 60-120 deg included angle.
- 5.9 Use a contaminant circuit reservoir which has a total enclosed volume of at least 700% of the moving element volume at full stroke length (swept rod volume).
- 5.10 Use a circulating fluid spray system having a volume (measured in millilitres) numerically equal to 120 times the diameter (measured in millimetres) of the moving element and which incorporates a sample line whose fluid volume shall not exceed 10 ml.
- 5.11 Use a control filter capable of achieving the initial cleanliness level.
- 5.12 Use a test rod fabricated from case-hardened and hard-chrome plated bar stock cut to the proper length to provide the designated stroke and having a diameter compatible with the seal. The surface finish of the rod should not exceed a $0.4 \mu\text{m}$ ($16 \mu\text{in}$) AA finish.

6. CIRCULATING SYSTEM QUALIFICATION PROCEDURE:

- 6.1 Install a wiper seal in the gland of the test fixture.
- 6.2 Adjust system volume (millimetres) to be numerically equal to 120 times the diameter (millimetres) of the largest cylinder rod to be used.
- 6.3 Circulate fluid through the filter until the contaminant background is less than 5 mg/l.
- 6.4 Bypass filter and add a sufficient amount of "AC" Fine Test Dust to establish a level of 140 mg/l.
- 6.5 Operate circulating system at the flow rate to be used for testing, and extract four samples at 3-h intervals from the system per ANSI/B93.19-1972.
- 6.6 Measure the gravimetric level of each sample per SAE ARP 785.
- 6.7 Circulate the fluid through the filter until contaminant background level is less than 5 mg/l.
- 6.8 Consider the system qualified for testing if the gravimetric levels of paragraph 6.6 are within 10% of the average gravimetric level for the four samples taken and this average is also within 10% of the 140 mg/l requirement.

7. EXTERNAL CONTAMINANT ENVIRONMENT QUALIFICATION PROCEDURE:

- 7.1 Establish the proposed (zero visibility) air-dust environment using "AC" Coarse Test Dust in the chamber enclosing the cylinder rod.

- 7.2 Sample (twice over a 4-h period) the air-dust environment by drawing a known volume of air-dust mixture through a pre-weighed 0.45 μm membrane (See Fig. 2.)
- 7.3 Weigh the membranes obtained in paragraph 7.2 and calculate the weight of dust collected (in grams) on a standard cubic metre basis.
- 7.4 Consider the external contaminant environment qualified if the two gravimetric levels obtained in paragraph 7.3 meet the requirement specified in paragraph 4.2.

8. TEST PROCEDURE:

- 8.1 Install wiper seal in the gland of the test fixture (oriented as specified by manufacturer).
- 8.2 Adjust system volume (millilitres) to be numerically equal to 120 times the diameter (millimetres) of the cylinder rod.
- 8.3 Establish specified operating temperatures of spray oil by means of appropriate heater system.
- 8.4 Cycle the cylinder rod while circulating the test system fluid through the control filter until initial cleanliness level is obtained.
- 8.5 With the filter blocked from the circulating system, measure the initial cleanliness level using the turbidimeter described in paragraph 5.6. Or, flush at least 10 ml, but not more than 25 ml, of fluid through the sample line and extract a 100 ml sample per ANSI/B93.19-1972 and evaluate per SAE ARP 785 in order to evaluate initial cleanliness level.
- 8.6 Measure and record the initial fluid volume in the circulating system.
- 8.7 Measure the contaminant concentration on a continuous basis by using the turbidimeter described in paragraph 5.6 or extract samples every 1000 cycle-metres and analyze per paragraph 8.5.
- 8.8 Establish the specified controlled air-dust environment surrounding the exclusion device and the extended cylinder rod area.
- 8.9 Cycle the cylinder rod and obtain gravimetric readings or appropriate samples as specified in paragraph 8.7 until 12 200 cycle-metres have been accumulated or a 140 mg/l gravimetric level has been reached in the circulating fluid. The air-dust side of the wiper seal must remain dry (no noticeable puddling) at all times; otherwise, the test must be terminated.
- 8.10 Record data as required on the Wiper Seal Test Report Sheet.

9. PRESENTATION OF RESULTS:

- 9.1 Plot the contaminant concentration as measured by the turbidimeter or conventional equipment versus cycle-metres on regular coordinate paper.

- 9.2 Report the values of the gravimetric levels of the test fluid at both 30% and 100% of the terminal cycling distance together with the associated values of the cycling distance.
- 9.3 Rate and report the exclusion capability of the wiper seal on the basis of the ingress of 10 μm and larger particles per minute between the 30% and 100% points of terminal cycling distance, as determined by the following equation:

$$C_1 = \frac{1.44 \times 10^5 (G_{100} - G_{30}) (V_f)}{(CM_{100} - CM_{30})}$$

where:

C_1 = ingress rate, particles greater than 10 μm per metre of cycling distance

G_{100} = gravimetric level at termination, mg/l

G_{30} = gravimetric level at 30% of terminal cycling distance, mg/l

V_f = initial volume of circulating fluid, l

CM_{100} = cycling distance accrued at test termination, m

CM_{30} = 30% of CM_{100} , m

10. TEST CREDIBILITY: (NOTE: This section removed at the time of the first five-year review.)

- 10.1 This procedure was validated by the actual testing of 26 wiper seals at the Fluid Power Research Center at Oklahoma State University.
- 10.2 The capability of the procedure to discriminate between ingress characteristic of various wiper seals and to possess the necessary control needed to achieve repeatability of results between like seals has been established, as demonstrated by the bar graph in Fig. 3.

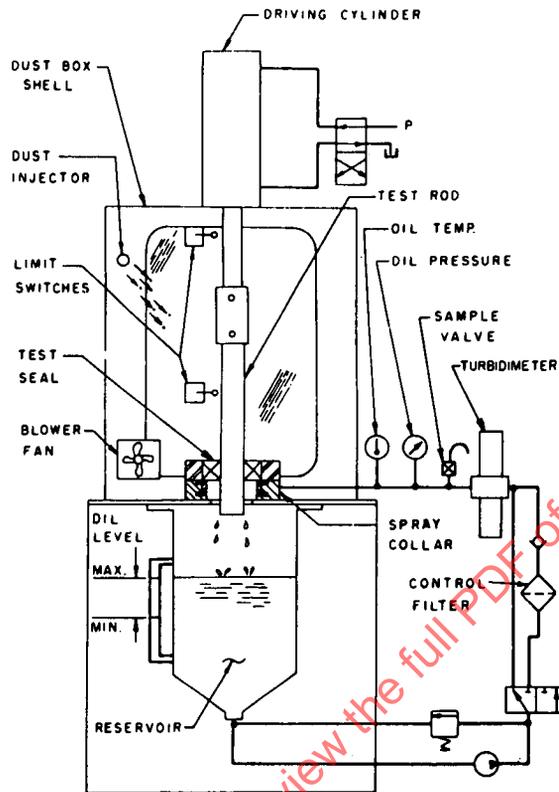


FIG. 1--SCHEMATIC OF WIPER SEAL INGRESSION TEST SYSTEM

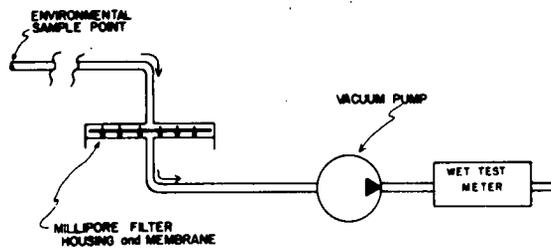


FIG. 2--VACUUM CIRCUIT NEEDED TO SAMPLE AIR-DUST ENVIRONMENT

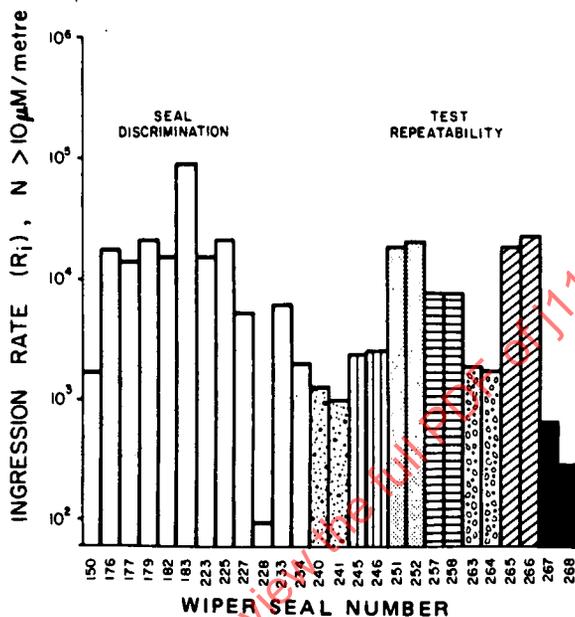


FIG. 3--TYPICAL INGRESSION RATES FOR WIPER SEALS SHOWING DISCRIMINATION AND REPEATABILITY CHARACTERISTICS OF TEST