SAE International

SURFACE VEHICLE RECOMMENDED PRACTICE

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Hydraulic Fluid Power - Accelerated Method for Determining the Wear Characteristics of a Hydraulic Component Due to Contaminants

RATIONALE

SAE J2470 provides a test procedure to identify the sensitivity of valves to sticking or degraded performance due to contaminants but does not identify or measure the wear characteristics of hydraulic components due to contaminants. Some standards have attempted to predict the wear characteristics over the life of the component but often do not standardize the contaminants and are costly to run because of their long duration. This Recommended Practice provides an accelerated procedure to determine the wear characteristics of various hydraulic components by using the SAE J2470 test apparatus with a very high level of contaminants that permits testing and comparison of designs in a relatively short time.

1. SCOPE

1.1 This Recommended Practice defines a procedure, which will aid in assessing the contaminant wear characteristics of hydraulic components. This procedure utilizes a very high level of contaminant that permits an accelerated test to determine the wear effects of contamination in a relatively short period. This recommended practice utilizes the contamination sensitivity test circuit identified in SAE J2470.

1.2 This procedure does not establish contamination wear requirements for any hydraulic component. The user of this procedure needs to be aware of the system contamination level that the component will operate in and select test contamination levels significantly higher than the operating level in order to assess the suitability of the component.

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 ARP490 Electrohydraulic Servovalves

SAE ARP785 Aerospace - Procedure for the Determination of Particulate Contamination in Hydraulic Fluids by the Control Filter Gravimetric Procedure

SAE AS4059 Aerospace Fluid Power - Cleanliness Classification for Hydraulic Fluids

SAE AIR4246 Contaminants for Aircraft Turbine Engine Fuel System Component Testing

SAE J2470 Hydraulic Fluid Power - Valves - Method for Assessing the Lock Sensitivity to Contaminants

2.1.2 NFPA Publications

Available from the National Fluid Power Association, 3333 N. Mayfair Road, Suite 211, Milwaukee, WI 53222-2319, Tel: 414-778-3344, www.nfpa.com.

NFPA/T3.5.15M Hydraulic fluid power - Valves - Method for determining the internal leakage characteristics

NFPA/T3.5.30 Hydraulic fluid power - Measurement of response time - Solenoid operated directional control valves

2.1.3 ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org or from the National Fluid Power Association, 3333 N. Mayfair Road, Suite 211, Milwaukee, WI 53222-2319, Tel: 414-778-3344, www.nfpa.com.

ISO 1219-1 Fluid power systems and components - Graphic symbols and circuit diagrams - Part 1: Graphic symbols for conventional use and data-processing applications

ISO 3448 Industrial liquid lubricants - ISO viscosity classification

ISO 4021 Hydraulic fluid power - Particulate contamination analysis - Extraction of fluid samples from lines of an operating system

ISO 4405 Hydraulic fluid power - Fluid power - Fluid contamination - Determination of particulate contamination level by the gravimetric method

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

ISO 5598 Fluid power systems and components - Vocabulary

ISO 10770-1 Hydraulic fluid power - Electrically modulated hydraulic control valves - Part 1: Test Methods for four-way directional flow control valves

ISO 10770-2 Hydraulic fluid power - Electrically modulated hydraulic control valves - Part 2: Test Methods for three-way directional flow control valves

ISO 12103-1 Road vehicles -Test dust for filter evaluation - Part 1: Arizona test dust

ISO 16889 Hydraulic fluid power filters - Multi-pass method for evaluating filtration performance of a filter element

3. DEFINITIONS

For definitions of terms not identified below see ISO 5598.

3.1 CONTAMINATION SENSITIVITY

The change in component performance caused by particulate contaminants in the fluid.

4. GENERAL TEST REQUIREMENTS

The basic test circuit shall be similar to that identified in SAE J2470 with modifications as necessary for the type of component being tested. This test circuit can be adapted from a filter multi-pass test circuit used by many filter manufacturers to conduct multi-pass tests of filter performance in accordance with ISO 16889.

4.1 Test Equipment

4.1.1 Test Equipment for Testing of Hydraulic Components

4.1.1.1 The test system shall consist of a test circuit as illustrated in Figures 1 through 4 consisting of a reservoir, a pumping unit, an injection system, a heat exchanger, a flow meter, pressure gauges, a temperature indicator, a relief valve and cleanup control filters in addition to the component under test. Select components for the test circuit that are of a design known to function satisfactorily with contaminated fluid. Use a hydraulic pump for testing valves and actuators which is as insensitive to contamination as possible. Ball check valve type piston pumps have been shown to be suitable for this purpose. Figures 2 through 4 show test circuits for various types of components.

4.1.1.2 Construct the reservoir with a conical bottom having an included angle of less than 90 degrees to ensure sufficient fluid agitation. Diffuse the hydraulic fluid entering the reservoir below the surface of the fluid.

4.1.1.3 Construct the injection chamber in a manner which ensures that no contaminant is trapped in the chamber. A chamber with a volume of approximately 500 mL, with a length to diameter ratio of approximately 10 and having a conical bottom with an included angle of less than 90 degrees, is recommended.

4.1.1.4 Use a heat exchanger that does not constitute a contaminant trap.

NOTE: It is recommended that either a one or two-pass unit be used and mounted vertically with the hydraulic flluid entering the heat exchanger from the bottom. It is also recommended that the hydraulic fluid be circulated through the tube side and the water through the shell side.

4.1.1.5 Use a flow meter that is insensitive to contaminant and is accurate to within 2% of full value.

4.1.1.6 Use control filters which are capable of providing a contaminant background of less than or equal to 40 particles/mL greater than 4 µm(c) size and less than or equal to 10 particles/mL greater than 14 µm(c) size.

4.1.1.7 Provide for gravimetric measurement of the contamination level of the fluid in accordance with SAE ARP785 or ISO 4405.

4.2 Test Fluid and Volume

4.2.1 Use a mineral oil of viscosity grade 32 fluid in accordance with ISO 3448 unless the customer identifies a specific fluid.

4.2.2 A test system (exclusive of the system cleanup filter circuit) with a fluid volume that is numerically equal to one-fourth to one-half the designated volume flow per minute is recommended. The fluid volume shall be recorded.

4.3 Materials

4.3.1 Have available a supply of clean fluid sample bottles and a supply of clean slurry injection bottles.

4.4 Precautions

4.4.1 Ensure that the connecting lines and components are of such size that turbulent mixing will exist throughout the test circuit, excluding the components being tested.

4.4.2 Take precautions to prevent contaminant traps, silting areas, and combinations of cyclonic separation zones and quiescent chambers. Also ensure that the test circuit does not exhibit the presence of entrained air.