SAE INTERNATIONAL

SURFACE VEHICLE STANDARD

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(R) Hydraulic Power Pump Test Procedure

RATIONALE

This standard is revised to update references and SI units, and to add test system cleanliness (4.8), a presentation of results section (Section 10), and an appendix section (Appendix A).

1. SCOPE

This test code describes tests for determining characteristics of hydraulic positive displacement pumps used on off-road self-propelled work machines as referenced in SAE J1116.

1.1 Purpose

This test code establishes conditions for pump tests, outlines a procedure for tests, and establishes a method of presenting pump test data. The procedure covers the following determinations:

a. Derived capacity

b. Delivery characteristics

c. Power input

d. Power loss

e. Overall efficiency

f. Pressure compensator response and recovery

g. Flow compensator response and recovery

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 +1 724-776-4970 (outside USA), www.sae.org.

SAE J1116 Categories of Off-Road Self-Propelled Work Machines

SAE J1276 Standardized Fluid for Hydraulic Component Tests

2.1.2 ISO Publications

Copies of these documents are available online at http://webstore.ansi.org/.

ISO 4406 Hydraulic Fluid Power - Fluids - Method for Coding the Level of Contamination by Solid Particles

3. DEFINITIONS

3.1 DELIVERY

The flow output per unit time expressed in liters per minute (L/min) or gallons per minute (gpm).

3.2 DEADHEAD PRESSURE

The pressure developed by a pressure compensated pump when the outlet is blocked (delivery is zero).

3.3 STANDBY PRESSURE

The pressure developed by a flow-compensated pump when no load signal pressure is present and the pump outlet is blocked.

3.4 MARGIN PRESSURE

In a flow-compensated pump, the differential between the pressure measured at the pump outlet port and the pressure controlling pump displacement at some condition other than standby.

3.5 RESPONSE TIME, PRESSURE COMPENSATOR

The time in milliseconds between the instantaneous pressure's crossing of deadhead pressure on the pressure rise and its subsequent reaching of deadhead pressure on the pressure drop when tested according to Test 4 of this procedure (see Figure A4).

3.6 RECOVERY TIME, PRESSURE COMPENSATOR

The time, in milliseconds, between the start of the pressure drop and the subsequent reaching of 75% of the deadhead pressure on the first rise of the instantaneous pressure curve when tested according to Test 4 of this procedure (see Figure A4).

3.7 SETTLING TIME

The time, in milliseconds, between the instantaneous pressure's crossing of deadhead pressure on the pressure rise and its subsequent decay into the repeatable pressure ripple when the pressure compensator is tested according to Test 4 of this procedure (see Figure A4).

3.8 RESPONSE TIME, FLOW COMPENSATOR

The time, in milliseconds, between the start of the pressure drop and the subsequent reaching of the standby pressure when tested according to Test 6 of this procedure (see Figure A5).

3.9 RECOVERY TIME, FLOW COMPENSATOR

The time, in milliseconds, between the start of the pressure rise and the initial development of 75% of deadhead pressure when tested according to Test 6 of this procedure (see Figure A5).

3.10 DERIVED CAPACITY

The actual pump displacement as measured in Test 1, expressed in mL/rev or in^3/rev.

3.11 OVERSHOOT

The difference between the peak pressure spike and the mean steady-state deadhead pressure observed during the response time test (see Figure A4).

4. MATERIAL AND APPARATUS

4.1 Test Fluid

Test fluid shall preferably be per SAE J1276. The actual fluid type and viscosity shall be recorded on worksheets (Figures A1 to A3).

4.2 Pump Torque and Speed Measuring Apparatus

Torque measurement shall be accurate within ±1% and speed measurement shall be accurate within ±0.5%. The test setup shall not impose radial or axial loads upon the driveshaft of the hydraulic pump under test. Torque shall be expressed in Newton meters (N·m) or inch-pound force (lbf·in).

4.3 Flow Measurement

Flow measurement shall be expressed in liters per minute (L/min) or gallons per minute (gpm) and accurate within ±2.0%.

4.4 Pressure Measurement

Outlet pressure shall be expressed in kilopascals gauge (kPag) or pounds per square inch gauge (psig). Inlet pressure shall be expressed in millimeters of Mercury absolute (mm Hg abs) or inches of Mercury absolute (in Hg abs). Pressure measurement shall be accurate to within ±2.0%

4.5 Temperature Measurement and Control

Fluid temperature shall be measured in the reservoir at the entrance to the pump supply line by means of a thermometer or thermocouple. Fluid temperature shall be maintained at the prescribed level throughout the test within ±3 °C (5 °F). Temperature shall be expressed in degrees Celsius (°C) or degrees Fahrenheit (°F).

4.6 Pump Inlet Line

Total pressure drop from the reservoir to the pump inlet shall not exceed 127 mm Hg (5 in Hg). Unless otherwise required, the pump inlet pressure at the inlet fitting shall be maintained within 25.4 mm Hg (1 in Hg) of atmospheric pressure at pump maximum displacement and rated speed. This can be controlled by reservoir fluid level and/or reservoir pressure. The inlet pressure shall be permitted to rise as variable pump displacement is reduced. A shutoff valve may be installed at least 20 diameters upstream from the pump in the inlet line.

4.7 Reservoir

To minimize aeration, the return fluid shall enter the reservoir at a point below the surface of the fluid. Return fluid shall be diffused in such a manner as to minimize turbulence in the reservoir and to prevent the return fluid short circuiting to the pump inlet. Provision shall be made to prevent settlings entering the inlet line. Filtration shall be provided such that the fluid cleanliness level is maintained within the pump manufacturer's recommendations.

4.8 System Cleanliness

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

5. WORKING FORMULAS

The following formulas may be utilized to calculate performance parameters:

5.1 SAE Theoretical Hydraulic Power

See Equations 1 and 2.

$$= \frac{\text{Derived Cap. (mL/rev.) x Speed (rpm) x Pressure (kPag)}}{60000}(W) \quad \text{(Eq. 1)}$$

$$= \frac{\text{Derived Cap. } (in^3/rev) \times \text{Speed(rpm)} \times \text{Pressure(psig)}}{396000}(HP) \quad \text{(Eq. 2)}$$

5.2 Hydraulic Power

See Equations 3 and 4.

$$= \frac{\text{Delivery}(L/min) \times \text{Pressure(kPag)}}{60}(W) \quad \text{(Eq. 3)}$$

$$= \frac{\text{Delivery(gpm)} \times \text{Pressure(psig)}}{1714}(HP) \quad \text{(Eq. 4)}$$

5.3 Power Input

See Equations 5 and 6.

$$= \frac{\text{Torque}(N \cdot m) \times \text{Speed(rpm)}}{9.549}(W) \quad \text{(Eq. 5)}$$

$$= \frac{\text{Torque}(lbf \cdot in) \times \text{Speed(rpm)}}{63025}(HP) \quad \text{(Eq. 6)}$$

5.4 Torque Efficiency, (%)

See Equation 7.

$$= \frac{\text{Theoretical Hydraulic Power}}{\text{Power Input}} \times 100 \quad \text{(Eq. 7)}$$