

Submitted for recognition as an American National Standard

Hydraulic Motor Test Procedures

1. **Scope**—This test code describes tests for determining characteristics of hydraulic positive displacement motors as used on construction and industrial machinery as referenced in SAE J1116. These characteristics are to be recorded on data sheets similar to the one shown in Figure 1. Two sets of data sheets are to be submitted: one at 49 °C (120 °F) and one at 82 °C (180 °F).

1.1 **Purpose**—This test code establishes conditions for motor tests, outlines a procedure for tests, and establishes a method of presenting motor test data.

The procedure covers the following determinations:

- a. SAE volumetric rating
- b. SAE running torque characteristics
- c. SAE stall torque characteristics
- d. Power output
- e. Power loss
- f. Torque efficiency
- g. Overall efficiency

2. Reference

2.1 **Applicable Publication**—The following publication forms a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

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

3. Material and Apparatus

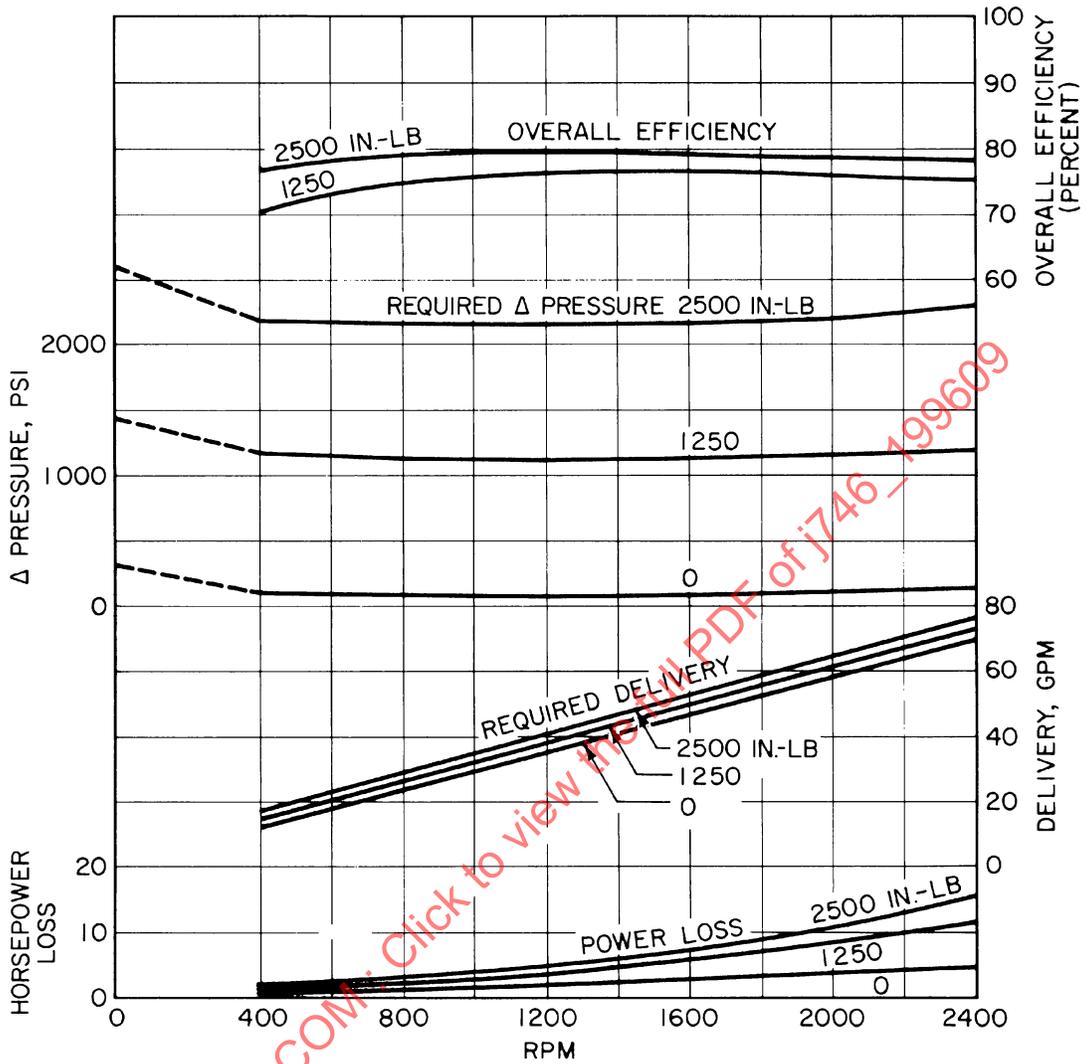
3.1 **Test Fluid**—Test fluid shall preferably be a mineral base oil designed for hydraulic service. Fluid viscosity shall be within the limits of 95 to 115 SUS at 49 °C (120 °F) and 50 to 54 SUS at 82 °C (180 °F).

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SAE J746 Revised SEP96



PERFORMANCE DATA ON A CONSTANT DISPLACEMENT HYDRAULIC MOTOR

Manufacturer: Acme Mfg. Co.

Test fluid: Mineral base hydraulic oil

Series or type: ZYX

Fluid viscosity @ test temperature: 100 SUS

Model: 8Z24

Temperature of test fluid: 120 °F

Motor rotation: Double

SAE volumetric rating: 35.5 GPM/1000 RRP

FIGURE 1—WORK SHEET

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- 3.2 Motor Torque and Speed Measuring Apparatus**—Torque measurement must be accurate within $\pm 1\%$ and speed measurement must be accurate within $\pm 0.5\%$. The test setup shall not impose radial or axial loads upon the driveshaft of the hydraulic motor under test.
- 3.3 Flow Measurement**—Flow measurement shall be accurate within $\pm 2.0\%$.
- 3.4 Pressure Measurement**—Pressure measurement shall be accurate within $\pm 2.0\%$.
- 3.5 Temperature Measurement and Control**—Fluid temperature shall be measured in the motor outlet line by means of a thermometer or thermocouple. Fluid temperature shall be maintained at the prescribed level throughout the test within $\pm 2.8\text{ }^{\circ}\text{C}$ ($\pm 5\text{ }^{\circ}\text{F}$).

3.6 Drain Line—Total pressure drop in drain line, if required, shall be as low as possible.

3.7 Motor Outlet Line—Total pressure drop in outlet line shall be as low as possible.

4. General Definitions and Test Conditions

4.1 Temperature—Shall be expressed in degrees Centigrade (C) or Fahrenheit (F).

4.2 Pressure—Shall be expressed in Newtons per square centimeter gage ($\text{N}/\text{cm}^2\text{g}$) or pounds per square inch gage (psig).

4.3 SAE Volumetric Rating—The SAE volumetric rating of a hydraulic motor shall be defined as delivery to the motor in liters per minute (Lpm) or gallons per minute (gpm) at a speed of 1000 rpm and zero torque on the shaft at a fluid temperature of $49\text{ }^{\circ}\text{C}$ ($120\text{ }^{\circ}\text{F}$).

4.4 SAE Stall Pressure—Shall be defined as the differential pressure required to maintain a specified motor torque at 1 rpm.

4.5 Delivery—Shall be defined as the measured flow rate to the motor. It equals the sum of exhaust flow plus drain line flow. It shall be expressed in liters per minute (Lpm) or gallons per minute (gpm).

4.6 Pressure—Shall be defined as the pressure differential across motor ports in pounds per square inch gage (psig) or Newtons per square centimeter gage ($\text{N}/\text{cm}^2\text{g}$).

5. Working Formulas

5.1 SAE Theoretical Torque

$$= \frac{\text{SAE volumetric rating (Lpm)} \times \text{pressure (N/cm}^2\text{g)}}{628.3} = \text{N} \cdot \text{m} \quad (\text{Eq. 1})$$

$$= \frac{\text{SAE volumetric rating (gpm)} \text{ pressure (psig)}}{27.2} = \text{lb} \cdot \text{in} \quad (\text{Eq. 2})$$

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5.2 SAE Theoretical Delivery

$$= \frac{\text{SAE volumetric rating (Lpm)} \times \text{rpm}}{1000} = \text{Lpm} \quad (\text{Eq. 3})$$

$$= \frac{\text{SAE volumetric rating (gpm)} \times \text{rpm}}{1000} = \text{gpm} \quad (\text{Eq. 4})$$

5.3 SAE Theoretical Hydraulic Power

$$= \frac{\text{SAE theoretical delivery (Lpm)} \times \text{N/cm}^2\text{g}}{6} = \text{watts (W)} \quad (\text{Eq. 5})$$

$$= \frac{\text{SAE theoretical delivery (gpm)} \times \text{psig}}{1714} = \text{horsepower (hp)} \quad (\text{Eq. 6})$$

5.4 Hydraulic Power

$$= \frac{\text{Delivery (Lpm)} \times \Delta \text{ pressure (N/cm}^2\text{g)}}{6} = \text{watts (W)} \quad (\text{Eq. 7})$$

$$= \frac{\text{Delivery (gpm)} \times \Delta \text{ pressure (psig)}}{1714} = \text{horsepower (hp)} \quad (\text{Eq. 8})$$

5.5 Power Output

$$= (\text{Output Torque (N} \cdot \text{m)} \times \text{rpm} \times 0.105) = \text{watts (W)} \quad (\text{Eq. 9})$$

$$= \frac{\text{Output Torque (lb-in)} \times \text{rpm}}{63\,025} = \text{horsepower (hp)} \quad (\text{Eq. 10})$$

5.6 Power Loss

$$= \text{Hydraulic power (W)} - \text{Power output (W)} = \text{watts (W)} \quad (\text{Eq. 11})$$

$$= \text{Hydraulic power (hp)} - \text{Power output (hp)} = \text{horsepower (hp)} \quad (\text{Eq. 12})$$

5.7 Overall Efficiency

$$= \frac{\text{Power output}}{\text{Hydraulic power}} \times 100 = \text{percent (\%)} \quad (\text{Eq. 13})$$

5.8 Torque Efficiency

$$= \frac{\text{Power output}}{\text{SAE theoretical hydraulic power}} \times 100 = \text{percent (\%)} \quad (\text{Eq. 14})$$

$$= \frac{\text{Output torque}}{\text{SAE theoretical torque}} \times 100 = \text{percent (\%)} \quad (\text{Eq. 15})$$

6. Test 1

- a. Set up the motor as in Figure 2, except uncoupled from load.
- b. Operate the motor from minimum to maximum speed in suitable increments, one speed being 1000 rpm. If 1000 rpm is too fast, operate at 100 rpm and then convert to 1000 rpm to use the SAE equations. Record inlet and outlet pressure, delivery, and rpm.
- c. Couple the motor to the load and repeat Test 1, step b at maximum rated torque and one intermediate torque. Record inlet and outlet pressure, torque, delivery, and rpm.
- d. Set up the motor as recommended in Figure 3.
- e. Operate the motor at 1 rpm. Record the maximum and minimum pressure differential required to maintain the same torque as in Test 1, step c.

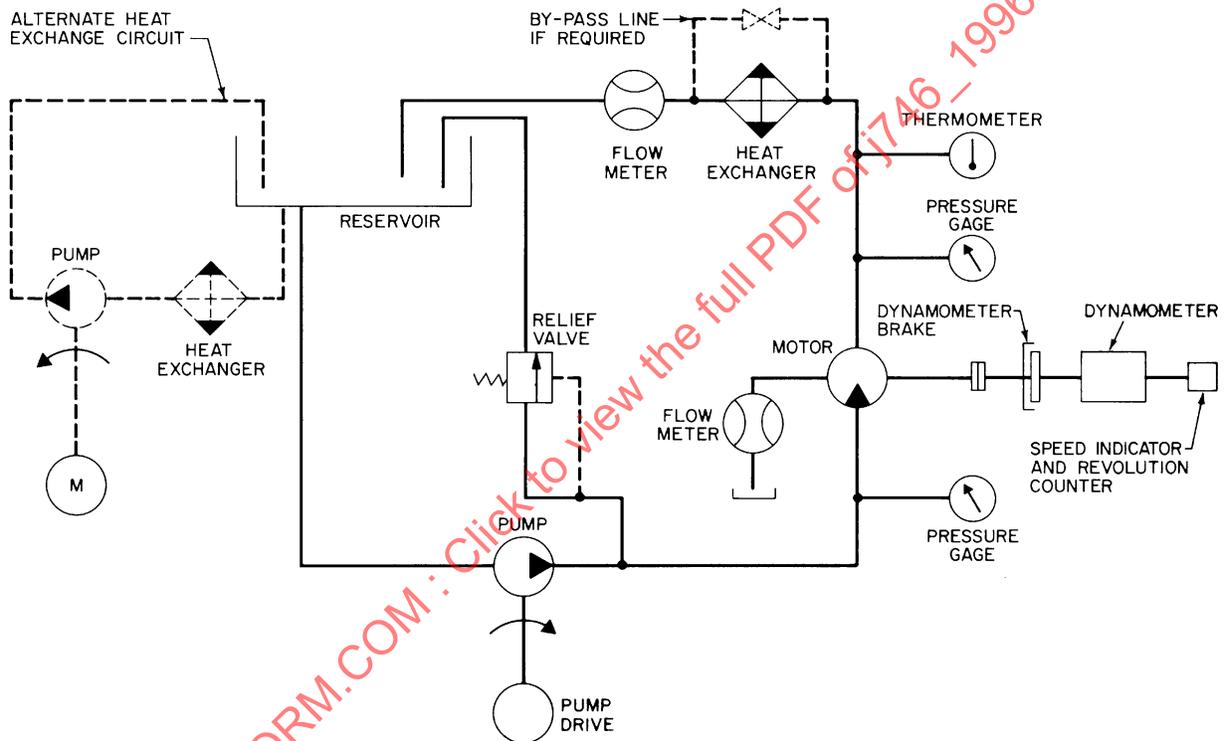


FIGURE 2 TYPICAL TEST SETUP FOR TORQUE AND HORSEPOWER DETERMINATION