



TECHNICAL REPORT

J60a

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RUBBER CUPS FOR HYDRAULIC
ACTUATING CYLINDERS—SAE J60a

SAE Standard

Report of Nonmetallic Materials Committee approved January 1946 and last revised by Hydraulic Brake Systems Actuating Committee December 1967.

1. Scope—These specifications cover molded cups 2 in. in diameter and under, compounded from high temperature resistant rubber for use in hydraulic actuating cylinders employing motor vehicle fluid conforming to the requirements specified in SAE J1702 and SAE J1703.

These specifications cover the performance tests of hydraulic brake cups under specified conditions and do not include requirements relating to chemical composition, tensile strength, and elongation of the rubber compound.

Disc brake seals are not covered by this specification.

2. General Material Requirements

2.1 Workmanship and Finish—Cups shall be free from blisters, pin holes, cracks, protuberances, embedded foreign material, or other physical defects which can be detected by thorough inspection, and shall conform to the dimensions specified on the drawings.

2.2 Marking—The identification mark of the manufacturer as recorded by the Rubber Manufacturer's Association and other details as specified on drawings shall be molded into each cup.

2.3 Packaging—Cups shall be packaged to meet requirements specified by the purchaser.

2.4 Sampling—The minimum lot on which complete specification tests shall be conducted for quality control testing, or the frequency of any specific type test used to control production, shall be agreed upon by the manufacturer and the purchaser.

3. Test Requirements

3.1 Resistance to Fluid at Elevated Temperature—After being subjected to the test for resistance to fluid at elevated temperature as prescribed in paragraph 4.1, the cups shall conform to the requirements specified in Table 1. The cups shall show no disintegration as evidenced by excessive tackiness, blisters, or sloughing indicated by carbon black separation on the surface of the rubber cup.

3.2 Precipitation—Not more than a light precipitate shall be formed by the cups in the approved test fluid when tested by the procedure specified in paragraph 4.2.

3.3 Wheel Cylinder Heat Pressure Stroking—Wheel cylinder cups when tested by the procedure specified in paragraph 4.3 shall meet the following performance requirements:

3.3.1 Lip Diameter Change—The minimum lip diameter of wheel cylinder cups after the stroking test shall be greater than the wheel cylinder bore by the minimum dimensions specified in Table 2.

3.3.2 Leakage—Constant dampness past the cups or fluid discoloration of the filter paper on two or more inspections shall be cause for rejection.

3.3.3 Corrosion—Pistons and cylinder bore shall not show corrosion as evidenced by pitting to an extent discernible to the naked eye, but staining or discoloration shall be permitted.

3.3.4 Change in Hardness—Rubber cups shall not decrease in hardness by more than 15 points.

3.3.5 Condition of Test Cups—Wheel cylinder cups shall not show excessive tackiness, scoring, scuffing, blistering, cracking, chipping (heel abrasion), or change in shape from original appearance.

3.4 Master Cylinder Heat Pressure Stroking—Master cylinder cups when tested by the procedure specified in paragraph 4.4 shall meet the following performance requirements:

3.4.1 Lip Diameter Change—The minimum lip diameter of master cylinder cups after the stroking test shall be greater than the master cylinder bore by the minimum dimensions specified in Table 3.

3.4.2 Leakage—Constant dampness past the secondary cup or fluid discoloration of the filter paper on two or more inspections shall be cause for rejection.

3.4.3 Corrosion—Piston and cylinder bore shall not show corrosion as evidenced by pitting to an extent discernible to the naked eye, but staining or discoloration shall be permitted.

3.4.4 Change in Hardness—The durometer hardness of the primary and secondary master cylinder test cups shall not decrease in hardness by more than 15 points when tested according to the procedure specified in paragraph 4.7.

3.4.5 Condition of Test Cups—The primary and secondary cups shall not show excessive tackiness, scoring, scuffing, blistering, cracking, chipping (heel abrasion), or change in shape from original appearance.

3.5 Low Temperature Performance

3.5.1 Leakage—No leakage of fluid shall occur when cylinder cups are tested according to the procedure specified in paragraph 4.5.1.

3.5.2 Bend Test—The cylinder cup shall not crack and shall return to its approximate original shape within 1 minute when tested according to the procedure specified in paragraph 4.5.2.

3.6 Oven Aging—Cylinder cups when tested according to the procedure specified in paragraph 4.6 shall meet the following requirements:

3.6.1 Change in Hardness—The change in durometer hardness shall be within the limits of -5 to $+5$ points.

3.6.2 Condition of Test Cups—The cups shall show no evidence of tackiness, blistering, or change in shape from original appearance.

3.7 Corrosion Resistance—After completion of the oven corrosion resistance test as detailed in paragraph 4.8, the wheel cylinder and master cylinder assembly components shall conform to the following requirements:

3.7.1 Not more than a light precipitate shall be found in the remaining fluid or deposit in the cylinder. See paragraph 4.2 for definition.

3.7.2 Cylinder cups shall separate from the cylinder and piston during disassembly without evidence of adhesion.

3.7.3 The metal shall be free from rust, corrosion, sludge, and gum. A slight discoloration of the parts shall not be cause for rejection.

TABLE 1—FLUID RESISTANCE AT ELEVATED TEMPERATURES

Change in	
Volume	+5 to +20%
Outside diameter, lip	0 to +5.75%
Outside diameter, base	0 to +5.75%
Durometer hardness (Shore A)	-15 to 0

TABLE 2—WHEEL CYLINDER CUPS—"EXCESS OVER BORE"

Diameter, mm (in.)	mm (in.) min
Through 25.4 (1)	0.508 (0.020)
Over 25.4 (1) through 38.1 (1-1/2)	0.635 (0.025)
Over 38.1 (1-1/2) through 50.8 (2)	0.762 (0.030)

TABLE 3—MASTER CYLINDER CUPS—"EXCESS OVER BORE"

Diameter, mm (in.)	mm (in.) min
Through 25.4 (1)	0.508 (0.020)
Over 25.4 (1) through 38.1 (1-1/2)	0.635 (0.025)
Over 38.1 (1-1/2) through 50.8 (2)	0.762 (0.030)

3.8 Storage Corrosion—After 12 cycles in the humidity cabinet when run according to the procedure specified in paragraph 4.9, there shall be no evidence of corrosion adhering to or penetrating the wall of the cylinder bore which was in contact with the test cup. Slight discoloration (staining) or any corrosion or spots away from the contact surface of the test cups shall not be cause for rejection.

4. Test Procedures

4.1 Resistance to Fluid at Elevated Temperature—Dimensional Test

4.1.1 APPARATUS—Micrometer, shadowgraph, or other suitable apparatus to measure accurately in thousandths of an inch, and glass containers of approximately ½ pt capacity which can be tightly sealed.

4.1.2 TEST SPECIMENS—Four cups shall be used, two for testing at 70 C (158 F) and two for testing at 120 C (248 F).

4.1.3 PROCEDURE—The cups shall be rinsed in isopropyl or ethyl alcohol and wiped dry with a clean, lint-free cloth to remove dirt and packing debris. Cups shall not be left in the alcohol for more than 30 sec.

The lip and base diameters shall be measured to the nearest thousandth of an inch, taking the average of two readings at right angles to each other. Care shall be taken when measuring the diameters before and after aging that the measurements be taken in the same manner and at the same locations.

Determine and record the initial durometer hardness of the test cups. Refer to paragraph 4.7 and Fig. 5

The volume of each cup shall be determined in the following manner:

Weigh the cups in air (W_1) to the nearest milligram and then weigh the cup immersed in distilled water at room temperature (W_2). (A Jolly spring balance, adequately shielded from air currents, may be used for making these determinations.) Quickly dip each specimen in alcohol and then blot dry with filter paper free of lint and foreign material.

Two cups shall be completely immersed in 75 ml of the specified test fluid, as outlined in Appendix A, in each of two suitable glass containers and the containers shall be sealed to prevent vapor loss. One container shall be placed in an oven at 120 ± 2 C (248 ± 3.6 F) for a period of 70 hr. The other container shall be placed in an oven at 70 ± 2 C (158 ± 3.6 F) for 120 hr. At the end of the heating period, remove the cups from the oven and allow to cool in the container at 23 ± 5 C (73.4 ± 9 F) for 60-90 minutes. At the end of the cooling period, remove the cups from the container and rinse in isopropyl or ethyl alcohol and wipe dry with a clean, lint-free cloth. Cups shall not remain in the alcohol for more than 30 sec.

After removal from the alcohol and drying, place each cup in a separate, tared, stoppered weighing bottle and weigh (W_3). Remove each cup from its weighing bottle and weigh immersed in distilled water (W_4) to determine water displacement after hot fluid immersion.

The final volume, dimensions, and durometer hardness of each cup shall be determined within 60 minutes after rinsing in alcohol.

4.1.4 CALCULATION AND REPORT

4.1.4.1 Volume change shall be reported as a percentage of the original volume. The calculation shall be made as follows:

$$\% \text{ increase in volume} = \frac{(W_3 - W_4) - (W_1 - W_2)}{(W_1 - W_2)} \times 100$$

where: W_1 = initial weight in air

W_2 = initial weight in water

W_3 = weight in air after immersion in test fluid

W_4 = weight in water after test

4.1.4.2 Dimensional Changes—The original measurements shall be subtracted from the measurements taken after the test and the difference reported in inches and as a percentage of the original diameters.

4.1.4.3 Change in durometer hardness shall be determined and recorded.

4.1.4.4 Examine the cups for disintegration as evidenced by tackiness, blisters, or sloughing.

4.2 Precipitation Test

4.2.1 APPARATUS—Glass containers of approximately ½ pt capacity which can be tightly sealed.

4.2.2 TEST SPECIMENS—Two cups shall be used.

4.2.3 PROCEDURE—To determine the precipitation characteristics of the test cups, place the cups in a suitable glass container containing 75 ml of the test fluid specified in Appendix A. The container shall be sealed to prevent vapor loss and placed in an oven at 120 ± 2 C

(248 ± 3.6 F) for 70 hr. At the end of the heating period, remove the container from the oven and allow to cool at room temperature for 24 hr. The resulting precipitate shall be classified as none, trace, light, medium, or heavy. (It is recommended that a blank be run on the fluid with each series of tests.)

(a) A trace precipitate shall be flocculent and remain in suspension.

(b) A light precipitate shall be flocculent, may settle, but possess no crystalline formations.

(c) A medium precipitate shall be primarily flocculent material with a few small crystals.

(d) A heavy precipitate shall be large in volume and contain both flocculent and crystalline material.

4.3 Wheel Cylinder Heat Pressure Stroking

4.3.1 APPARATUS

4.3.1.1 Oven—A well-designed, uniformly heated, standard dry air oven conforming to the requirements specified in paragraph 4 of ASTM D 573, Method of Test for Accelerated Aging of Vulcanized Rubber by the Oven Method.¹

NOTE: When strip heaters are used, they shall be placed not less than 6 in. from cylinders on test, but shall be shielded to prevent radiation to any cylinder.

4.3.1.2 Actuating Heat Pressure Stroking Fixture for Wheel Cylinder Cups—The actuating heat pressure stroking fixture shall be designed to provide a 4.76 ± 0.79 mm ($\frac{3}{16} \pm \frac{1}{32}$ in.) movement of each piston. During the first 2.38 mm ($\frac{3}{32}$ in.) movement of the piston, the pressure shall build up to 10.5 kg/cm² (150 psi) maximum; during the second 2.38 mm ($\frac{3}{32}$ in.) movement of the piston, the pressure shall increase to 70 ± 3.5 kg/cm² (1000 ± 50 psi). The rate of operation shall be held at a uniform reciprocating motion of 1000 ± 100 strokes/hour. Fig. 2 illustrates a recommended pressure kg/cm² (psi) versus wheel cylinder piston movement curve for a 25.4 mm (1 in.) diameter wheel cylinder cup tested in the stroking test fixture shown in Fig. 1.

NOTE: A new wheel cylinder assembly must be used for each test.

4.3.2 TEST SPECIMENS—Two wheel cylinder cups shall be used as test specimens.

4.3.3 PROCEDURE—The wheel cylinder cups shall be rinsed in isopropyl or ethyl alcohol and wiped dry with a clean, lint-free cloth to remove dirt and packing debris. Cups shall not remain in the alcohol for more than 30 sec.

The lip diameter measurements shall be determined to the nearest thousandth of an inch, taking the average of two readings at right angles to each other. In the case of double lip cups, these measurements shall be taken after the cup has been assembled on the piston.

Determine and record the initial durometer hardness of the test cups.

The internal parts, which may include among other things cups, pistons, springs, expanders, etc., shall be installed in a wheel cylinder of known diameter using the test fluid specified in Appendix A as a lubricant. (Boots shall not be used.) Install the wheel cylinder assembly on the stroking fixture and place a sheet of filter paper under each end of the wheel cylinder to catch and determine leakage. The stroking fixture assembly shall be placed in an oven and actuated for 70 hr at 120 ± 2 C (248 ± 3.6 F). The actuating means and the oven heater shall be shut off at the termination of the 70 hr stroking period with the master cylinder piston in the off position to relieve retained pressure in the system. After 1 hr cooling period with the oven door open and a ventilating fan on, disconnect the fluid line at the wheel cylinder inlet. Remove the entire stroking test fixture containing the test wheel cylinder from the oven and allow to cool for 22 ± 2 hr at room temperature. Immediately after completion of the 22 hr cooling period, careful inspection shall be made to check for fluid leaks past the cups and results recorded, the fluid shall be drained from the system, and the cups shall be removed from the wheel cylinder. Double lip cups shall be measured before removal from the pistons. The cups shall be rinsed in isopropyl or ethyl alcohol and dried with compressed air. Cups shall not remain in the alcohol for more than 30 sec. Inspect cups for tackiness, scoring, scuffing, blistering, cracking, chipping (heel abrasion), and change in shape from original appearance.

Inspect cylinder parts, recording any pitting on pistons and cylinder walls.

¹Published by the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.