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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

HIGHWAY VEHICLE STANDARD

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(R) RUBBER BOOTS FOR DRUM-TYPE HYDRAULIC BRAKE WHEEL CYLINDERS

1. SCOPE:

This document covers molded rubber boots used as end closures on drum-type wheel brake actuating cylinders to prevent the entrance of dirt and moisture, which could cause corrosion and otherwise impair wheel brake operation.

The document includes performance tests of brake cylinder boots of both plain and insert types under specified conditions and does not include requirements relating to chemical composition, tensile strength, or elongation of the rubber compound. Further, it does not cover the strength of the adhesion of rubber to the insert material where an insert is used.

The rubber material used in these boots is classified as suitable for operation in a temperature range of −40 to +120 ± 2°C (−40 to +248 ± 3.6°F).

2. GENERAL REQUIREMENTS:

2.1 Workmanship and Finish: Boots shall be free from blisters, pinholes, 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 Manufacturers Association, and other details, as specified on drawings, shall be molded into each boot.

2.3 Packaging: Boots 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 on by the manufacturer and the purchaser.

3. TEST REQUIREMENTS:

3.1 Resistance to Fluids at Elevated Temperature: After being subjected to the test for resistance to fluids at elevated temperatures, as prescribed in 4.4, a boot shall conform to the following requirements:

Change in volume: -10 to +15%
Change in hardness: -10 to +10 points

3.2 Heat Stroking Test: After stroking, as detailed in 4.5, a boot shall be free of flex cracks which extend through the wall thickness, and shall fit tightly around the cylinder and push rod.

3.3 Low Temperature Stroking Test: During stroking, as detailed in 4.6, a boot shall not crack or separate from its assembled position on the cylinder or become loose on the push rod.

3.4 Tension Set Test: After being subjected to the tension set test prescribed in 4.7, a boot shall show no more than 75% tension set.

3.5 Heat Resistance Test (Static): After the heat resistance test, as detailed in 4.8, a boot shall conform to the following requirements:

a. No cracking shall occur when flexed similarly to service conditions.
b. Change in hardness: -5 to +10 points

3.6 Ozone Resistance Test: At the end of the 70 h exposure period, as detailed in 4.9, test specimens shall be removed from the ozone chamber and examined under 2X magnification. Surface of the test specimens shall show no evidence of cracking, rupture, or other deterioration.

4. TEST PROCEDURES:

4.1 Test Specimens: Specimens prepared for a particular test shall be cut from the same approximate location on different sample boots. Hardness test specimens shall be prepared to present a flat molded surface to the indentor.

4.2 Test Fluids: The brake fluid used for testing shall be RM 66-03.[1]

4.3 Hardness: The method of determining rubber hardness shall be as described in ASTM D 1415-83, Standard Test Method for Rubber Property - International Hardness. If agreed on by vendor and purchaser, an alternate procedure, ASTM D 2240-86, Standard Test Method for Rubber Property - Durometer Hardness, may be used.

[1]Obtainable from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

4.4 Resistance to Fluids at Elevated Temperature:

4.4.1 Apparatus: Circulating air oven as specified in Section 5 of ASTM D 573-88, Standard Test Method for Rubber - Deterioration in an Air Oven.

Use a screw top, straight sided, round glass jar[2], having a capacity of approximately 250 cm^3 and inner dimensions of approximately 125 mm in height and 50 mm in diameter, and a tinned steel lid (no insert or organic coating).

4.4.2 Test Specimens: A section weighing approximately 3 to 5 g shall be cut from each of two boots.

4.4.3 Procedure: The specimens shall be rinsed in isopropyl or ethyl alcohol and wiped dry with a clean, lint-free cloth to remove dirt and packing debris. Specimens shall not be left in the alcohol for more than 30 s.

Determine and record the initial hardness of the test specimens. Refer to 4.3.

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

Weigh each specimen in air (M_1) to the nearest milligram and then weigh the specimen immersed in distilled water[3] at room temperature (M_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 wipe dry with a clean lint-free cloth.

Two specimens shall be completely immersed in 75 cm^3 of the test fluid in the glass jar and tightly capped.

The jar shall be placed in an oven at 120°C ± 2 (248°F ± 3.6) for a period of 70 h ± 2. At the end of the heating period, remove the specimens from the oven and allow to cool in the jar at 23°C ± 5 (73.4°F ± 9) for 60 to 90 min. At the end of the cooling period, remove the specimens from the jar and rinse in isopropyl or ethyl alcohol and wipe dry with a clean, lint-free cloth. Specimens shall not remain in the alcohol for more than 30 s.

After removal from the alcohol and drying, place each specimen in a separate, tared, stoppered weighing bottle and weigh (M_3). Remove each specimen from its weighing bottle and weigh it immersed in distilled water[3] (M_4) to determine water displacement after hot fluid immersion.

The final volume and hardness of each specimen shall be determined within 60 min after rinsing alcohol.

[2]Suitable effect on rubber test jars (SAE part no. RM-51) and tinned lids (SAE part no. RM-52) can be obtained from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

[3]A trace of a suitable wetting agent not large enough to significantly affect the specific weight of the water should be added to the distilled water to eliminate small air bubbles trapped on the rubber surface during the weighing process.

4.4.4 Calculation and Report:

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

$$\% \text{ change in volume} = \frac{(M_3-M_4) - (M_1-M_2)}{M_1-M_2} \times 100$$

where:

M_1 = initial mass in air
M_2 = initial mass in water
M_3 = mass in air after immersion in test fluid
M_4 = mass in water after immersion in test fluid

4.4.4.2 Change in hardness shall be determined and recorded.

4.4.4.3 Examine the specimens for disintegration as evidenced by blisters or sloughing.

4.5 Heat Stroking Test:

4.5.1 Apparatus: Circulating air oven as specified in Section 5 of ASTM D 573.

Stroking fixtures as shown in Fig. 1 of SAE J1601 or equivalent.

4.5.2 Test Specimens: Two boots shall be used as test specimens.

4.5.3 Procedure: Install two sample wheel cylinder boots on the cylinder for which they are designed, or equivalent. Then mount the cylinder into the actuator assembly, operating at 1000 strokes/h with a stroke length of 3.8 mm ± 1.7 (0.15 in ± 0.07).

Then place the cylinder assembly in the oven and actuate for 22 h ± 1 at 120°C ± 2 (248°F ± 3.6). After the actuation of the assembly, it shall be removed from the oven, allowed to cool to room temperature, and the boots examined for flex cracks and general appearance.

4.6 Low Temperature Stroking Test:

4.6.1 Apparatus: The cold chamber, in which the test specimens are exposed to the low temperature, shall be of sufficient size to contain the apparatus assembled with test specimens and so arranged as to permit the operator to check and operate it without removal from the chamber. It shall be capable of maintaining a uniform atmosphere of cold dry air within the specified temperature range of -40°C to -43 (-40°F to -45.4).

Stroking fixture shall be as shown in Fig. 4 of SAE J1601 or equivalent.

4.6.2 Test Specimens: Two boots shall be used as test specimens.

4.6.3 Procedure: Install the sample wheel cylinder boots on the cylinder, for which they are designed, or equivalent. Place the test boots and test apparatus in a cold chamber and expose to a temperature of -40°C to -43 (-40°F to -45.4) for 70 h ± 2. Then stroke the boots with the stroking apparatus for six strokes, 30 s apart, without removal from the cold chamber.

4.7 Tension Set Test:

4.7.1 Apparatus: Circular stretching mandrel having a diameter which will expand by 15% one or the other of the sealing ends attached to the wheel cylinder or to the actuating rod. The mandrel diameter is calculated as 115% of the molded diameter of the chosen boot end. The molded diameter shall be calculated from the average of two measurements made at right angles to each other. The mandrel shall be provided with a smooth lead-in chamfer to prevent cutting of the rubber and shall itself have a polished machine finish (0.40 µm [16 µin] AA maximum).

Circulating air oven as specified in Section 5 of ASTM D 573.

4.7.2 Procedure:

a. Measure to the nearest 0.02 mm (0.001 in) the inside diameters of the ends of three specimen boots and record. Assemble on stretching mandrels. Place assemblies in the oven and age for 70 h ± 2 at 120°C ± 2 (248°F ± 3.6). Remove the assemblies and cool at room temperature for 1 h. Remove the boots. Allow to recover between 1/2 and 1 h. Again measure the diameter and record.

b. Calculate the tension set as a percentage of the original stretch deflection:

$$\text{Tension set} = \frac{D_2 - D_1}{D_3 - D_1} \times 100$$

where:

D_1 = unaged inside diameter of the boot
D_2 = aged inside diameter of the boot
D_3 = diameter of the stretching mandrel

4.7.3 No less than three specimens shall be tested.

4.8 Heat Resistance Test - Static:

4.8.1 Apparatus: Circulating air oven as specified in Section 5 of ASTM D 573.

4.8.2 Procedure: Select two sample boots for the heat resistance test. Determine the initial hardness of the boots as detailed in 4.3. Suspend the test specimens in the oven for 22 h ± 1 at 120°C ± 2 (248°F ± 3.6). Remove them from oven, allow to cool at room temperature for 16 to 96 h, then check for hardness and flexibility.

4.9 Ozone Resistance Test:

4.9.1 Apparatus: The apparatus shall consist of an ozone chamber as described in ASTM D 1149-86, Standard Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber, and shall be capable of maintaining an ozone concentration of 50 mPa ± 5 (50 parts of ozone/100 million parts of air by volume ± 5).

Stretching mandrel (see 4.7.1).

4.9.2 Test Specimens: Test specimens shall be two boots.

4.9.3 Procedure: Assemble the boots on the stretching mandrels (which will provide 15 + 0, -3% stretch in the boot bead section) and allow to rest for 22 h ± 1 at room temperature, then subject the boots installed on the mandrels to an ozone concentration of 50 mPa ± 5 by volume at 40°C ± 2 (104°F ± 3.6) for 70 h ± 2.

The (R) is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.