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МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

Road vehicles — Petroleum-based brake-fluid for stored-energy hydraulic brakes

Véhicules routiers — Liquide de frein à base pétrolière pour dispositifs de freinage à centrale hydraulique

Reference number
ISO 7308 : 1987 (E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 7308 was prepared by Technical Committee ISO/TC 22, *Road vehicles.*

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Contents

Annexes

Road vehicles — Petroleum-based brake-fluid for stored-energy hydraulic brakes

1 Scope

This International Standard lays down the characteristics and test methods for petroleum-based brake-fluids used in the hydraulic brake systems of road vehicles.

2 Field of application

The brake-fluid specified in this International Standard is for use in road vehicle hydraulic brake systems equipped with synthetic rubber cups and seals (butadiene-acrylonitrile copolymer or equivalent).

It is for use in hydraulic brake systems equipped with a pump; it may also be used in other systems without a pump. This brake-fluid is not intended for use under arctic conditions.

3 References

ISO 37, *Rubber, vulcanized — Determination of tensile stress-strain properties*.

ISO 48, *Vulcanized rubbers — Determination of hardness (Hardness between 30 and 85 IRHD)*.

ISO 1817, *Rubber, vulcanized — Determination of the effect of liquids*.

ISO 2235, *Abrasive sheets — Designation, dimensions and tolerances*.

ISO 3104, *Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity*.

ISO 3405, *Petroleum products — Determination of distillation characteristics*.

ISO 7309, *Road vehicles — Hydraulic braking systems — ISO reference petroleum base fluid*.

ASTM D 91, *Test for precipitation number of lubricating oils*.

ASTM D 892, *Test for foaming characteristics of lubricating oil*.

ASTM D 974, *Test for neutralization number by color-indicator titration*.

ASTM D 1744, *Test for water in liquid petroleum products by Karl Fischer reagent*.

ASTM D 2266, *Test for wear preventive characteristics of lubricating grease (four-ball method)*.

ASTM D 2603, *Test for shear stability of lubricating oils containing polymers using an injector rig*.

ASTM D 3182, *Recommended practice for rubber — Materials, equipment and procedures for mixing standard compounds and preparing standard vulcanized sheets*.

4 Definition

For the purposes of this International Standard, the following definition applies.

stored-energy hydraulic brakes: Braking system where energy is supplied by a hydraulic fluid under pressure, stored in one or more accumulator(s), fed from one or more pressure pump(s) each fitted with a means of limiting the pressure to a maximum value. This value shall be specified by the manufacturer.

5 Materials

The quality of the materials used shall be such that the resulting product will conform to the requirements of this International Standard and ensure uniform characteristics. The fluid shall be green in colour. On visual inspection, the fluid shall be clear and free of suspended matter, dirt and sediment.

6 Requirements

6.1 Boiling point

Brake-fluid when tested by the procedure specified in 7.1 shall have a minimum boiling point of 235 °C.

When tested by the same method, the temperature corresponding to 10 % of condensate shall be at least 250 °C.

6.2 Viscosity

Brake-fluid when tested by the procedure specified in 7.2 shall have the kinematic viscosities specified in 6.2.1 and 6.2.2.

6.2.1 At −40 °C

Not more than 2 000 mm²/s (2 000 cSt).

6.2.2 At 100 °C

Not less than 6 mm²/s (6 cSt).

6.3 Water content

Brake-fluid when tested by the procedure specified in 7.3 shall have a water content of 0,005 % or less.

6.4 Fluidity and appearance at low temperatures

6.4.1 At −40 °C

When brake-fluid is tested by the procedure specified in 7.4.1, the black contrast lines on the hiding power chart shall be clearly discernible when viewed through the fluid in the sample bottle. The fluid shall show no stratification or sedimentation and, upon turning the sample bottle upside down, the air bubble shall reach the fluid surface in not more than 10 s.

6.4.2 At −50 °C

When brake-fluid is tested by the procedure specified in 7.4.2, the black contrast lines on the hiding power chart shall be clearly discernible when viewed through the fluid in the sample bottle. The fluid shall show no stratification or sedimentation and, upon turning the sample bottle upside down, the air bubble shall reach the fluid surface in not more than 35 s.

6.5 Hygroscopicity

When brake-fluid is tested by the procedure specified in 7.5, the increase in mass of the sample shall be below 0,1 %.

6.6 Foaming

When brake-fluid is tested by the procedure specified in 7.6, the foaming tendency, reported in millilitres, shall be

— at 24 °C: 100 max.
— at 93 °C: 200 max.
— at 24 °C (after test at 93 °C): 100 max.

The complete absence of foam after blowing, reported in minutes, shall be

— at 24 °C: 2 max.
— at 93 °C: 2 max.
— at 24 °C (after test at 93 °C): 2 max.

6.7 Compatibility

6.7.1 At −40 °C

When brake-fluid is tested by the procedure specified in 7.7.1, the black contrast lines on the hiding power chart shall be clearly discernible when viewed through the fluid in the centrifuge tube.

The fluid shall show no stratification or sedimentation.

6.7.2 At 60 °C

When brake-fluid is tested by the procedure specified in 7.7.2, the fluid shall show no stratification, and sedimentation shall not exceed 0,05 % (V/V) after centrifuging.

6.8 Effect on rubber

Brake-fluid, when tested by the procedure specified in 7.8, shall not show changes of characteristics greater than the values given in table 1.

Table 1 — Rubber characteristics changes

Rubber	Hardness change IRHD	Volume change %
Polychloroprene	0 to −10 max.	0 to +10
Butadiene-acrylonitrile	+3 to −5 max.	0 to +10

6.9 Performance under simulated service

Brake-fluid, when tested by the procedure specified in 7.9, shall meet the performance requirements specified in 6.9.1 and 6.9.10.

6.9.1 Metal parts shall not show corrosion as evidenced by pitting to an extent discernible to the naked eye; staining or discoloration is permitted.

6.9.2 The initial diameter of any cylinder or piston shall not change by more than 0,13 mm during test.

6.9.3 Rubber cups shall not decrease in hardness by more than 15 IHRD and shall not reach unsatisfactory operating condition as evidenced by excessive scoring, scuffing, blistering, cracking, chipping (heel abrasion), or change in shape.

6.9.4 The base diameter of the rubber cups shall not increase by more than 0,9 mm.

6.9.5 The average lip diameter interference set of all the rubber cups in the test shall not be greater than 65 %.

6.9.6 During any period of 24 000 strokes, the volume loss of fluid shall not exceed 36 ml.

6.9.7 The cylinder pistons shall not seize or function improperly throughout the test.

6.9.8 During the last 100 strokes at the end of the test, the volume loss of fluid shall not exceed 36 ml.

6.9.9 The fluid at the end of the test shall not be in an unsatisfactory operating condition as evidenced by sludge, jel or abrasive grittiness, and sedimentation shall not exceed 1,5 % (V/V) after centrifuging.

6.9.10 No more than a trace of gum shall be deposited on brake cylinder walls or other metal parts during the test. The brake cylinders shall be free of deposits which are abrasive or which cannot be removed when rubbed with a cloth wetted with white spirit.

6.10 Corrosion

Brake-fluid, when tested by the procedure specified in 7.10, shall not cause corrosion exceeding the limits shown in table 2. Apart from the area where the metal strips are in contact, they shall be neither pitted nor roughened to an extent discernible to the naked eye; staining or discoloration is permitted.

Table 2 — Corrosion test strips and mass changes

Test strips*	Test metal ISO designation	Maximum permissible mass change mg/cm² of surface area
Electrolytic copper	Cu-DLP	± 0,05
Brass	CuZn39Pb1	± 0,05
Bronze	CuSn8P	± 0,05
Steel	C 35	± 0,05
Steel	Type 4	± 0,05
Cast iron	Ft 20	± 0,05
Zinc alloy	ZnAl4	± 0,05
Aluminium	AlMg1SiCu	± 0,05

* See annexes D and E.

The fluid at the end of the test shall show no jelling at 23 ± 5 °C. No crystalline deposit shall form and adhere to either the glass jar walls or the surface of the metal strips. The fluid shall not contain more than 0,10 % (V/V) sediment.

The neutralization index measured by the method specified in ASTM D 974 shall not change by more than ± 1 mg of potassium hydroxide (KOH) per gram.

The rubber samples at the end of the test shall show no disintegration, as evidenced by blisters or sloughing indicated by carbon black separation on the surface of the rubber.

6.11 Shear stability

When tested by the method specified in 7.11, the decrease in viscosity of the fluid at 100 °C, measured according to the method described in 7.2, shall not exceed 0,5 mm²/s.

6.12 Anti-wear stability

When tested by the method specified in 7.12, the brake-fluid shall not produce a scar greater than 1 mm in diameter.

7 Test methods

7.1 Boiling point

Determine the boiling point of the fluid as the temperature of initial boiling according to the method in ISO 3405.

7.2 Viscosity

Determine the kinematic viscosity according to the method in ISO 3104.

7.3 Water content

The water content shall be measured in accordance with ASTM D 1744 (method of direct titration by potentiometer known as the Karl Fischer method).

7.4 Fluidity and appearance at low temperatures

7.4.1 At − 40 °C

Place 100 ml of fluid in a glass sample bottle of approximately 125 ml capacity, an outside diameter of 37 ± 0,5 mm and an overall height of 165 ± 2,5 mm. Cork the bottle and place it in a cold bath maintained at − 40 ± 2 °C for 144 ± 4 h.

Remove the bottle from the bath, quickly wipe it with a clean, lint-free cloth wetted with ethanol or acetone, and determine the transparency of the fluid by holding the bottle against a hiding power chart (see annex B) and observing the clarity of the contrast lines on the chart when viewed thorough the fluid. Examine the fluid for evidence of stratification and sedimentation. Turn the bottle upside down and determine the number of seconds required for the air bubble to reach the fluid surface.

7.4.2 At − 50 °C

Place 100 ml of fluid in a glass sample bottle of approximately 125 ml capacity, an outside diameter of 37 ± 0,5 mm and an overall height of 165 ± 2,5 mm. Cork the bottle and place it in a cold bath maintained at − 50 ± 2 °C for 6 ± 0,2 h.

Remove the bottle from the bath, quickly wipe it with a clean, lint-free cloth wetted with ethanol or acetone, and determine the transparency of the fluid by holding the bottle against a hiding power chart and observing the clarity of the contrast lines on the chart when viewed through the fluid. Examine the fluid for evidence of stratification or sedimentation. Turn the bottle upside down and determine the number of seconds required for the air bubble to reach the fluid surface.

7.5 Hygroscopicity

7.5.1 Apparatus

7.5.1.1 Desiccator, in borosilicate glass with a cover fitted with a ground glass tap and porcelain disc as shown in figure 1.

7.5.1.2 Crystallization dish, in borosilicate glass as shown in figure 1.

7.5.1.3 Oven that can be kept at 50 ± 1 °C.

Dimensions in millimetres

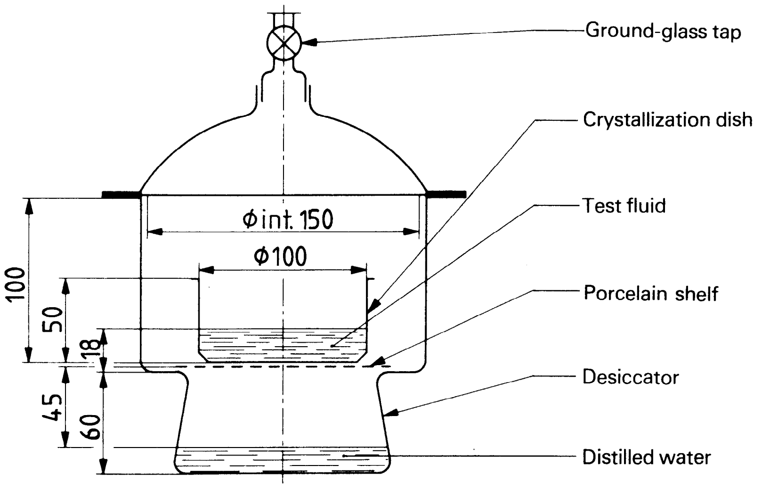


Figure 1 — Hygroscopicity apparatus

7.5.2 Method

Pour 150 ml of distilled water into the bottom of the desiccator (7.5.1.1). For each test, replace the distilled water.

Place the desiccator in the oven (7.5.1.3) at 50 ± 1 °C, for 2 h.

Weigh the crystallization dish (7.5.1.2) within 1 mg.

Pour approximately 100 g of fluid weighed to the nearest 1 mg into the crystallization dish. This operation shall be carried out rapidly and immediately before putting the crystallization dish in the desiccator.

Quickly put the crystallization dish in the desiccator and put the whole unit in the oven set at 50 ± 1 °C, for 16 h.

Remove the desiccator crystallization dish unit from the oven, leaving the crystallization dish in the desiccator and cover with a watch-glass to prevent drops of condensed water falling in.

After leaving for 4 to 8 h, remove the crystallization dish, wipe the outside with a dry cloth and reweigh immediately to within 1 mg.

Calculate the percentage increase in mass.

7.6 Foaming

The foaming test is conducted according to ASTM D 892.

7.7 Compatibility

7.7.1 At −40 °C

Mix 50 ml of the fluid to be tested with 50 ml of the ISO reference fluid (see ISO 7309) and pour this mixture into a cone-shaped centrifuge tube which is then corked. Place the centrifuge tube in a bath maintained at −40 ± 2 °C, for 22 ± 2 h. Remove the centrifuge tube from the bath, quickly wipe it with a clean, lint-free cloth wetted with ethanol or acetone, and determine the transparency of the fluid by holding the tube against a hiding power chart and observing the clarity of the contrast lines on the chart when viewed through the fluid. Examine the fluid for stratification and sedimentation.

7.7.2 At −60 °C

Put the centrifuge tube (see 7.7.1) in an oven maintained at 60 ± 2 °C, for 22 ± 2 h. Remove the tube from the oven and immediately examine the contents for evidence of stratification. Determine the percentage sediment by volume as described in ASTM D 91.

7.8 Effect on rubber

Use standard vulcanized sheets of polychloroprene and butadiene-acrylonitrile meeting the specifications given in annexes A and C.

7.8.1 Test strip sampling

From sheets of 2 mm thickness corresponding to the elastomers given in table 1, cut out two test strips B as given in ISO 1817.

7.8.2 Apparatus and method

The apparatus and the method are those described in ISO 1817 (case of rubber after immersion).

7.8.3 Test conditions

See table 3.

Table 3 — Test conditions to simulate effect on rubber

Rubber	Duration of test	Test temperature
Polychloroprene Butadiene-acrylonitrile	70 ± 2 h	120 ± 2 °C

7.8.4 Measurements

At the end of the test, reweigh the test strips B to the nearest 0,1 mg. The change in mass after immersion in the fluid is thus obtained.

Determine the volume change by the method given in ISO 1817 (gravimetric method).

Determine the changes in mechanical characteristics according to the method given in ISO 1817 (case of rubber after immersion).

7.9 Performance under simulated service

The test to determine performance under simulated service is an evaluation of the lubrication quality of the brake fluid.

7.9.1 Test apparatus[1)]

7.9.1.1 Stroking fixture, shown in figure 2 with the components specified in 7.9.1.1.1 to 7.9.1.1.3.

7.9.1.1.1 Master cylinder

One cast iron hydraulic brake system cylinder of approximately 28 mm diameter fitted with an uncoated steel standpipe.

7.9.1.1.2 Brake cylinder assemblies

Four cast iron straight bore hydraulic brake wheel cylinder assemblies of approximately 28 mm diameter, as shown in figure 3.

With the stroking fixture apparatus, four fixture units are required including appropriate adapter mounting plates to hold the brake wheel cylinder assemblies (see figure 3).

7.9.1.1.3 Brake pressure actuating mechanism

A suitable actuating mechanism (air or hydraulic) to apply a force to the master cylinder push rod without side thrust is needed.

The force applied by the actuating mechanism shall be adjustable and capable of applying sufficient thrust to the master cylinder to create a pressure of at least 7 MPa in the simulated brake system. A pressure gauge or pressure recorder, with a range of at least 0 to 7 MPa, shall be installed between the master cylinder and the brake assemblies; it shall have a shut-off valve and a bleed valve to remove air from the connecting tubing.

The actuating mechanism shall be designed to permit adjustable stroking rates of approximately 1 000 strokes/h. A mechanical or electrical counter shall be used to record the total number of strokes.

7.9.1.2 Insulated cabinet or **oven**, big enough to house the four fixture assemblies, master cylinder, and necessary connections. A suitable thermostatically controlled heating system is required to maintain a temperature of 120 ± 5 °C. Heaters shall be shielded to prevent direct radiation to wheel or master cylinders.

7.9.2 Preparation of test apparatus

7.9.2.1 Wheel cylinder assemblies

New wheel cylinder assemblies with diameters as specified in 7.9.1.2 shall be used. Pistons shall be made from unanodized SAE AA 2024 aluminium alloy.

Disassemble the cylinders and remove the rubber cups. Clean all metal parts with white spirit, and dry with clean compressed air. Inspect the working surfaces of all metal parts for scoring, galling, pitting and cylinder bore roughness, and discard all defective parts. Remove any stains on cylinder walls with polishing paste and hexane. If stains cannot be removed, discard the cylinder.

Measure the internal diameter of each cylinder at locations approximately 19 mm from each end of the cylinder bore, taking measurements in line with the hydraulic inlet opening at right angles to this centreline. Discard the cylinder if any of these four readings exceeds maximum or minimum limits of 28,55 and 28,52 mm. Select parts to ensure that the clearance between each piston and mating cylinder is between 0,08 and 0,13 mm.

Use new butadiene-acrylonitrile rubber (ISO/NBR) cups, as specified in figure 6, that are free of lint and dirt. Discard any cups with defects such as cuts, moulding flaws or blisters. Measure the lip and base diameters of all test cups to the nearest 0,02 mm with an optical comparator or a micrometer along the centreline of the ISO and rubber type identification, and at right angles to this centreline.

Determine the base diameter measurements at least 0,4 mm above the bottom edge and parallel to the base of the cup. Discard any cup where the two measured lip or base diameters differ by more than 0,08 mm. Average the lip and base diameters of each cup. Determine the hardness of all cups by the procedure specified in ISO 48. If this International Standard cannot be used, another procedure may be selected using a rubber anvil (see figure 9).

1) Test apparatus components may be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096, USA.

Dimensions in millimetres

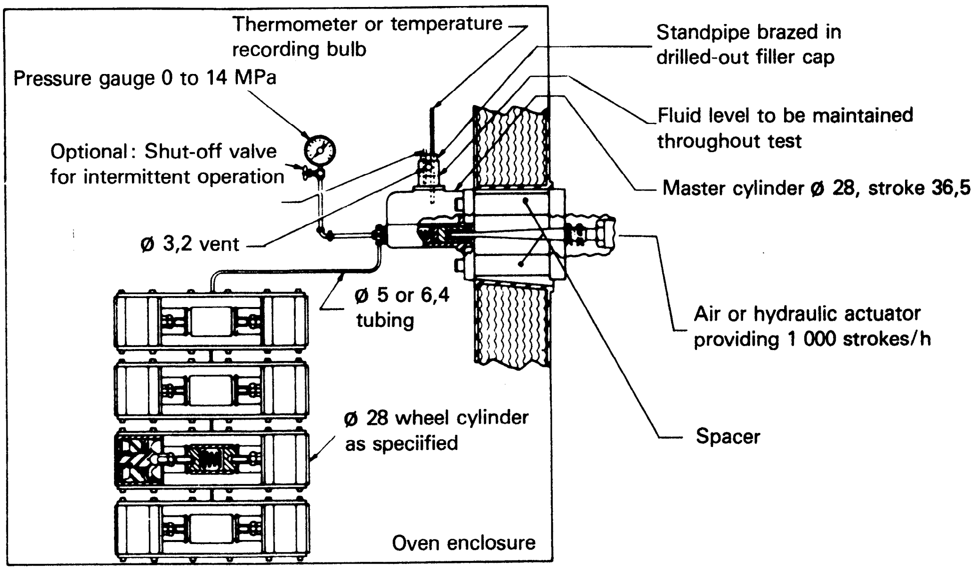
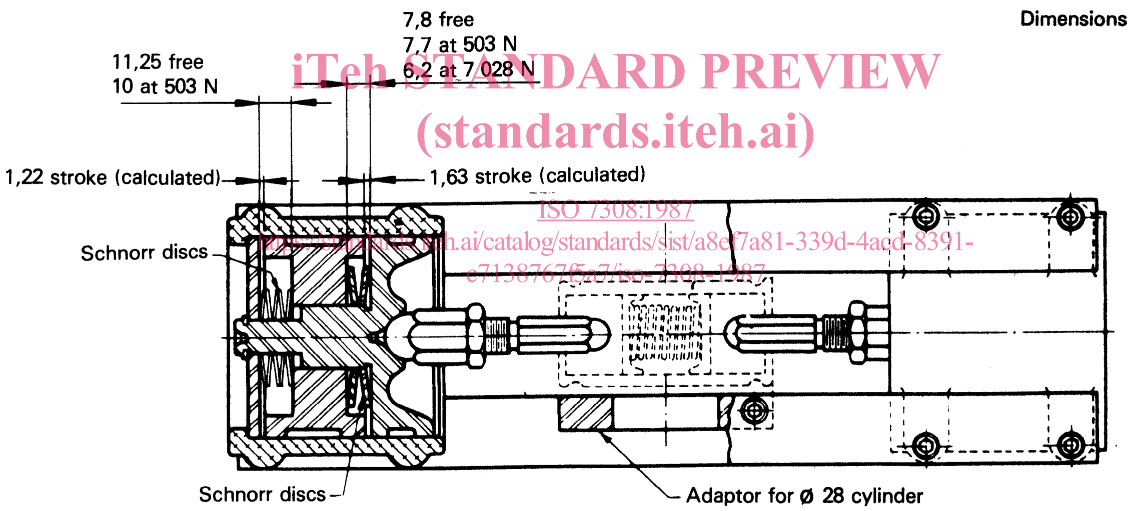


Figure 2 — Stroking test apparatus

Dimensions in millimetres



NOTE — Lubricate all moving parts of fixture with multipurpose grease containing 3 % min. MoS_2 or equivalent.

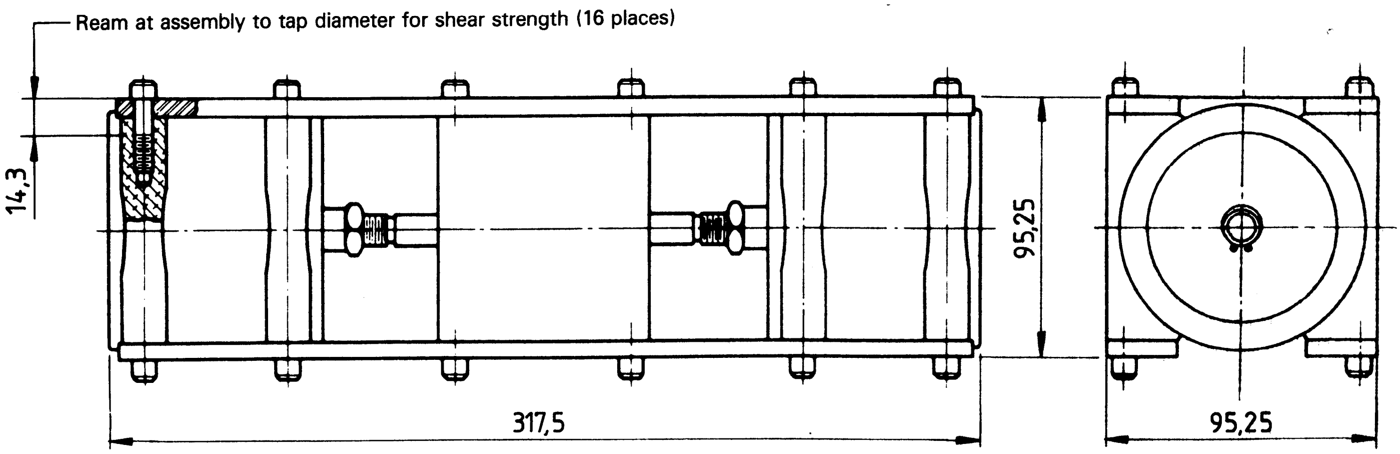


Figure 3 — Wheel cylinder (detail of figure 2)

Clean the rubber parts with hexane and lint-free cloth. Dry with clean compressed air. Dip the rubber and metal parts of wheel cylinders, except the housing and rubber boots, in the fluid to be tested and install them in accordance with the manufacturer's instructions. Manually stroke the cylinders to ensure that they operate easily. Install the cylinders in the simulated brake system.

7.9.2.2 Master cylinder

A new master cylinder meeting the specifications of 7.9.1.1.1 and having a piston made from SAE CA 360 W copper base alloy (half-hard) and new ISO NBR cups as specified in figures 7 and 8 in annex A, which have been inspected, measured and cleaned in the manner specified in 7.9.2.1 shall be used. However, prior to determining the lip and base diameters of the secondary cup, dip it in test brake-fluid, assemble on the piston, and maintain the assembly vertical at 23 ± 5 °C, for at least 12 h.

Inspect the relief and supply parts of the master cylinder and discard the cylinder if these parts have burrs or sharp edges. Measure the internal diameter of the cylinder at two locations: approximately midway between the relief and supply parts and approximately 19 mm beyond the relief port toward the bottom or discharge end of the bore, taking measurements at each location on the vertical and horizontal centrelines of the bore. Discard the cylinder if any reading exceeds maximum or minimum limits of 28,65 and 28,57 mm. Measure each of the outside diameters of the master cylinder piston at two points approximately 90° apart. Discard the piston if any of these four readings exceeds maximum or minimum limits of 28,55 and 28,52 mm.

Dip the rubber and metal parts of the master cylinder, except the housing and the push-rod-boot assembly, in the fluid to be tested and install them in accordance with the manufacturer's instructions. Manually stroke the master cylinder to ensure that it operates easily. Install the master cylinder in the simulated brake system.

7.9.2.3 Steel tubing

Double-wall steel tubing shall be used. A complete replacement of tubing is essential when visual inspection indicates any corrosion or deposits on the inner surface of the tubing. Tubing from the master cylinder to one wheel cylinder shall be replaced for each test (minimum length 900 mm).

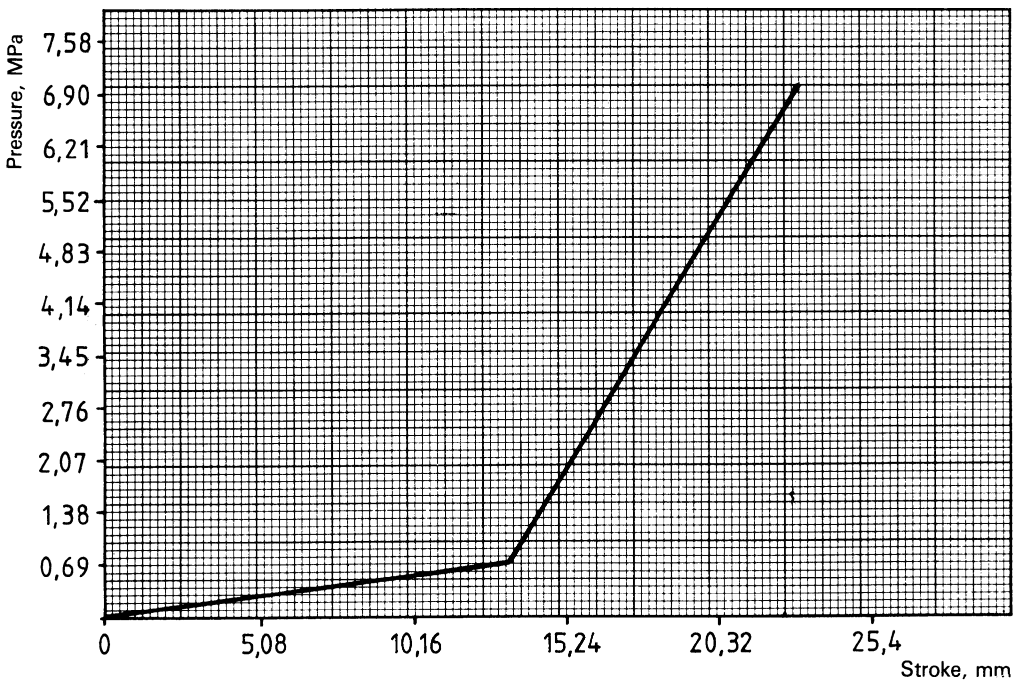
Uniformity in tubing size is desirable between master cylinder and wheel cylinders. The standard master cylinder has two outlets for tubing, both of which shall be used.

7.9.2.4 Assembly and adjustment of test apparatus (see figure 2)

Install the wheel (7.9.1.1.2), prepared in accordance with 7.9.2, and master cylinder (7.9.1.1.1) in the cabinet (7.9.1.2). Fill the system with test fluid, bleeding all wheel cylinders and the pressure gauge to remove air from the system.

Operate the actuator (7.9.1.1.3) manually to apply a pressure of more than the required operating pressure, and inspect the system for leaks. Adjust the actuator to obtain a pressure of 7 ± 0,3 MPa.

Figure 4 illustrates the approximate pressure build-up versus the master cylinder piston movement with the stroking fixture



NOTES

1 Typical master cylinder cup stroke versus pressure using a fixture as in figure 2.

2 Ø 28 mm master cylinder influencing four Ø 28 mm wheel cylinders.

Figure 4 — Master cylinder piston stroke