| GM WORLDWIDE ENGINEERING STANDARDS | Test Procedure | GMW14759 |
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# Determination of the Permeability of Elastomers to Liquids or Vapor

## 1 Introduction

**Note:** Nothing in this standard supercedes applicable laws and regulations.

**Note:** In the event of conflict between the English and domestic language, the English language shall take precedence.

**1.1 Purpose.** The purpose of this standard is to determine the permeability of elastomers to liquids, or liquid/vapor mixtures to which they are in contact during service. This method is applicable to either sheet material in Method A or Method B or separately molded test seals in Method C.

**1.2 Applicability.** This specification describes the test methods used for permeation testing of elastomeric sheet material or elastomeric molded test seals.

**1.3 Remarks.** None.

## 2 References

**Note:** Only the latest approved standards are applicable unless otherwise specified.

**2.1 External Standards/Specifications.**

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|---|---|---|---|
| DIN 50011-11 | IEC 60079-0 | ISO 188 | SAE J2665 |
| DIN 5001112 | | | |

**2.2 GM Standards/Specifications.**

None

**2.3 Additional References.**

Laboratory Accreditation Requirements

Material Specifications

Relevant Engineering Drawings

## 3 Resources

**3.1 Facilities.**

**3.1.1 Calibration.** The test facilities and equipment shall be in good working order and shall have a valid calibration label.

**3.1.2 Alternatives.** Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

**3.2 Equipment.**

**3.2.1 Test Equipment.**

**3.2.2 Thickness Gauge.** The thickness gauge must indicate the test piece thickness to an accuracy of 0.01 mm. The two (2) contact members consist of domed surfaces of spherical radius 12.5 mm, formed on rods of 10 mm diameter, between which the test pieces are placed. The force between the contact members shall be 0.85 N ± 0.03 N. The thickness gauge shall normally consist of one fixed contact member, with the other contact member moving vertically and linked to a suitable dial gauge.

**3.2.2.1 For Method A and Method B.** The thickness gauge must be, capable of indicating the test piece thickness to an accuracy of 0.01 mm. The two (2) contact members consist of domed surfaces of spherical radius 12.5 mm, formed on rods of 10 mm diameter, between which the test pieces are placed. The force between the

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contact members shall be 0.85 ± 0.03 N. The thickness gauge shall normally consist of one fixed contact member, with the other contact member moving vertically and linked to a suitable dial gauge.

**3.2.2.2 For Method C.** Micrometer capable of measuring sample thickness to 0.0025 mm (0.0001 in).

**3.2.3 Test Apparatus for Method A and Method B.** The test apparatus shall consist of cylindrical aluminum vessel with internal dimensions per Appendix A, Figure A1. Around the opening, there shall be a recess, 54 mm diameter and 1.5 mm ± 0.1 mm deep for the test piece in case of test piece thickness of 2 mm ± 0.1 mm. In case of test pieces with deviating thickness supporting discs or spacer rings shall be used. It shall be ensured that the thickness of the test piece is compressed to about 75% of its original height. The test piece shall be clamped between the vessel and the clamp ring, which also has an internal diameter of 35 mm ± 0.5 mm. The ring shall also have on the side, which is close to the test vessel, a recess 42 mm ± 0.5 mm diameter and 2 mm ± 0.5 mm depth for the installation of a support mesh.

**3.2.3.1** The support mesh shall consist of suitable gauze, and of such spacing that, while the area in contact with the test piece is at a minimum, it is sufficiently strong to resist the test piece being displaced from its position by the internal pressure developed within the vessel during the test. The ring shall be clamped to the test vessel by means of six (6) equally spaced screws. Other dimensions are shown in Appendix A, Figure A1.

**3.2.4 Test Apparatus for Method C.** See Appendix A, Figure A2 and Figure A3 for the dimensions of the apparatus. The joint between the center plate and cup top must be sealed to prevent vapor loss. Use a 55 Shore A to 70 Shore A durometer, 70% fluorine fluorocarbon terpolymer ring (red), 60.4 mm inside diameter (ID) x 76.2 mm outside diameter (OD) x 4.8 mm thick. A layer of two (2) part high temperature resistant epoxy is placed around the outer circumference to seal the joint between the aluminum cup and its upper rim.

**3.2.4.1** Fastener hardware consists of six (6), 4.8 mm x 38 mm (6/32 in x 1.5 in) socket cap screw, six (6) 4.8 mm (6/32 in) hex nut, and twelve (12) 9.5 mm (⅜ in) OD washer. Shims are placed between cap and cup to allow a 25% compression on the gasket ring. The tightening sequence is described in the SAE J2665 procedure although a longer bolt length is needed to compensate for the ledge ring thickness.

**3.2.5** Heating oven capable of maintaining the required temperatures within the specified tolerances (e.g., heat oven to ISO 188 Method B) for non-flammable liquids; heating oven per DIN 50011-11 and DIN 50011-12; with explosion proof interior structure per IEC 60079-0 for flammable liquids.

**3.2.6** Balance with a capacity of 1000 g maximum, and an accuracy ± 0.01 g.

**3.2.7** Test medium shall be specified on the relevant engineering drawings or material specifications.

**3.3 Test Vehicle/Test Piece.** See 3.4.2. Elastomeric sheet material or elastomeric molded test seals.

**3.4 Test Time.** Reference the lab test procedure(s) in Section(s) 4.12 or 4.13 for timing details.

**3.4.1 Test Material.**

**3.4.2 Shape and Size.** Unless otherwise specified, the following test pieces shall be used.

**3.4.3 Standard Test Piece for Method A and Method B.** Cylindrical discs 50 mm ± 1 mm in diameter, and 2.0 mm ± 0.1 mm in thickness, either molded or cut from sheet.

**3.4.3.1 Test Pieces from Complete Components.** Where complete components are supplied for test, standard test pieces as described shall be cut from the component. The thickness of the complete component shall be used as thickness of the test piece.

**3.4.3.2** In the special case where the complete component will be used as test piece, an appropriate test vessel must be provided.

**3.4.4 Standard Test Piece for Method C.** A single cavity compression molded ring specimen, 3.17 mm wide x 6.35 mm high x 50.8 mm inside diameter (ID).

**3.4.5 Number of Test Pieces.** For initial sample approval and arbitration purposes, at least three (3) test pieces cut from at least two (2) components shall be tested, for routine quality control purposes at least one (1) test piece shall be tested.

**3.5 Test Required Information.** See 5.3.

**3.6 Personnel/Skills.** Per laboratory accreditation requirements.

## 4 Procedure

**4.1 Preparation.**

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**4.1.1 Test Sample Preparation.** The minimum time between vulcanization and testing of elastomers shall be 72 h. The test piece shall remain at a temperature of +23 °C ± 5 °C for at least 8 h before testing, and shall be free from strain during this period.

**4.1.2 Test Procedure Method A and Method B.**

**4.1.2.1** Prior to the test, the thickness of the test piece shall be measured at five (5) positions minimum, equally distributed over the test area, at a temperature of +23 °C ± 5 °C. The mean thickness shall be calculated from these individual values.

**4.1.2.2** The test vessel shall be, completely, filled with the test medium in the case of tests to Method A, or to a depth of 40 mm in the case of tests to Method B. The test piece shall then be placed into the recess on top of the vessel, the support mesh carefully placed on top of it, and the ring attached by the six (6) screws.

**4.1.2.3** The test assembly shall be weighed to the nearest 10 mg (this weight is = $\mathbf{m_1}$ for calculation see 5.3.1) and placed in the heating oven at the specified temperature for the specified time. In the case of tests to Method A the test assembly shall be inverted, and stood upon the screws, which attach the ring, during the test. For tests to Method B it shall remain as assembled.

**4.1.2.4** After the specified test period the test assembly shall be removed from the oven and allowed to cool at +23 °C ± 5 °C for 0.5 h to 2 h, then be weighed to the nearest 10 mg (this weight is = $\mathbf{m_2}$ for calculation see 5.3.1).

**4.1.3 Test Procedure Method C.**

**4.1.3.1** Test to SAE J2665 at 40 °C using the cup modifications described here, see 4.1.3.1.1 thru 4.1.3.1.6, and illustrated in Appendix A, Figure A2, Figure A3 and Figure A4.

**4.1.3.1.1 Cup:** aerospace grade aluminum 6061.

**4.1.3.1.2 Cap:** 7.6 mm thick aluminum top plate has a machined groove 2.5 mm deep x 3.17 mm wide (see Appendix A, Figure A2). The cap is machined to accommodate a single cavity compression molded ring specimen. Six (6), 4 mm holes are drilled into the top plate.

**4.1.3.1.3 Fasteners:** six (6), 4.8 mm x 38 mm (6/32 in x 1.5 in) socket cap screw, six (6), 4.8 mm (6/32 in) hex nut, and twelve (12), 9.5 mm (⅜ in) outside diameter (OD) washer.

**4.1.3.1.4 Shims:** compression control is 25%, Method C dimensions to permit 25% compression of specimen between cap and cup.

**4.1.3.1.5 Test Specimen:** molded ring 3.17 mm wide x 6.35 mm high x 50.8 mm ID.

**4.1.3.1.6 Sealing Ring (Cap to Cup):** a 55 Shore A to 70 Shore A durometer, 70% fluorine fluorocarbon terpolymer ring (red), 60.4 mm ID x 76.2 mm OD x 4.8 mm thick.

The tightening sequence is described in the SAE J2665 procedure although a longer bolt length is needed to compensate for the ledge ring thickness. Up to nine (9) months may be required on very low permeation compounds to reach equilibrium or stabilization. For compounds with very long stabilization periods, tentative approval will be granted ahead of the permeation results. Exposed area calculation is based on the internal shimmed height and the gasket thickness.

**4.2 Conditions.**

**4.2.1 Environmental Conditions.** Not applicable.

**4.2.2 Test Conditions.** Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

**4.2.3 Summary of Test Method.** Samples of elastomers are tested for their permeability to liquids, or liquid/vapor mixtures, to which they are in contact during service.

**4.2.3.1 Method A (Code A).** Liquid only is in direct contact with the elastomer.

**4.2.3.2 Method B (Code B) and Method C (Code C).** Vapor only is in contact with the elastomer.

**4.2.4 Test Temperature.** The test temperature shall be specified with consideration of the service usage and type of elastomer concerned. See Table 1.

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