



Designation: **D5662—19a** **D5662 – 23**

Standard Test Method for Determining Automotive Gear Oil Compatibility with Typical Oil Seal Elastomers¹

This standard is issued under the fixed designation D5662; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope*

1.1 This test method² covers the determination of the compatibility of automotive gear oils with specific nitrile, polyacrylate, and fluoroelastomer oil seal materials.

1.2 Users of this test method should obtain Test Methods **D412**, **D471**, and **D2240** and become familiar with their use before proceeding with this test method.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

<https://standards.iteh.ai/catalog/standards/sist/fce3dd59-46cf-4a73-822c-fc23d1c8e88/astm-d5662-23>

2.1 ASTM Standards:³

D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension

D471 Test Method for Rubber Property—Effect of Liquids

D2240 Test Method for Rubber Property—Durometer Hardness

D5704 Test Method for Evaluation of the Thermal and Oxidative Stability of Lubricating Oils Used for Manual Transmissions and Final Drive Axles

D5760 Specification for Performance of Manual Transmission Gear Lubricants

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.2 SAE Standard:⁴

J2360 Lubricating Oil, Gear Multipurpose (Metric) Military Use

¹ This test method is under the jurisdiction of ASTM Committee **D02** on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee **D02.B0.03** on Automotive Gear Lubricants & Fluids.

Current edition approved Nov. 1, 2019/Nov. 1, 2023. Published November 2019/November 2023. Originally approved in 1995. Last previous edition approved in 2019 as **D5662—19**; **D5662 – 19a**. DOI: [10.1520/D5662-19A](https://doi.org/10.1520/D5662-19A); [10.1520/D5662-23](https://doi.org/10.1520/D5662-23).

² Until the next revision of this test method, the ASTM Test Monitoring Center will update changes in this test method by means of Information Letters; these can be obtained from the ASTM Test Monitoring Center, 6555 Penn Ave., Pittsburgh, Pa 15206-4489. Attention: 203 Armstrong Drive, Freeport, PA 16229. Director: Administrator. This edition incorporates revisions in all Information Letters through No. **19-2-23-1**.

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

⁴ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

*A Summary of Changes section appears at the end of this standard

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *dumbbell, n*—the specific cut shape (Die C) of an elastomer as explained in the section on dumbbell specimens in Test Methods **D412**.

3.1.2 *formulation, n*—the specific chemical composition used in manufacturing a seal elastomer or a reference oil.

3.1.3 *percent ultimate elongation, n*—the stretch length at rupture of an elastomer dumbbell oil-aged by running this procedure minus the rupture stretch length of an untested dumbbell, all divided by rupture stretch length of the untested dumbbell and then multiplied by 100.

3.1.4 *percent volume change, n*—the change in volume of a test specimen as explained in the procedure for change in volume in Test Method **D471**.

4. Summary of Test Method

4.1 Non-reference oils are tested using a modified version of Test Method **D471** on specific elastomer compounds. Measured quantities are percent ultimate elongation changes (further referred to as just percent elongation changes), durometer Type A hardness changes, and percent volume changes. Reference oils are run concurrently in the same oil bath to measure consistency from one test to another.

4.2 The duration of these tests is 240 h. The reference oils are available from the ASTM Test Monitoring Center (TMC).⁵ The seal materials are available through a Central Parts Distributor (CPD).⁶

5. Significance and Use

5.1 There are several major causes of automotive lubricant-related seal failures. This test method addresses only those failures caused by excessive elastomer hardening, elongation loss, and volume swell and attempts to determine the likelihood that an oil might cause premature sealing system failures in field use. This test method may be used as a requirement of a performance specification, such as Specification **D5760** and J2360.

5.2 Another major cause of seal failure is the formation of carbon, varnish, and sludge-like deposits on the seal lip. The deposit-forming characteristics of automotive gear oils are evaluated in Test Method **D5704**. That procedure is intended in part to evaluate the potential for oils to cause premature seal failure in field service.

6. Apparatus

6.1 Specific test equipment as outlined in Test Methods **D412**, **D471**, and **D2240** is required.

6.1.1 *Hardness Durometer*—See Test Method **D2240**.

6.1.1.1 *Calibration*—Calibrate the hardness durometer annually. Use an outside source, with standards traceable to National Institute for Standards Technology (NIST) for annual calibration. Perform checks with internal standards weekly. Checks with internal standards shall be within ± 3 points. Calibrate internal standards annually, using an outside source, with standards traceable to NIST.

⁵ Reference oils are available from the ASTM Test Monitoring Center, 6555 Penn Ave., Pittsburgh, PA 15206-4489; 203 Armstrong Drive, Freeport, PA 16229.

⁶ The Central Parts Distributor for this procedure is Test Engineering Inc., 12758 Cimarron Path, Suite 102, San Antonio, TX 78249.

6.1.2 *Tension Testing Machine*—See Test Methods **D412**. Set the testing machine rate of grip separation for the percent elongation change determinations at 8.5 mm/s \pm 0.8 mm/s. Calibrate the tension testing machine in accordance with manufacturer⁷ instructions. See Example Settings for Instron Machine, available from the TMC website.⁸

6.1.2.1 *Calibration*—Calibrate the tension testing machine annually. The manufacturer shall perform an annual calibration, using NIST traceable standards.

6.1.3 *Glass Tubes*, having an outside diameter of 38 mm and an overall length of 300 mm. The tube is fitted loosely with an aluminum foil-covered stopper.

6.1.4 *Balance*—Use any commercially available balance capable of weighing samples to the nearest 1.0 mg.

6.1.4.1 *Calibration*—Calibrate the balance annually. Use an outside source, with standards traceable to NIST for annual calibration. Perform checks with internal standards monthly, using NIST traceable weights. The difference between the weights and balance shall be <0.5 mg. Calibrate internal standards annually, using an outside source, with standards traceable to NIST.

7. Reagents and Materials

7.1 Specific reference test oils are maintained and distributed by the TMC.⁵ To receive the test oils and seal materials, individual laboratories shall commit to furnishing the TMC with reference data developed using these reference materials.

7.2 The CPD is responsible for maintaining the numbering and tracking system for the seal elastomer batches used. The Surveillance Panel is responsible for approval of elastomer batches (see **Appendix X1**). Only approved elastomer batches are to be used for reference tests and tests run to meet industry specifications. Certain specific information concerning these reference materials is available only to the CPD. This information is used to ensure batch-to-batch consistency.

7.2.1 Information and location of the current CPD is also available from the TMC.

7.3 Specific reference seal elastomers used are a nitrile (NI), a polyacrylate (PA), and a fluoroelastomer (FL). Notation of the numbering system is established by the TMC as follows:

[Type] Y

<https://standards.iteh.ai/catalog/standards/sist/fce3dd59-46cf-4a73-822c-fc123d1c8e88/astm-d5662-23>

where:

Type = NI, PA, FL, and

Y = Batch number of the particular formulation.

7.4 The shelf life for the PA and FL seal elastomers is five years from the date the batch was cured. For NI seal elastomer, the shelf life is three years from the date the batch was cured. Invalidate any test with a seal beyond its shelf life or not stored according to **7.4.1**. Consult the TMC for any approved exceptions to this lifespan. Place a note in the comments section of the test report where exceptions have been approved.

7.4.1 Store elastomers in a refrigerator maintained at 3 °C to 6 °C.

7.5 The shelf life of reference oils is typically five years unless the TMC, through their analysis, specifies otherwise.

7.6 *Wetting Solution of Aerosol OT*—0.1 % sodium diocetyl sulfosuccinate, made by a 1.0 % dilution of a 10 % solution with reagent water.

⁷ Trademark of Instron Worldwide. The sole source of supply of the apparatus known to the committee at this time is Instron Worldwide Headquarters, 825 University Ave., Norwood, MA 02062-2643. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,¹ which you may attend.

⁸ Available at https://www.astmtmc.org/ftp/docs/gear/osct/procedure_and_ils/Instron_Settings.pdf.

8. Procedure

8.1 The testing laboratory shall conduct reference oil tests concurrently with the non-reference oil in the same oil bath. Reference oils shall perform within a specific range prescribed and evaluated by TMC for validity and updated as needed.

8.2 Prior to cutting specimens and prior to performing elongation tests for initial properties, allow 3 h for the elastomer to warm to $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, as required by Test Methods **D412**. Referring to the procedure in Test Methods **D412**, use Die C to cut a set of twelve dumbbell specimens out of the elastomer sheets as required for each reference and non-reference oil tested.

8.2.1 Cut the dumbbells parallel to the grain using the same unaltered dies for the entire lot. When cutting dumbbells, only cut one thickness at a time to avoid any dimensional variations.

8.2.2 Cut all elastomer specimens, including those used for measuring initial properties, from the same elastomer batch. Use these dumbbells for measuring the percent elongation changes.

8.2.3 Next, cut twelve rectangular specimens, 25 mm by 50 mm, for the percent volume change and hardness testing; each specimen having a thickness of $1.9\text{ mm} \pm 0.12\text{ mm}$.

8.2.4 Finally, cut twelve more NI, PA, and FL dumbbells for the purpose of determining initial elongation properties. Since initial elongation is not measured until after the test completes (see **8.2.7**), cutting of the initial elongation specimens after the test completes is also permissible.

8.2.4.1 In order to suspend the elastomer specimens as described in **8.2.6** and **8.4**, punch a hole in each not exceeding 3.25 mm (0.128 in.) in diameter.

8.2.5 Randomly select sets of twelve dumbbells and twelve rectangular specimens for testing from the different sheets of test elastomers.

8.2.5.1 Use the water displacement procedure in accordance with Test Method **D471** to determine the initial volume measurements. Weigh the coupon in air, M1, to the nearest 1 mg. For the mass in water, immerse the coupon in a 1.0 % wetting solution of aerosol OT, then place the coupon in distilled water, M2, at ambient temperature. Make sure no air bubbles are clinging to the coupon surface before recording the mass to the nearest 1 mg.

<https://standards.iteh.ai/catalog/standards/sist/fce3dd59-46cf-4a73-822c-fcf23d1c8e88/astm-d5662-23>

8.2.6 The elastomer specimens are used in groups of three. To differentiate each individual specimen within its group, cut one corner from one of them and two corners from another of them using a razor blade or razor knife. The hypotenuse of the removed corner shall measure $5\text{ mm} \pm 2\text{ mm}$ ($0.197\text{ in.} \pm 0.079\text{ in.}$). Do not write on the specimens using a paint stick, marker, or anything else as this may alter the elastomer surface area exposed to the test fluid.

8.2.7 Measure initial elastomer properties of hardness and volume prior to the start of testing. Initial elongation properties are determined just prior to running the end of test dumbbells because of instrument calibration. Take care to measure hardness at least 10 mm (0.394 in.) from any specimen edge.

8.3 Fill the test tubes with $150\text{ mL} \pm 5\text{ mL}$ of non-reference or reference oil as appropriate.

8.4 Use four test tubes for each elastomer/oil combination. In each tube, suspend from a stainless steel wire hanger bent at a 90° angle (dimensions shown in **Fig. 1**) three rectangular specimens and three dumbbells in each of the four tubes. Use 316 stainless steel M6 washers meeting DIN 125 specification as spacers in between the specimens to aid in the separation. The intent is that the spacer material not chemically interact with the test fluid or elastomer.

8.4.1 **Fig. 2** shows the arrangement of spacers and test specimens.

8.4.2 Top the test tube with a stopper wrapped in aluminum foil.

8.4.3 Test the non-reference oil using one or more of the three different seal elastomers with the same batch of elastomers as being used for the reference oil.

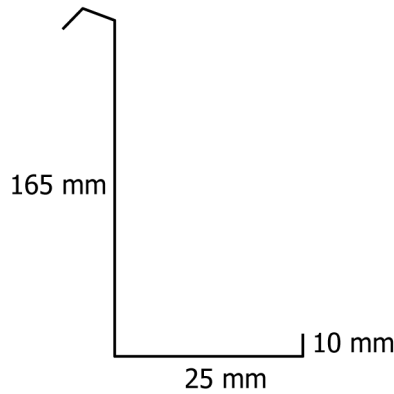


FIG. 1 Wire Hanger

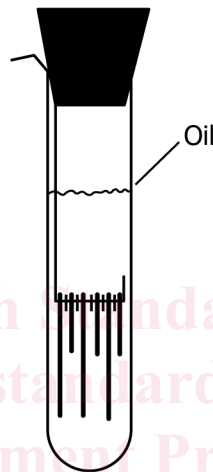


FIG. 2 Test Tube Arrangement

iTeh Standards
(<https://standards.itih.ai>)
Document Preview

ASTM D5662-23

<https://standards.itih.ai/catalog/standards/sist/fce3dd59-46cf-4a73-822c-fc23d1c8e88/astm-d5662-23>

8.4.4 Place the tubes randomly in an oil bath capable of maintaining a test oil temperature within $\pm 1^\circ\text{C}$ for a period of $240\text{ h} \pm 0.5\text{ h}$ (see **Table 1**).

8.4.4.1 Measure the test oil temperature with a thermocouple or resistance temperature detector (RTD) inside a dummy test tube containing bath oil within the oil bath.

8.4.4.2 Record test oil temperature at a minimum of once every minute.

8.4.4.3 Calculate the percent deviation for the elastomer material test oil temperature shown in **Table 1** using the following equation. Record the results in the test report.

$$\text{percent deviation} = \sum_{i=1}^n \left(\frac{M_i}{0.5R} \times \frac{T_i}{D} \right) \times 100 \quad (1)$$

M_i = absolute value of the magnitude of the test parameter out of specification limit at occurrence i ,

R = test parameter specification range,

T_i = length of time the test parameter was outside of specification range at occurrence i . (T_i is assumed to be no less than the recorded data-acquisition frequency, unless supplemental readings are documented), and

D = test duration in same units as T_i .

8.4.4.4 Invalidate any test that exceeds the percent deviation limits in **Table 1**.

TABLE 1 Test Oil Temperatures

Material	Test Oil Temperature, °C	Percent Deviation Limits
Nitrile	100 ± 1	1 %
Polyacrylate	150 ± 1	1 %
Fluoroelastomer	150 ± 1	1 %

8.4.5 Conduct all reference and non-reference oil testing on each seal elastomer in the same oil bath. Complete reference oil and non-reference oil tests for each seal elastomer within 8 h of each other to be considered the same test.

8.5 At the end of the test period, remove the specimens from the hot oil using the wire hanger and place them on a clean absorbent towel. Allow the specimens to cool for no longer than 30 min before beginning measurements.

8.5.1 Remove the specimens from the wire hanger, and place them on a clean absorbent towel. Remove the excess oil with a clean absorbent towel, and begin testing.

8.6 Determine type A hardness testing, percent volume in air and water, and percent elongation, as done in 8.2.6 and 8.2.7. Complete testing within 2 h of removal from the test oil.

8.7 Observe the following notes/modifications to Test Method D471.

8.7.1 Report percent change in elongation (see Test Methods D412) and percent volume change (see Test Method D471) from the original using the same water displacement procedure described in 8.2.6.

8.7.1.1 When using a wire hanger to aid in the weighing of the test coupon, deduct the mass of the wire hanger from the gross mass to determine the actual mass of the test coupon. Record the actual mass of the test coupons in the test report and use the actual masses for the percent volume change calculations.

8.7.1.2 Conduct all reference and non-reference oil testing on each seal elastomer in an oil bath capable of maintaining a test oil temperature within ±1 °C for a period of 240 h ± 0.5 h (see Table 1).

8.7.2 Report durometer Type A hardness change points from original (see Test Method D2240).

8.7.2.1 Stack the three rectangular specimens on top of each other on a hard horizontal surface. Because the elastomers specified for this test are slightly less than 2 mm in thickness, the stack of three specimens will be less than the 6 mm thickness required by Test Method D2240. Follow Test Method D2240 in every other respect. Take hardness readings 1 s after the pin makes contact with the elastomer stack. Take three readings on each side of the rectangular specimen and report the average of all six readings.

8.7.2.2 After taking the first set of measurements, rotate the bottom specimen to the top of the stack and take a second set of measurements.

8.7.2.3 Rotate the bottom specimen to the top one more time to obtain the third set of measurements.

8.7.3 For each data set, calculate the average value and the sample standard deviation using the equation:

$$\sigma = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n - 1}} \quad (2)$$

where:

- σ = sample standard deviation,
- n = number of data points in the set,
- X_i = individual data set value, and
- \bar{x} = mean of the data set.

$$\text{Change in volume, \%} = [(M3 - M4) - (M1 - M2)] / (M1 - M2) \times d \times 100$$