Designation: D 5662 – 06

An American National Standard

Standard Test Method for Determining Automotive Gear Oil Compatability with Typical Oil Seal Elastomers[1]

This standard is issued under the fixed designation D 5662; 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 reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method[2] 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 D 412, D 471, and D 2240 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 the standard. The values given in parentheses are for information only.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [3]

D 412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension

D 471 Test Method for Rubber Property—Effect of Liquids

D 2240 Test Method for Rubber Property—Durometer Hardness

D 5704 Test Method for Evaluation of the Thermal and Oxidative Stability of Lubricating Oils Used for Manual Transmissions and Final Drive Axles

D 5760 Specification for Performance of Manual Transmission Gear Lubricants

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

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 D 412.

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 D 471.

4. Summary of Test Method

4.1 Non-reference oils are tested using a modified version of Test Method D 471 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. Table 1 shows the types of seal materials and their associated test reference oils and temperatures. The reference oils are available from the ASTM Test Monitoring Center (TMC).[4] The seal materials are available through a Central Parts Distributor (CPD).[5]

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 D 5760.

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.B0 on Automotive Lubricants.

Current edition approved May 1, 2006. Published May 2006. Originally approved in 1995. Last previous edition approved in 1999 as D 5662–99.

[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: Administrator. This edition incorporates revisions in all Information Letters through No. 05–1.

[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] Reference oils are available from the ASTM Test Monitoring Center, 6555 Penn Ave., Pittsburgh, PA 15206-4489.

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

TABLE 1 Seal Materials, Reference Oils, and Test Temperatures

Seal Material	Reference Oils	Test Temperature
Nitrile	No. 161, No. 162	100°C
Polyacrylate	No. 160, No. 161	150°C
Fluoroelastomer	No. 160, No. 161	150°C

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 D 5704. 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 D 412, D 471, and D 2240 is required.

6.1.1 *Hardness Durometer*—See Test Method D 2240.

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.

6.1.2 *Tension Testing Machine*—See Test Method D 412. Set the testing machine rate of grip separation for the percent elongation change determinations at 8.5 ± 0.8 mm/s.

6.1.2.1 *Calibration*—Calibrate the tension testing machine annually. Annual calibration shall be performed by the manufacturer, 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.[4] The oils used are labeled No. 160, No. 161, and No. 162, or current equivalent. To receive the test oils and seal materials, individual laboratories shall commit to furnishing the TMC with reference data developed using these reference materials. The TMC is also responsible for managing a system that ensures the performance and formulation concerning these reference oils.

7.2 The CPD is responsible for maintaining the numbering and tracking system for the seal elastomer batches used. 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 – X

where:

Type = NI, PA, FL,
Y = specific formulation of the elastomer type, and
X = batch number of the particular formulation.

7.4 The shelf life for the seal elastomers is two years from the date the batch was cured. Invalidate any test with a seal cure date older than two years.

7.4.1 Store the elastomers in a cool, dark, and dry place. The preferred method of storage is a refrigerator maintained at 3 to 6°C (38 to 42°F).

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 diocytl sulfosuccinate, made by a 1.0 % dilution of a 10 % solution with reagent water.

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+ 2°C, as required by Test Method D 412. Referring to the procedure in Test Method D 412, 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 25 by 50 by 2.0 ± 0.1-mm (1 by 2 by 0.08 ± 0.005-in.) rectangular specimens for the percent volume change and hardness testing.

8.2.4 Finally, cut twelve more NI, PA, and FL dumbbells for the purpose of determining initial elongation properties.

TABLE 2 Elastomer Specimens Required

Purpose	Nitrile		Polyacrylate		Fluoroelastomer	
	Dumb-bells	Speci-mens	Dumb-bells	Speci-mens	Dumb-bells	Speci-mens
Oil No. 160	0	0	12	12	12	12
Oil No. 161	12	12	12	12	12	12
Oil No. 162	12	12	0	0	0	0
Non-reference	12 each	12 each	12 each	12 each	12 each	12 each
Initial Properties	12	0	12	0	12	0
Totals for a Single Non-reference	48	36	48	36	48	36

8.2.5 Use Table 2 as a guide to determine the number of elastomer specimens required.

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

8.2.7 Use the following water displacement procedure in accordance with Test Method D 471 to conduct the initial and final volume measurements. Weigh the coupon in air, M1, to the nearest 1 mg. Making sure there are no air bubbles clinging to the surface, immerse the rectangular specimen into a 1.0 % wetting solution of aerosol OT before weighing it in distilled water, M2, at ambient temperature.

8.2.8 Ensure that initial elastomer properties of hardness and volume are determined prior to the start of testing. Initial elongation properties are determined just prior to running the end of test dumbbells because of instrument calibration.

8.3 Fill the test tubes with 150 ±5 mL of non-reference or reference oil as appropriate.

8.3.1 See Table 1 for combinations of reference test oils and seal materials required for testing. Test the non-reference oil using one or more of the three different seal elastomers.

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. Place 3.0 to 5.0-mm spacers in between the specimens to aid in the separation. The spacer material shall not affect the liquid or the rubber.

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 See Table 1 for the combinations of reference test oils and seal materials required for testing. 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.

8.4.4 Place the tubes randomly in an oil bath capable of maintaining a test oil temperature (see Table 1) within ±1°C for a period of 240 ± 0.5 h.

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.

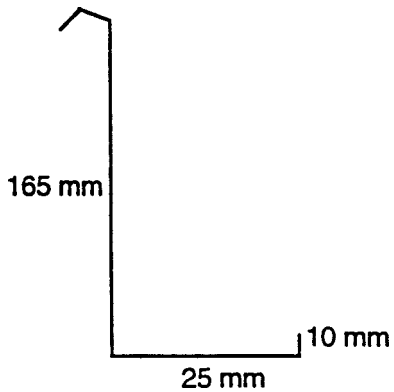

FIG. 1 Wire Hanger

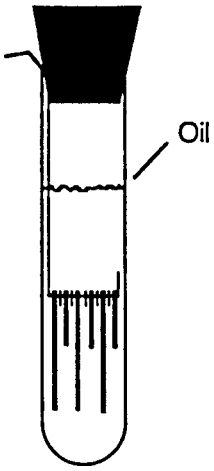

FIG. 2 Test Tube Arrangement

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.

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 Complete testing for durometer Type A hardness, percent volume, and percent elongation changes within 2 h of removal from the test oil.

8.7 Observe the following notes/modifications to Test Method D 471.

8.7.1 Report percent change in elongation (see Test Method D 412) and percent volume change (see Test Method D 471) from the original using the same water displacement procedure described in 8.2.7.

8.7.2 Report durometer Type A hardness change points from original (see Test Method D 2240).

8.7.2.1 On a hard horizontal surface, stack the three rectangular specimens on top of each other to obtain the 6-mm thickness required by Test Method D 2240. Hardness readings are to be taken 1 s after the pin makes contact with the elastomer. 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:

$$\sigma = [\text{num}]1[\text{den}]N - 1\ [\text{end}]Ni{=}1\ (x_i - x)^2 \qquad (1)$$

where:

σ = sample standard deviation,
N = number of data points in the set,
X_I = individual data set value,
$|A/X)$ = mean of the data set, and
I = index to denote one of a set of data.

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

where:
$M1$ = the original weight in air,
$M2$ = the original weight in water,
$M3$ = the end of test weight in air,
$M4$ = the end of test weight in water, and
d = the density of the medium in which the specimen was weighed. In this case water is used, so the multiplication is by 1.

8.8 *Excessive Data Variability*—Criteria for determining test validity, consistent with accepted industry standards, are currently being developed by the task force in conjunction with the TMC. Should the reference test be determined to be invalid, repeat all testing on that particular oil/elastomer pair.

9. Report

9.1 Use the Final Report Forms (Annex A2) to report both the reference oil and non-reference oil test results. Report the data as specified in the Data Dictionary (Annex A3). Report the following information:

9.1.1 Percent elongation changes (see Test Methods D 412),

9.1.2 Percent volume changes (see Test Method D 471),

9.1.3 Type A durometer hardness change points (see Test Method D 2240),

9.1.4 End of test date,

9.1.5 Elastomer batch date and code,

9.1.6 Oil bath identification, and

9.2 Report to the TMC the information identified in 9.1 for the reference oils only.

9.3 Round test results according to Practice E 29.

10. Precision and Bias

10.1 Test precision is established on the basis of reference oil test results (for operationally valid tests) monitored by the ASTM TMC. The data are reviewed annually by the OSCT Surveillance Panel. Contact the ASTM TMC for the current industry data. Table 3 summarizes reference oil precision of the test as of Aug. 2, 2004.

10.1.1 *Intermediate Precision Conditions*—Conditions where test results are obtained in the same laboratory with the same test method using the same test oil, with changing conditions such as operators, measuring equipment, test stands, and time between tests.

NOTE 1—Intermediate precision is the appropriate term for this test method, rather than repeatability, which defines more rigorous within-laboratory conditions.

TABLE 3 OSCT Reference Oil Precision[A]

$S_{i.p.}$ = intermediate precision standard deviation,
i.p. = intermediate precision,
S_R = reproducibility standard deviation, and
R = reproducibility.

Variable	Intermediate Precision		Reproducibility	
	$S_{i.p.}$	i.p.[B]	S_R	R[B]
Percent Elongation	12.27	34.36	12.44	34.83
Durometer Type A Hardness	5.11	14.31	5.12	14.34
Percent Volume Change	3.19	8.93	3.19	8.93

[A] These statistics are based on results obtained on Test Monitoring Center Reference Oils 160, 161, and 162 over the period from Aug. 1, 2002 through Aug. 2, 2004.
[B] This value is obtained by multiplying the standard deviation by 2.8.

10.1.1.1 *Intermediate Precision Limit (i.p.)*—The difference between two results obtained under intermediate precision conditions that would in the long run, in the normal and correct conduct of the test method, exceed the value show in Table 3, in only one case in twenty. When only a single test result is available, the Intermediate Precision Limit can be used to calculate a range (test result ± Intermediate Precision Limit) outside of which a second test result would be expected to fall about one time in twenty.

10.1.2 *Reproducibility Conditions*—Conditions where test results are obtained with the same test method using the same test oil in different laboratories with different operators using different equipment.

10.1.2.1 *Reproducibility Limit (R)*—The difference obtained under reproducibility conditions that would in the long run, in the normal and correct conduct of the test method, exceed the value shown in Table 3, in only one case in twenty. When only a single test result is available, the Reproducibility Limit can be used to calculate a range (test result ± Reproducibility Limit) outside of which a second test result would be expected to fall about one time in twenty.

10.2 No estimate of the bias for this procedure is possible because the performance results for an oil are determined only under the specific conditions of the test and no absolute standards exist.

11. Keywords

11.1 compatibility; elastomer; elongation change; gear oil; hardness change points; oil seal; volume change

ANNEXES

(Mandatory Information)

A1. THE ROLE OF THE TEST MONITORING CENTER

A1.1 The ASTM Test Monitoring Center (TMC) is a nonprofit organization located at 6555 Penn Ave., Pittsburgh, PA 15206-4489. It is staffed to administer engineering studies; conduct laboratory visits; perform statistical analyses of tests; to blend, store, and ship reference oils; and to provide associated administrative functions connected with the referencing and calibration of various lubricant tests. The TMC maintains a close connection with test sponsors, test developers, the surveillance panels, and the testing laboratories. The management of these functions is vested in the Test Monitoring Board, whose members are elected by Subcommittee D02.B0. The TMC operates under the ASTM Charter and its associated bylaws and regulations, the bylaws of Committee D02 and of Subcommittee D02.B0, and the Rules and Regulations of the Test Monitoring Board. The operating income of the TMC is obtained from fees levied on the reference oils supplied and on the conduct of the calibration tests. These fees are set by Subcommittee D02.B0 and are regularly reviewed.

A1.2 Information Letters

A1.2.1 It occasionally becomes necessary to change a test procedure and to notify test laboratories of the change before the change can be considered by Subcommittee D02.B0 on Automotive Lubricants or Committee D02 on Petroleum Products and Lubricants. In such a case the TMC will issue an Information Letter. Subsequently, prior to each semiannual Committee D02 meeting, the accumulated Information Letters are balloted in Subcommittee D02.B0. This ballot is reviewed at the Subcommittee D02.B0 meeting, and the actions taken are then considered by Committee D02. In this way, the ASTM due process procedures are applied to the Information Letters.

A1.2.2 The review of an Information Letter prior to its original issue will differ in accordance with its nature. In the case of an Information Letter that does not affect test results, such as notification of a part number change, the TMC is authorized to issue an Information Letter. A survey or study conducted by the Surveillance Panel resulting in a recommendation for a change in hardware or procedure may result in the issuance of an Information Letter. If urgent changes to hardware or procedure are obviously necessary, the test sponsor and the TMC may issue an Information Letter and present it for approval, with the background and data, for approval by the Surveillance Panel prior to the next semiannual D02 meeting.

A1.2.3 Authority for the issue of Information Letters was given by the Committee on Technical Committee Operations (COTCO) in 1984, as follows:

NOTE A1.1—"COTCO recognizes that D02 has a unique and complex situation. The use of Information Letters is approved provided that each letter (at its initial issue) contains a disclaimer to the effect that it has not obtained ASTM consensus. These Information Letters should be moved to such consensus as rapidly as possible."

A1.3 *Test Monitoring Center Memoranda*—In addition to the Information Letter system, the TMC will provide information to the Surveillance Panel and to participating laboratories in the form of ASTM TMC memoranda. These memoranda are used to convey such information as batch approvals for test parts or materials, to clarify misunderstandings concerning the test procedure, to provide notes and suggestions for the collection and analysis of special data for which the TMC may call for, or for any other matters having no direct effect on the test performance, results, or precision and bias.

A1.4 *Precision Data*—Test precision is established on the basis of reference oil (calibration) test results monitored by the ASTM TMC. Current data may be obtained from the TMC.

A2. FINAL REPORT FORMS

A2.1 The final report forms for reporting reference and non-reference oil test results are provided as Figs. A2.1-A2.8. Three sets of reference and non-reference forms (Form 1 through Form 6) are used for the three types of elastomer materials.

(OIL SEAL COMPATIBILITY TEST)
VERSION *19980122*
CONDUCTED FOR
TSTSPON1
TSTSPON2

LABVALID	V = VALID
	I = INVALID

Test Number	
Bath Number:(Flouroelastomer)	*BATHNUMF*
Bath Number:(Polyacrylate)	*BATHNUMP*
Bath Number:(Nitrile)	*BATHNUMN*

Date Completed:(Flouroelastomer)	*DTCOMPF*	EOT Time:	*EOTTIMEF*
Date Completed:(Polyacrylate)	*DTCOMPP*	EOT Time:	*EOTTIMEP*
Date Completed:(Nitrile)	*DTCOMPN*	EOT Time:	*EOTTIMEN*

Oil Code :(Flouroelastomer)	*OILCODE*	CMIR1:	*CMIR1*	CMIR2:	*CMIR2*
Oil Code:(Polyacrylate)	*OILCODE*	CMIR3:	*CMIR3*	CMIR4:	*CMIR4*
Oil Code:(Nitrile)	*OILCODE*	CMIR5:	*CMIR5*	CMIR6:	*CMIR6*

Alternate Codes:	*ALTCODE1*	*ALTCODE2*	*ALTCODE3*

In my opinion this test *OPVALID* been conducted in a manner in accordance with the Test Method D 5662 and the appropriate amendments through the information letter system. The remarks included in this report describe the anomalies associated with this test.

SUBMITTED BY:

SUBLAB
Testing Laboratory

SUBSIGIM
Signature

SUBNAME
Typed Name

SUBTITLE
Title

FIG. A2.1 Test Report Cover