Designation: D 3137 – 81 (Reapproved 2001)

Standard Test Method for Rubber Property—Hydrolytic Stability[1]

This standard is issued under the fixed designation D 3137; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method covers the determination of the ability of rubber to withstand the environmental effects of high humidity. This is accomplished by examination of the material after removal from the moisture-laden environment. It is designed for testing specimens of rubber materials cut from standard sheets prepared in accordance with Practice D 3182.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *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.* (For specific precautionary statements, see Note 1.)

2. Referenced Documents

2.1 *ASTM Standards:*

D 412 Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers— Tension[2]

D 573 Test Method for Rubber—Deterioration in an Air Oven[2]

D 3040 Practice for Preparing Precision Statements for Standards Related to Rubber and Rubber Testing[3]

D 3182 Practice for Rubber—Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets[2]

3. Summary of Test Method

3.1 Test specimens are exposed to the influence of humid environments under definite conditions of temperature, humidity, and time for the purpose of measuring the resulting hydrolytic degradation by noting the change in tensile strength after exposure over distilled water.

4. Significance and Use

4.1 Rubber and rubber products for certain applications must withstand the environmental effect of high humidity and resist the deterioration of physical properties under these conditions with time. This test method allows performance properties to be determined under the accelerated conditions of high humidity and elevated temperature.

4.2 In view of climatic variations in service conditions, this method may not give results correlating exactly with service performance. However, the test method yields comparative data on which to base judgment as to service quality and it is useful in research and development work.

4.3 This test method is not applicable to coated fabrics; its use for materials other than rubber has not been established.

5. Test Conditions

5.1 *Temperature*—The test temperature shall be 85 ± 1°C (185 ± 2°F).

5.2 *Exposure Period*—The exposure period shall be 96 ± 1 h.

5.3 *Conditioning Period*—After the specified exposure period, the specimens shall be conditioned on a flat surface for 16 to 96 h at 50 ± 5 % relative humidity and 23 ± 2°C (73.4 ± 3.6°F).

6. Procedure

6.1 *Original Tensile Strength*—Cut three ASTM dumbbell or ring specimens and condition for at least 3 h at 23 ± 2°C (73.4 ± 3.6°F) prior to testing. Determine the original tensile strength in accordance with Test Methods D 412.

6.2 *Deteriorated Tensile Strength*—Cut three specimens from the same rubber sheet from which specimens were cut for the original tensile strength. Measure the thickness of each specimen and suspend the specimens in a container approximately 1 dm^3(1 qt) in volume and at least 170 mm (6.7 in.) in height, containing 100 cm^3 of distilled water. Suspend the specimens on noncorrosive metal hooks, soldered to the bottom of the container cap or on a glass "tree" placed in the container, so that the specimens do not contact the container or each other. Cap the container loosely and place the container in a circulating air oven (see Test Method D 573) according to the required test conditions (see 5.1 and 5.2). After 15 min, open

[1] This test method is under the jurisdiction of ASTM Committee D11 on Rubber and is the direct responsibility of Subcommittee D11.15 on Degradation Tests.

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[2] *Annual Book of ASTM Standards*, Vol 09.01.

[3] Discontinued—see *1986 Annual Book of ASTM Standards*, Vols 09.01 and 09.02.

the oven briefly and secure the container cap tightly. At the end of the required exposure period, remove the container from the oven and loosen the cap (see Note 1). When the container has cooled to approximately room temperature, remove and condition the specimens (see 5.3). After the conditioning period, determine the tensile strength in accordance with Test Methods D 412, using the original unexposed thickness or cross-sectional area.

NOTE 1—The cap of the container should not be secured tightly prior to placing the container in a circulating air oven at elevated temperature. Such a procedure could result in a potentially hazardous condition involving a pressurized container. Similarly, the container cap should be loosened upon removal from the oven to prevent the occurrence of a partial vacuum in the sealed container.

NOTE 2—It should be recognized that the change in tensile strength of a rubber that has been exposed to the conditions of this test may be due, in part, or totally, to the effects of the elevated temperature rather than to the effects of humidity. To aid in distinguishing between the two effects, it is recommended that in addition to testing specimens of rubber by means of this method, specimens also be tested for change in tensile strength in accordance with Test Method D 573 for 96 ± 1 h at 85 ± 1°C (185 ± 2°F).

NOTE 3—In the event that a significant loss in tensile strength is noted after the 96 ± 1-h exposure over water (a loss not attributed to the effects of heat alone), the rubber may be considered to be hydrolytically unstable under these conditions. In cases where it is difficult to make this judgment, or whether it is desired to perform in-depth studies of the rates of hydrolysis, the test over water at 85 ± 1°C (185 ± 2°F) may be performed for longer exposure periods. Suggested exposure intervals are 168 ± 1, 240 ± 1, and 336 ± 1 h. For in-depth studies of materials having poor resistance to hydrolysis under the standard test conditions (see Section 5), a lower test temperature such as 70 ± 1°C (158 ± 2°F) may be used.

6.3 Take the median of the values for three specimens as the characteristic of the piece of rubber tested with the exception of the following conditions, in which case use the median of the values for five specimens:

6.3.1 If one or more values do not meet the specified requirements when tested for compliance with specifications, or

6.3.2 If referee tests are being made.

7. Calculation

7.1 Calculate the percentage change in tensile strength as follows:

$$\text{Percent change in tensile strength} = [(T - T_0)/T_0] \times 100 \quad (1)$$

where:

T_0 = original tensile strength of specimens, and
T = tensile strength after exposure.

8. Report

8.1 The report shall include the following:

8.1.1 Results calculated in accordance with Section 6,

8.1.2 All observed and recorded data on which the calculations are based,

8.1.3 Time of exposure,

8.1.4 Date of preparation of the rubber, if known,

8.1.5 Date of test, and

8.1.6 Type and dimensions of specimens used.

9. Precision and Bias

9.1 This precision statement was prepared in accordance with statistical and other testing terminology and concepts presented in Practice D 3040.

9.2 The precision of this test method was calculated from the precision statement of Test Methods D 412 for the tensile strength measurement of rubber-like materials. These precision data are based on tests conducted exclusively with vulcanized sheets prepared by the National Bureau of Standards by 69 laboratories on 9 materials. A “test result” is the mean value obtained from the testing of 3 dumbbell specimens.

9.3 This test method measures the percentage of change in tensile strength of a rubber-like material after exposure for 96 h to a hydrolytic environment. The best estimate of precision for this test method is derived from twice that of the variance measured for the tensile strength in accordance with Test Methods D 412.

9.4 The calculated laboratory quality control (LQC) precisions for this test method are shown as follows:

Property, % change in tensile strength			Units, %	Range of Value, 0 to 100 %		
Within Laboratory				Among Laboratory		
S	CV	LSD		S	CV	LSD
2.1	0.042	5.9		4.2	0.084	11.9

9.5 The LQC precision values for S (%) given are equivalent to “repeatability” for within-laboratory testing and to“ reproducibility” for among-laboratory testing.