Designation: D1460 – 86 (Reapproved 2014)

Standard Test Method for Rubber Property—Change in Length During Liquid Immersion[1]

This standard is issued under the fixed designation D1460; 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 covers a technique to measure the effect of immersion liquids on rubber vulcanizates or rubbery materials. Change in specimen geometry and dimensions are observed through the transparent walls of the tube containing the specimen immersed in the liquid. Although it may be employed with any liquid, it is especially applicable to liquids that are so volatile that they must be maintained under pressure during the period of immersion.

1.2 This test method differs from Test Method D471 in that volume changes are approximated from observed dimensional changes rather than being calculated directly.

1.3 The values stated in SI units are to be regarded as the 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D471 Test Method for Rubber Property—Effect of Liquids

D1349 Practice for Rubber—Standard Conditions for Testing

D3182 Practice for Rubber—Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets

D3183 Practice for Rubber—Preparation of Pieces for Test Purposes from Products

3. Significance and Use

3.1 This test method gives the rubber technologist two means to evaluate the effect of liquids on rubber vulcanizates or rubbery materials. Volatile, nonvolatile, and other liquids that require pressure to maintain a liquid state may be used. Data obtained on rubbery materials exposed to liquids by this method may be used to predict their behavior in applications involving similar exposure. These changes in length have been found to be useful for specifications but do not necessarily indicate changes for design purposes.

4. Test Fluid

4.1 The test liquid may be any one of the standard liquids described in Test Method D471, or any other liquids to which the vulcanizate may be exposed in service. Mixtures of volatile liquid and oil may be employed in Apparatus B, in which case the oil shall be introduced with the specimen, and the volatile liquid introduced later by way of the lower valve.

5. Apparatus

5.1 Two types of apparatus may be used, as follows:

5.1.1 *Apparatus A* consists of a plain glass tube 10 mm in outside diameter and 250 mm long, sealed at one end. A glass rod 7.5 mm in diameter and approximately 20 mm in length is placed in the bottom of each tube to support the test specimen. The opposite end of the tube is closed by a small vented rubber stopper after the fluid and specimen have been introduced, or, in the case of a volatile liquid, this end may be heat-sealed.

5.1.2 *Apparatus B* consists of a 300-mm (12-in.) length of extra-heavy glass pipe with flanged ends, approximately 20 mm (¾ in.) in inside diameter, one end being closed originally by a blind flange with suitable gasket, and the other by a similar blind flange applied after the specimen has been introduced. Both flanges are drilled, tapped, and connected to metal valves by short lengths of threaded tubing. The lower valve is for admitting the fluid after the pipe has been closed; the upper valve is for discharging the vapors of the liquid at the conclusion of the test.

5.2 Apparatus B is preferred to Apparatus A when employing a liquid that requires pressure (not exceeding 1.1 MPa (160 psi)) to maintain it in the liquid state during the period of immersion. This category includes most refrigerants, liquid petroleum gases, anhydrous ammonia, and so forth. By the use of Apparatus B, the difficult and possibly hazardous operation of heat-sealing the tube is avoided. For pressures above 1.1

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[2] 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.

MPa (160 psi) it is still necessary to employ Apparatus A, using tubing of sufficient wall thickness to support the pressure. For use with Apparatus B, it is assumed that the liquid is available in a metal container with threaded connection suitable for attaching to the lower valve.

6. Accessory Apparatus

6.1 *Reading Table* (*for Apparatus A only*)—The reading table shall consist of a glass plate to which a sheet of millimetre graph paper is taped, and illuminated from below.

6.2 *Specimen Holder* (*for Apparatus B only*)—The specimen holder shall consist of a 250 by 16-mm (10 by ⅝-in.) strip of cardboard or thin wood with one bench mark inscribed on one face about 50 mm (2 in.) from the upper end, a second bench mark 100 mm (5 in.) below the first, and a series of 1-mm (0.050-in.) graduations extending both below and above the lower bench mark. Each graduation corresponds to a 1% change in length, and the number of graduations should be enough to measure the maximum increase (or decrease) in length developed by the material under test.

6.3 *Rack* (optional), for supporting any number of containers of either type in the vertical position.

6.4 *Conditioning Room,* maintained at 23 ± 2°C (73.4 ± 3.6°F) for tests at room temperature, or, optionally, at other temperatures.

6.5 *Thermostatically Controlled Oven or Liquid Bath,* for tests at any specified elevated temperatures specified in Practice D1349.

7. Test Specimens

7.1 *For Use With Apparatus A*—The test specimen shall be a rectangular strip 100 mm (4.0 in.) in length by 1.6 mm (0.0625 in.) in width, cut from a standard 2.0 mm (0.075 in.) thick sheet prepared as described in Practices D3182 and D3183, or an equivalent specimen cut from a commercial article where feasible. In general, one specimen shall be cut in the longitudinal and one in the transverse direction of the grain.

7.2 *For Use With Apparatus B*—The test specimen shall be a rectangular strip 150 mm (6 in.) in length and 10 to 15 mm (0.4 to 0.6 in.) in width, prepared in all other respects in accordance with 7.1.

8. Procedure

8.1 *For Apparatus A*—Place each specimen in a tube so that the lower end of the specimen rests on the glass rod of the tube. Measure the original length of the specimen, L_1, by means of the reading table. Add 10 cm^3 of test liquid, and stopper or seal the tube according to the type of liquid employed. After conditioning for the desired time at a temperature in accordance with Practice D1349 and returning to 23 ± 2°C (73.4 ± 3.6°F) place the tube on the reading table and read the immersed length, L_2. In reading, avoid parallax by lining up a line on the graph paper with its reflection in the walls of the tube. Calculate the percentage increase in length as follows:

$$\text{Increase in length, } \% = [(L_2 - L_1)/L_1] \times 100$$

If L_1 does not appreciably deviate from 100 mm, the percentage increase may be given simply as $L_2 - L_1$.

8.2 *For Apparatus B*—Inscribe the specimen with a bench mark exactly 127 mm (5 in.) from its lower edge. Staple this bench mark to the upper bench mark of the specimen holder, using a commercial stapling machine. The lower edge of the specimen will now be even with the lower bench mark on the holder. Place the assembly of specimen and holder in the pipe so that the bottom of the specimen holder rests on the lower flange. If a mixture of oil and volatile liquid is to be employed, the oil shall be introduced at this point. Bolt the upper flange on with the valve open. Connect the cylinder of test liquid to the lower valve and then open this valve and the cylinder valve to permit the test liquid to fill the pipe to a point 12 mm (½ in.) above the top of the specimen. Considerable boiling will take place during this operation, the vapors escaping by way of the upper valve. Close both valves and disconnect the cylinder. If oil is present, mix the liquids by inverting the pipe. Condition the pipe as in 8.1 and bring the pipe to 23 ± 2°C (73.4 ± 3.6°F). Determine the percentage increase or decrease in length by direct observation of the position of the lower edge of the specimen. At the conclusion of the test, open the upper valve and allow the liquid to boil away before disassembling the apparatus.

9. Report

9.1 The report shall include the following:

9.1.1 The apparatus employed,

9.1.2 Type of test fluid,

9.1.3 Time and temperature of immersion,

9.1.4 Increase in length of specimens in percent of original, giving separate values for longitudinal and transverse specimens, and the change in length for all specimens, and

9.1.5 An approximate estimate of volume increase, which may be read from Table 1, determined from the average increase in length.

NOTE 1—This table is based on the assumption that an increase in the unmeasured dimension (thickness) corresponds to the average of the length and cross directions, which may not be correct in the case of vulcanizates with pronounced grain characteristics or those containing anisotropic fillers.

10. Precision and Bias

10.1 Due to a lack of laboratories willing to participate in round-robin testing, no precision data are available for this test method.

11. Keywords

11.1 length change; liquid immersion

TABLE 1 Relationship of ΔL to ΔV

NOTE 1—ΔL is the corrected percentage difference in length of the test specimen and ΔV is the corresponding change in volume expressed as a percentage of the original volume of the specimen.

ΔL, %	ΔV, %	ΔL, %	ΔV, %	ΔL, %	ΔV, %	ΔL, %	ΔV, %	ΔL, %	ΔV, %
0.5	1.5	20.5	75.0	40.5	177.3	60.5	313.5	80.5	488.1
1.0	3.0	21.0	77.2	41.0	180.3	61	317.3	81	493.0
1.5	4.5	21.5	79.4	41.5	183.3	61.5	321.2	81.5	498.0
2.0	6.1	22.0	81.6	42.0	186.3	62	325.2	82	502.9
2.5	7.6	22.5	83.8	42.5	189.3	62.5	329.1	82.5	507.9
3.0	9.2	23.0	86.1	43.0	192.4	63	333.1	83	512.8
3.5	10.8	23.5	88.4	43.5	195.5	63.5	337.1	83.5	517.9
4.0	12.5	24.0	90.7	44.0	198.6	64	341.1	84	523.0
4.5	14.1	24.5	93.0	44.5	201.7	64.5	345.1	84.5	528.1
5.0	15.8	25.0	95.3	45.0	204.9	65	349.2	85	533.2
5.5	17.4	25.5	97.5	45.5	208.0	65.5	353.3	85.5	538.3
6.0	19.1	26.0	100.0	46.0	211.2	66	357.4	86	543.5
6.5	20.8	26.5	102.4	46.5	214.4	66.5	361.6	86.5	548.7
7.0	22.5	27.0	104.8	47.0	217.7	67	365.7	87	553.9
7.5	24.2	27.5	107.2	47.5	220.9	67.5	369.9	87.5	559.2
8.0	26.0	28.0	109.7	48.0	224.2	68	374.2	88	564.5
8.5	27.7	28.5	112.2	48.5	227.3	68.5	378.5	88.5	569.8
9.0	29.5	29.0	114.7	49.0	230.8	69	382.7	89	575.1
9.5	31.3	29.5	117.2	49.5	234.1	69.5	387.0	89.5	580.5
10.0	33.1	30.0	119.7	50.0	237.5	70	391.3	90	585.9
10.5	34.9	30.5	122.2	50.5	240.9	70.5	395.6	90.5	591.3
11.0	36.8	31.0	124.8	51.0	244.3	71	400.0	91	596.8
11.5	38.6	31.5	127.0	51.5	247.8	71.5	404.4	91.5	602.3
12.0	40.5	32.0	130.0	52	251.2	72	408.8	92	607.8
12.5	42.4	32.5	132.6	52.5	254.7	72.5	413.3	92.5	613.3
13.0	44.3	33.0	135.3	53	258.2	73	417.8	93	618.9
13.5	46.1	33.5	137.9	53.5	261.7	73.5	422.3	93.5	624.5
14.0	48.2	34.0	140.6	54	265.2	74	426.8	94	630.1
14.5	50.0	34.5	143.3	54.5	268.8	74.5	431.3	94.5	635.8
15.0	52.1	35.0	146.0	55	272.4	75	435.9	95	641.5
15.5	54.1	35.5	148.7	55.5	276.0	75.5	440.1	95.5	647.2
16.0	56.1	36.0	151.5	56	279.6	76	445.2	96	653.0
16.5	58.1	36.5	154.3	56.5	283.3	76.5	449.8	96.5	658.8
17.0	60.2	37.0	157.1	57	287.0	77	454.5	97	664.5
17.5	62.2	37.5	159.9	57.5	290.7	77.5	461.2	97.5	670.3
18.0	64.3	38.0	162.8	58	294.4	78	464.0	98	676.2
18.5	66.4	38.5	165.7	58.5	298.2	78.5	468.8	98.5	682.1
19.0	68.5	39.0	168.6	59	302.0	79	473.5	99	688.1
19.5	70.6	39.5	171.5	59.5	305.8	79.5	478.3	99.5	694.1
20.0	72.8	40.0	174.4	60	309.6	80	483.2	100	700.0