Designation: D 531 – 89 (Reapproved 1999)

# Standard Test Method for Rubber Property—Pusey and Jones Indentation[1]

This standard is issued under the fixed designation D 531; 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 indentation of rubber or rubber-like materials by means of the Pusey and Jones type of plastometer. This apparatus is used to measure the depth of indentation of an indentor, under fixed force into the surface of a rubber specimen.

1.2 The values stated in SI units are to be regarded as the standards.

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.*

## 2. Referenced Documents

2.1 *ASTM Standards:*

D 1415 Test Method for Rubber Property—International Hardness[2]

D 4483 Practice for Determining Precision for Test Method Standards in the Rubber and Carbon Black Industries[2]

NOTE 1—The specific dated edition of the practice that prevails in this document is referenced in the Precision section.

## 3. Significance and Use

3.1 The Pusey and Jones indentation value is the depth of indentation, expressed in hundredths of a millimetre, of a ball 3.175 mm (0.1250 in.) in diameter under an expressed force of 9.8 N (2.2 lbf). This value may be used to compare the indentation resistance of rubber and rubber-like materials.

3.2 The indentation value obtained should not be confused with hardness as measured by Test Method D 1415, since in the latter test the rubber immediately adjacent to the indentor is precompressed.

## 4. Apparatus

4.1 *Plastometer*, an instrument consisting of an indentor, a mass for applying a fixed gravitational force on the indentor, and a suitable device for indicating the depth of indentation.

4.1.1 *Support*—The supporting frame shall be configured so that the indentor and mass may be independently raised or lowered vertically, permitting the indentor to rest on the surface of the test specimen and the mass to be applied subsequently to the indentor.

4.1.2 *Indentor*, consisting of a vertical steel shaft attached at the upper end to the spindle of the indicator gage and having at the lower end a steel ball. The steel ball shall be 3.175 ± 0.015 mm (0.1250 ± 0.0005 in.) in diameter and shall be made of highly polished, noncorrosive hard metal properly treated to resist wear.

4.1.3 *Mass*—The mass shall be 1000 ± 0.01 g.

4.1.4 *Depth Indicator*—A dial gage or other suitable device graduated in increments of 0.01 mm (0.0004 in.) and having a range of at least 3 mm shall indicate the movement of the indentor.

4.1.5 *Specimen Holder*, for the block described in 5.1 shall be provided consisting of a clamp made of two metal plates held together by two threaded bolts as shown in Fig. 1. The purpose of the clamp is to hold the specimens flat and free from slight movements that might introduce variations into the test. The top plate shall be provided with a hole and slot for the operation of the indentor.

## 5. Test Specimens

5.1 The standard specimen shall be a uniform molded rectangular block approximately 13 mm (0.5 in.) in thickness, 30 mm (1.2 in.) in width, and 75 mm (3 in.) in length. The top and bottom faces shall be as parallel as possible. This specimen shall be used in all cases when the apparatus is employed for reference standard purposes as distinguished from routine control testing of commercial articles.

5.2 In routine testing, specimens may be used that have dimensions other than those of the standard specimen, including manufactured products of such size and shape to support the apparatus or where it can be suitably mounted above them.

## 6. Procedure

6.1 *Measurement of Indentation*—Place the specimen on a firm base with the surface under test horizontal. Flat specimens may rest on a table having a truly level surface or on the secondary base mentioned in 4.1.1. Place curved specimens such as rubber-covered rolls so that the center line of the

[1] This test method is under the jurisdiction of ASTM Commitee D-11 on Rubber and is the direct responsibility of Subcommittee D11.10 on Physical Testing.

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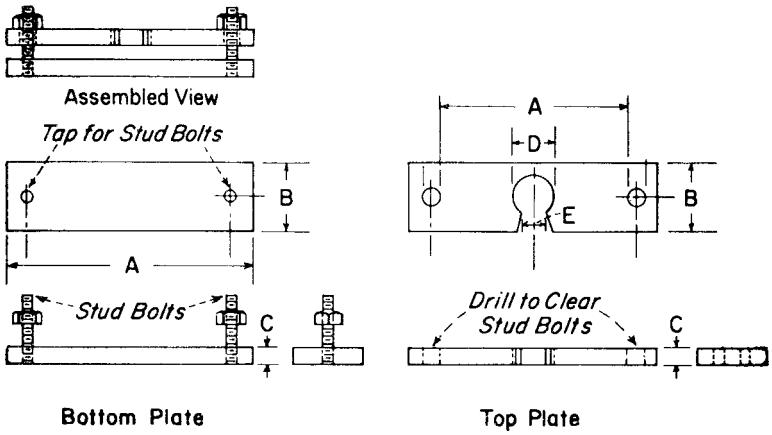
[2] *Annual Book of ASTM Standards*, Vol 09.01.




| mm | | in. |
|---|---|---|
| *A*, min | 80 | 3.15 |
| *B*, min | 30 | 1.2 |
| *D* | 17 to 18 | 0.67 to 0.70 |
| *E* | 11 to 12 | 0.43 to 0.47 |
| *F* | 60 | 2.36 |

**FIG. 1 Holder for Test Specimens**

indentor shaft is perpendicular to the tangent at the point of contact of the indentor. When using the standard specimen described in 5.1, clamp it in the specimen holder with the bolts tightened sufficiently to hold it firmly without compression. Mount the apparatus over the specimen and adjust, by means of a spirit level placed on the base, so that the indentor shaft is vertical. The plastometer shall not rock or be unsteady, whether its feet rest on the table around a small specimen or directly on a large specimen, or whether it is mounted on a rod and secondary base as is required with the standard specimen and holder. Lower the indentor shaft until the indentor is in contact with the specimen and the depth indicator is adjusted to read indentations up to 3 mm (0.12 in.). Adjust the dial so that the needle indicates zero. Lower the mass onto the indentor carefully without shock, and lower the supporting plate still farther so that the mass rests fully on the indentor. Read the amount of indentation on the gage exactly 1 min. after the application of the force.

6.2 *Number of Readings*—Take three readings, shifting the specimen to a new position for each reading.

6.3 *Temperature*—For comparative purposes, all tests shall be carried out at 23 ± 2°C (73 ± 3.6°F). Test specimens shall be conditioned at least 3 h immediately prior to testing. Specimens that are affected by atmosphere moisture shall be conditioned in an atmosphere controlled to 50 ± 5 % relative humidity for at least 24 h.

6.4 *Routine Tests*—When tests are made for control purposes on commercial articles of dimensions differing from those of the standard specimen and without using the specimen holder, the results are comparative only with those obtained under essentially the same conditions of specimen size and shape, temperature, and method of assembly of the apparatus and specimen.

6.5 *Pusey and Jones Indentation Number*— The median of three indentation values expressed as a whole number indicating the hundredths of millimetres of indentation shall be known as the Pusey and Jones indentation number.

NOTE 2—For certain federal specifications, a vibrator may be specified.

6.6 *Vibrator*—A small vibrator which is activated prior to the mass being applied to the indentor and operates continuously during a test to overcome any friction in the apparatus. An instrument that vibrates approximately 120 times per s, with an amplitude of vibration of the fixed platform of the tester varying from approximately 0.002 to 0.005 mm (0.0001 to 0.0002 in.), has been found satisfactory.

6.7 Such a vibrator may consist of a simple-cored solenoid fastened to the top of a C-shaped piece of strap steel. The lower part of the solenoid core is a loose cylindrical piece of steel with a shoulder at its lower end. When the current is off, the loose-cored section rests on a screw projecting from the bottom of the C-shaped support. When the current is on, the loose-cored section is attached to the solenoid but is restrained by a flat split ring of spring brass through which the cored section passes, and which bears on the shoulder of the cored section. The cored section is caused to vibrate by the alternating forces of attaction by the solenoid and repulsion by the flat ring acting as a spring. A small plate bearing a toggle switch for closing the circuit to the solenoid is fastened to the top of the C-shaped piece of strap steel by means of the same bolt that holds the solenoid. The bottom of the C-shaped piece is fastened by screws to a portion of a brass nut that serves to clamp the vibrator to one upright post of the tester.

## 7. Report

7.1 State that the test was made in accordance with this designation and include the following information:

7.1.1 The Pusey and Jones indentation number,

7.1.2 Description of test specimen including dimensions,

7.1.3 Date of vulcanization, if known,

7.1.4 Duration and temperature of vulcanization, if known,

7.1.5 Temperature of test room, and

7.1.6 Date of test.

## 8. Precision and Bias [3]

8.1 These precision statements have been prepared in accordance with Practice D 4483. Refer to Practice D 4483 for terminology and other testing and statistical concepts.

8.2 The Pusey and Jones Indentation Plastometer is used mainly in the rubber roll industry. In this program nointerlaboratory precision data were obtained due to the limited use of this test method. The precision program consisted of tests by one operator on three different (in-house) instruments on three different days. Four materials were tested. A test result is the median value of three separate (determinations) indentation measurements.

8.3 Table 1 gives the within and among "instrument" precision. Repeatability refers to within instrument variation; reproducibility refers to among (between) instrument variation, with the same operator for both.

8.4 *Bias*—In test method statistical terminology, bias is the difference between an average test value and the reference or true test property value. Reference values do not exist for this test method since the value or level of the test property is exclusively defined by the test method. Bias, therefore, cannot be determined.

[3] Supporting data are available from ASTM Headquarters. Request RR: D11–1028.

**TABLE 1 Special Precision Results—Pusey and Jones Indentation**

| Material | Mean Level | Within Instrument[A] | | | Between Instrument[A] | | |
|---|---|---|---|---|---|---|---|
| | | *S*(*w*) | *r*(*w*) | (*r*)(*w*) | *S*(*B*) | *r*(*B*) | (*r*)(*B*) |
| 1 | 11.7(a) | 0.265 | 0.750 | 6.4 | 0.374 | 1.06 | 9.1 |
| 2 | 20.9 | 0.296 | 0.838 | 4.0 | 0.309 | 0.875 | 4.2 |
| 3 | 38.1 | 0.379 | 1.073 | 2.8 | 0.668 | 1.89 | 5.0 |
| 4 | 63.0 | 0.192 | 0.543 | 0.86 | 1.67 | 4.73 | 7.5 |

[A]

*S(w)* = within instrument, standard deviation.
*r(w)* = repeatability (within instrument) measurement units.
*(r)(w)* = repeatability (within instrument), %.
*S(B)* = between instrument, standard deviation.
*r(B)* = repeatability (between instrument) measurement units.
*(r)(B)* = repeatability (between instrument), %.
*(a)* = Pusey and Jones indentation number.