



Designation: **C1419 – 99a (Reapproved 2009) C1419 – 14**

## Standard Test Method for Sonic Velocity in Refractory Materials at Room Temperature and Its Use in Obtaining an Approximate Young's Modulus<sup>1</sup>

This standard is issued under the fixed designation C1419; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This test method describes a procedure for measuring the sonic velocity in refractory materials at room temperature. The sonic velocity can be used to obtain an approximate value for Young's modulus.

1.2 The sonic velocity may be measured through the length, thickness, and width of the specimen.

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 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:*<sup>2</sup>

[C134 Test Methods for Size, Dimensional Measurements, and Bulk Density of Refractory Brick and Insulating Firebrick](#)

[C179 Test Method for Drying and Firing Linear Change of Refractory Plastic and Ramming Mix Specimens](#)

[C769 Test Method for Sonic Velocity in Manufactured Carbon and Graphite Materials for Use in Obtaining Young's Modulus](#)

[C885 Test Method for Young's Modulus of Refractory Shapes by Sonic Resonance](#)

[E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods](#)

[E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method](#)

[IEEE/ASTM SI10 American National Standard for Use of the International System of Units \(SI\): The Modern Metric System](#)

### 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:* [ASTM C1419-14](#)

3.1.1 *longitudinal sonic pulse, n*—a sonic pulse in which the displacements are in the direction of propagation of the pulse.

3.1.2 *pulse travel time, ( $T_t$ ), n*—the total time, measured in microseconds, required for the sonic pulse to traverse the specimen being tested, and for the associated electronic signals to traverse the circuits of the pulse propagation circuitry.

3.1.3 *zero time, ( $T_o$ ), n*—the travel time (correction factor), measured in microseconds, associated with the electronic circuits in the pulse-propagation system.

### 4. Summary of Test Method

4.1 The velocity of sound waves passing through the test specimen is determined by measuring the distance through the specimen and dividing by the time lapse between the transmitted pulse and the received pulse.<sup>3,4</sup> An approximate value for Young's modulus can be obtained as follows:

$$E = \rho v^2 \quad (1)$$

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee C08 on Refractories and is the direct responsibility of Subcommittee C08.01 on Strength. Current edition approved Sept. 1, 2009; Sept. 1, 2014. Published October 2009; October 2014. Originally approved in 1999. Last previous edition approved in 2004 as C1419 – 99a (2004); (2009). DOI: 10.1520/C1419-99AR09; 10.1520/C1419-14.

<sup>2</sup> 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.

<sup>3</sup> Schreiber, Anderson, and Soga, *Elastic Constants and Their Measurement*, McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, NY 10020, 1973.

<sup>4</sup> *American Institute of Physics Handbook*, 3rd ed., McGraw-Hill Book Co., 1221 Avenue of the Americas, New York, NY 10020, 1972, pp. 3–98ff.

where:

$E$  = Young's modulus of elasticity, Pa,

$\rho$  = density, kg/m<sup>3</sup>, and

$v$  = signal velocity, m/s.

4.2 Strictly speaking, the elastic constant given by this measurement is not  $E$  but  $C_{33}$ , provided the sonic pulse is longitudinal and the direction of propagation is along the axis of symmetry.<sup>3,4</sup>

**5. Significance and Use**

5.1 This test method is used to determine the sonic velocity and approximate Young's modulus of refractory shapes at room temperature. Since this test is nondestructive, specimens may be used for other tests as desired.

5.2 This test method is useful for research and development, engineering application and design, manufacturing quality and process control, and for developing purchasing specifications.

**6. Apparatus**

6.1 *Driving Circuit*, which consists of an ultra sonic pulse generator capable of producing pulses in a frequency range from 0.5 to 2.5 MHz.

6.2 *Transducer*, input.

6.3 *Transducer*, output.

6.4 *Oscilloscope*, dual trace with a preamplifier and time delay circuitry.

6.5 See Fig. 1 for a typical set-up.

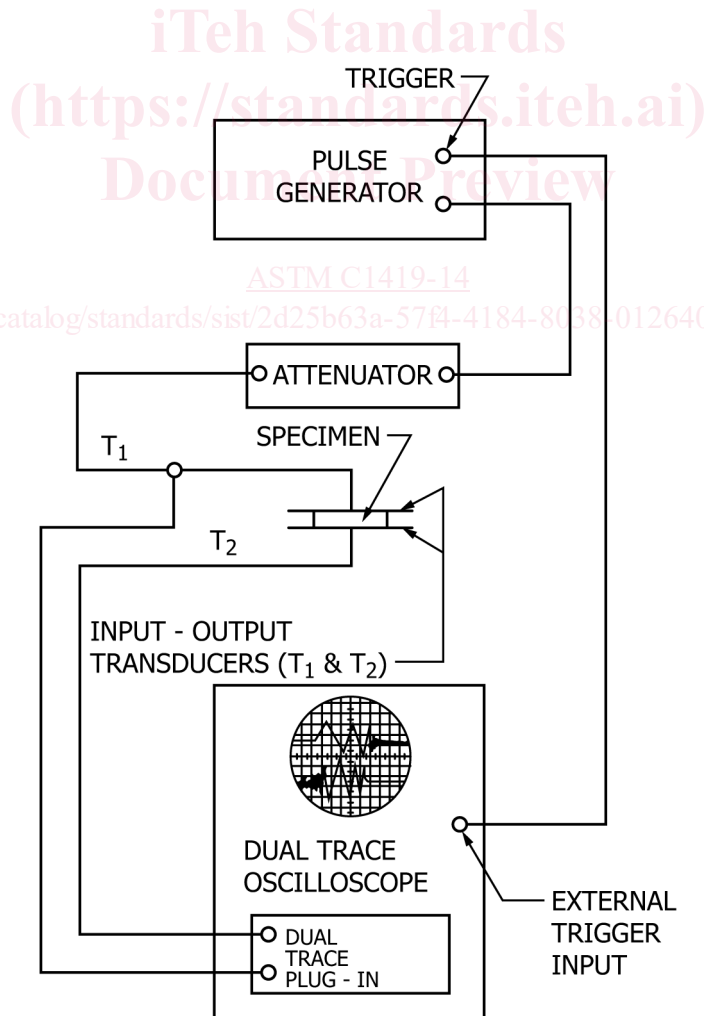


FIG. 1 Equipment Set-up