



Standard Test Methods for Rubber—Measurement of Processing Properties Using Capillary Rheometry¹

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1. Scope

1.1 These test methods describe how capillary rheometry may be used to measure the rheological characteristics of rubber (raw or compounded). Two methods are addressed: Method A—using a piston type capillary rheometer, and Method B—using a screw extrusion type capillary rheometer. The two methods have important differences, as outlined in 7-10 and 11-14, respectively.

1.2 These test methods cover the use of a capillary rheometer for the measurement of the flow properties of thermoplastic elastomers, unvulcanized rubber, and rubber compounds. These material properties are related to factory processing.

1.3 Since piston type capillary rheometers impart only a small amount of shearing energy to the sample, these measurements directly relate to the state of the compound at the time of sampling. Piston capillary rheometer measurements will usually differ from measurements with a screw extrusion type rheometer, which imparts shearing energy just before the rheological measurement.

1.4 Capillary rheometer measurements for plastics are described in Test Method D 3835.

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

1.6 *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

¹ These test methods are under the jurisdiction of ASTM Committee D11 on Rubber and are the direct responsibility of Subcommittee D11.12 on Processability Tests.

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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.

D 1349 Practice for Rubber—Standard Temperatures for Testing

D 1485 Test Methods for Rubber from Natural Sources—Sampling and Sample Preparation

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

D 3835 Test Method for Determination of Properties of Polymeric Materials by Means of a Capillary Rheometer

D 3896 Practice for Rubber from Synthetic Sources—Sampling

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

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *apparent (uncorrected) shear rate (γ)*—shear strain rate (or velocity gradient) of the rubber extrudate as it passes through the capillary die.

3.1.1.1 *Discussion*—This velocity gradient is not uniform through the cross-section of the capillary die. The shear rate is calculated for the region of highest shear, at the wall of the capillary. By selecting a die diameter and controlling the volume flow per unit time through the die, a specific level of apparent shear rate may be achieved. Alternately, the shear stress (entrance pressure) may be controlled, and the apparent shear rate measured.

3.1.1.2 Mathematically, the apparent shear rate for a Newtonian fluid at the wall is given as follows:

$$\gamma = \frac{32 Q}{\pi D^3} \quad (1)$$

where:

γ = apparent shear rate,

Q = quantity of fluid extruded in one second, mm³,

π = the constant pi, approximately 3.142, and

D = diameter of the measuring capillary, mm.

The units of apparent shear rate are reciprocal seconds (s⁻¹).

3.1.2 *apparent shear stress (τ)*—the measured resistance to flow through a capillary die; it may be determined by measuring the die entrance pressure for a specified die, then applying appropriate geometric factors.