



Standard Test Method for Measurement of Properties of Thermoplastic Materials by Screw-Extrusion Capillary Rheometer¹

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INTRODUCTION

This test method uses capillary rheometry to measure the rheological properties of thermoplastics and thermoplastic compounds. This test method utilizes a screw-extrusion-type capillary rheometer.

1. Scope*

1.1 This test method covers the use of a screw-extrusion-type capillary rheometer for the measurement of flow properties of thermoplastics and thermoplastic compounds. The measured flow properties, which are obtained through laboratory investigation, may help to describe the material behavior that occurs in factory processing.

1.2 Since a screw-type capillary rheometer imparts shear energy to the material during testing, the measurements will usually differ from those obtained with a piston-type capillary rheometer (see Test Method D 3835).

1.3 Capillary rheometer measurements for thermoplastics and thermoplastic compounds are described in Test Method D 3835.

1.4 The values stated in SI units are to be regarded as standard.

1.5 *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.*

NOTE 1—There is currently no equivalent ISO standard.

2. Referenced Documents

2.1 ASTM Standards:

D 618 Practice for Conditioning Plastics for Testing²

D 883 Terminology Relating to Plastics²

D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer²

D 3835 Test Method for Determination of Properties of Polymeric Materials by Means of a Capillary Rheometer³

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method⁴

3. Terminology

3.1 *Definitions (See Terminology D 883) :*

3.1.1 *apparent shear rate ($\dot{\gamma}_a$)*—shear strain rate (or velocity gradient) of the thermoplastic or thermoplastic compound 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, which is 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 *Discussion*—Mathematically, the apparent shear rate at the wall of the capillary for a Newtonian fluid at the capillary wall is given by the following:

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

where:

$\dot{\gamma}_a$ = apparent shear rate, s⁻¹,

Q = quantity of fluid extruded per time, mm³ /s,

π = 3.142, and

D = diameter of the measuring capillary, mm.

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

3.1.2.1 *Discussion*—Mathematically, apparent shear stress is given by the following:

$$\tau_a = \frac{P}{4 \cdot (L/D)} \quad (2)$$

¹ This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.30 on Thermal Properties.

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² Annual Book of ASTM Standards, Vol 08.01.

³ Annual Book of ASTM Standards, Vol 08.02.

⁴ Annual Book of ASTM Standards, Vol 14.02.

*A Summary of Changes section appears at the end of this standard.

