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AMERICAN SOCIETY FOR TESTING AND MATERIALS

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Standard Test Method for Molecular Weight Averages and Molecular Weight Distribution by Liquid Exclusion Chromatography (GEL Permeation Chromatography—GPC)¹

This standard is issued under the fixed designation D 3536; 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 the determination of molecular weight (MW) averages and the distribution of molecular weights in linear soluble polystyrene by liquid exclusion chromatography (gel permeation chromatography—GPC). The test method uses commercially available polystyrene (PS) standards and equipment for this purpose and is applicable for samples containing molecular weight components from 5000 to $3 \times 10^6 \text{ g} \cdot \text{mol}^{-1}$. This is discussed in more detail in 12.1. The test method is not absolute and requires calibration.

1.2 The values stated in SI units, based on Practice E 380, are to be regarded as the standard.

1.3 *This standard does not purport to address all of the safety problems, 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 3016 Practice for Use of Liquid Exclusion Chromatography Terms and Relationships²

E 380 Practice for Use of the International System of Units (SI)³

2.2 Other Document:

AMD 40 Bibliography on Liquid Exclusion Chromatography⁴

3. Summary of Test Method

3.1 In this technique a solution of a polymer sample is injected into a chromatographic column (series) packed with a solid, porous substrate which separates the diverse molecules according to their size in solution. The size-separated molecules are detected and recorded according to their concentration. Through calibration, sizes are converted to molecular weights, and various molecular weight parameters for the sample are calculated from the molecular weight/concentration data.

¹ This test method is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.70 on Analytical Methods (Section D20.70.02).

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² Annual Book of ASTM Standards, Vol 08.02.

³ Annual Book of ASTM Standards, Vol 14.02.

⁴ Available from ASTM, 1916 Race St., Philadelphia, PA 19103.

4. Significance and Use

4.1 *General Utility*—The molecular weight (MW) and molecular weight distribution (MWD) are fundamental characteristics of a polymer sample. They may be used for a wide variety of correlations for fundamental studies or product applications. For example, the observed molecular weight distribution may be compared to a predicted one from assumed kinetics or mechanisms of reaction, or both. Differences between the values will allow alteration of theory or experimental design. Similarly, strength, melt flow, and other properties may be dependent on molecular weight and molecular weight distribution.

4.2 *Limitations*—Because of the need for specific calibration of the polymer type under study, and because of the specific nature of polymer/solvent/column-packing interactions, this test method is valid only for polystyrene. However, many of the principles of the test method may be used to generate methods for other polymer systems.

5. Units and Symbols

5.1 Terms and relationships for this test method are defined in Practice D 3016.

5.2 Related to Function:

Function	Common Unit or Symbol	SI Unit or Symbol
Basic property definition	MW (molecular weight in daltons)	$\text{g} \cdot \text{mol}^{-1}$
Solvent flowrate	$\text{mL} \cdot \text{min}^{-1}$	$\text{m}^3 \cdot \text{s}^{-1}$
Sample volume or capacity	μL , mL	L
Column lengths	cm	m
Sample weight (mass)	mg	g
Pore size	μm	m
Chromatogram heights	mm	m

^A Same as common unit.

5.3 Equivalencies Used in This Test Method:

SI Unit or Symbol	Common Unit or Symbol
$1.667 \times 10^{-9} \text{ m}^3 \cdot \text{s}^{-1}$	$1 \text{ mL} \cdot \text{min}^{-1}$

6. Apparatus

6.1 *Introduction*—Liquid exclusion chromatography (GPC) is a specific form of liquid chromatography. The principal distinguishing features of GPC are the column