



Standard Test Method for Molecular Weight Averages and Molecular Weight Distribution of Certain Polymers by Liquid Size-Exclusion Chromatography (Gel Permeation Chromatography—GPC) Using Universal Calibration¹

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^{ε1} NOTE—Editorial changes were made throughout the text in October 1986.

1. Scope

1.1 This test method covers the determination of molecular weight (MW) averages and the distribution of molecular weights for linear, tetrahydrofuran-soluble macromolecules by liquid size-exclusion chromatography (GPC) using the principles of Universal Calibration. The test method uses commercially available polystyrene (PS) standards and equipment for this purpose and is applicable for samples containing molecular weight components whose retention volumes approximate the retention volume of PS, molecular weight from 5000 to $3 \times 10^6 \text{ g} \cdot \text{mol}^{-1}$. The test method is not absolute and requires calibration.

NOTE 1—See also Test Method D 3536.

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

1.3 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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. A specific hazard statement appears in Note 6.*

2. Referenced Documents

2.1 ASTM Standards:

D 2857 Test Method for Dilute Solution Viscosity of Polymers²

D 3016 Practice for Use of Liquid Exclusion Chromatography Terms and Relationships²

D 3536 Test Method for Molecular Weight Averages and Molecular Weight Distribution of Polystyrene by Liquid Exclusion Chromatography (Gel Permeation Chromatography—GPC)³

E 380 Practice for Use of the International System of Units (SI)⁴

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 08.03.

⁴ Annual Book of ASTM Standards, Vol 14.02. Excerpts of E 380 appear in the gray pages of this volume.

2.2 Other Document:

AMD 40 Bibliography on Liquid Exclusion Chromatography⁵

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 molecules according to their size in solution. The size-separated molecules are detected and recorded according to their concentration. Through Universal Calibration, molecular weight calibration curves for various polymers are obtained from PS standards. Various molecular weight parameters for the sample are calculated from the molecular weight/concentration data.

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 specific nature of polymer/solvent/column-packing interactions, it is possible that this method will not be applicable for some polymers. Such situations may be difficult to detect and may lead to inaccurate, but reproducible molecular weights. If highly accurate MW's are needed an absolute method such as osmometry (M_n) or light scattering (M_w) must be employed for confirmation. This method is valid only for polymers soluble in tetrahydrofuran (THF) for which Mark-Houwink viscosity parameters K and a are known (see Appendix X3). Although this method has been evaluated at 25°C, other temperatures can be used provided that the Mark-Houwink

⁵ Available from ASTM, 1916 Race St., Philadelphia, PA 19103.