



Designation: D 5577 – 94

Standard Guide for Techniques to Separate and Identify Contaminants in Recycled Plastics¹

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1. Scope

1.1 This guide is intended to provide information on available methods for the separation and classification of contaminants such as moisture, incompatible polymers, metals, adhesives, glass, paper, wood, chemicals, and original-product residues in recycled plastic flakes or pellets. Although no specific methods for identification or characterization of foam products are included, foam products are not excluded from this guide. The methods presented apply to post-consumer plastics.

1.2 For specific procedures existing as ASTM test methods, this guide only lists the appropriate reference. Where no current ASTM standard exists, however, this guide gives procedures for the separation or identification, or both, of specific contaminants. Appendix X1 lists the tests and the specific contaminant addressed by each procedure.

1.3 This guide does not include procedures to quantify the contaminants unless this information is available in referenced ASTM standards.

1.4 *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—Although this guide references ISO standards, there is no similar or equivalent ISO standard covering this topic.

2. Referenced Documents

2.1 ASTM Standards:

D 789 Test Methods for Determination of Relative Viscosity, Melting Point, and Moisture Content of Polyamide (PA)²

D 792 Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement²

D 883 Terminology Relating to Plastics²

D 1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics²

D 1193 Specification for Reagent Water³

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

D 1457 Specification for Polytetrafluoroethylene (PTFE) Molding and Extrusion Materials²

D 1505 Test Method for Density of Plastics by the Density-Gradient Technique²

D 1898 Practice for Sampling of Plastics²

D 1925 Test Method for Yellowness Index of Plastics²

D 3418 Test Method for Transition Temperatures of Polymers by Thermal Analysis⁴

D 4019 Test Method for Moisture in Plastics by Coulometric Regeneration of Phosphorus Pentoxide⁴

D 5033 Guide for the Development of Standards Relating to the Proper Use of Recycled Plastics⁵

D 5227 Test Method for the Measurement of Hexane Extractable Content of Polyolefins⁵

E 169 Practices for General Techniques of Ultraviolet-Visible Quantitative Analysis⁶

E 355 Practice for Gas Chromatography Terms and Relationships⁶

E 682 Practice for Liquid Chromatography Terms and Relationships⁶

E 794 Test Method for Melting and Crystallization Temperatures by Thermal Analysis⁷

E 1252 Practice for General Techniques for Qualitative Infrared Analysis⁶

2.2 ISO Standards:⁸

ISO 3451/1-1981 Plastics—Determination of Ash; Part 1: General Methods

ISO 1183-1987 Methods for Determining the Density and Relative Density of Noncellular Plastics

3. Terminology

3.1 This terminology used in this guide is in accordance with Terminology D 883 and Guide D 5033.

¹ This guide is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.70 on Analytical Methods.

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² Annual Book of ASTM Standards, Vol 08.01.

³ Annual Book of ASTM Standards, Vol 11.01.

⁴ Annual Book of ASTM Standards, Vol 08.02.

⁵ Annual Book of ASTM Standards, Vol 08.03.

⁶ Annual Book of ASTM Standards, Vol 14.01.

⁷ Annual Book of ASTM Standards, Vol 14.02.

⁸ Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.



3.2 Definitions of Terms Specific to This Standard:

3.2.1 *chemicals*—nonhazardous or hazardous materials (for example, insecticides or herbicides) potentially used in contact with plastic materials.

3.2.2 *glue*—adhesives used for labels or joining bottle parts (for example, ethylene-vinyl acetate).

3.2.3 *heavy metals*—metals heavier than sodium on the periodic table (for example, lead, arsenic, cadmium, chromium, or copper).

3.2.4 *heavy plastic*—unfilled polymers such as polystyrene, poly(ethylene terephthalate), and poly(vinyl chloride) and filled materials with densities greater than 1.00 g/cm³.

3.2.5 *light plastic*—polymers such as polyethylene and polypropylene with densities less than 1.00 g/cm³.

3.2.6 *original-product residues*—residues from any original-product contents of a plastic package (for example, milk, juice, or detergent).

3.2.7 *particles*—piece of metal, glass, wood, paper, or other discreetly shaped material equal to or larger than 0.1 mm².

3.2.8 *specks*—any material equal to or less than 0.1 mm².

4. Summary of Guide

4.1 This guide provides details of several procedures used to separate and classify contaminants including, but not limited to, moisture, original product residues, incompatible plastic, metal, paper, glass, adhesives, and wood in recycled plastic flakes or pellets. This guide lists existing ASTM and ISO methods that can be used to characterize solid and some liquid contaminants. In addition, this guide presents details of some industry procedures for identification of contaminants. Appendix X1 provides information on quantitative aspects of some of these industry standards that can also be used to estimate the concentration of various contaminants.

5. Significance and Use

5.1 Recycled plastic materials may contain incompatible plastic or other undesirable contaminants that could affect the processing or quality, or both, of the plastic prepared for reuse. Techniques to separate and identify incompatible plastics, moisture, chemicals, or original product residues, and solid contaminants such as metals, paper, glass, and wood are essential to the processing of recycled plastic materials.

5.2 This guide lists existing ASTM and ISO methods plus currently practiced industrial techniques for identification and classification of contaminants in recycled plastics flake or pellets.

6. Sampling

6.1 Unless otherwise stated, materials should be sampled in accordance with the procedures described in Practice D 1898. Adequate statistical sampling should be considered as an acceptable alternative.

7. Existing ASTM or ISO Procedures

7.1 Moisture:

7.1.1 A coulometric method (Test Method D 4019), the standard test method for haze (Test Method D 1003), Karl Fisher titration (Test Method D 789), or a gravimetric procedure (13.6.1 of Specification D 1457) can be used to estimate the moisture content of recycled plastic materials.

7.2 Visual Inspection and Product Uniformity:

7.2.1 Color:

7.2.1.1 Test Method D 1925 measures the yellowness index of clear acrylic plastics and the haze and the luminous transmittance procedure (Test Method D 1003) characterizes the color of transparent unpigmented recycled plastic materials. These tests are not readily applied to pigmented plastic samples.

NOTE 2—Test Method D 1925 is currently being revised by ASTM Subcommittee D20.40 to address reproducibility and bias problems.

7.2.2 *Melt Flow for Product Uniformity*—Uniformity of some recycled plastic flakes or pellets can be estimated by measuring the flow rate of the material using an extrusion plastometer (Test Method D 1238).

7.3 *Density or Specific Gravity*—The displacement method for specific gravity or relative density (Test Method D 792) or the density-gradient procedure for density (Test Method D 1505) are useful techniques to determine contamination of recycled plastic flakes or pellet samples with one or more other polymers.

NOTE 3—Test Method D 1505 uses relatively small test specimens, so it may not be applicable for analysis of nonhomogeneous recycled plastic materials.

7.4 Inorganic Contaminants:

7.4.1 An ash test, such as ISO 3451/1, or the muffle-furnace techniques currently being evaluated within ASTM Subcommittee D20.70 (project designation X70-8702) can be used to estimate the inorganic filler content of recycled plastic flake or pellets.

NOTE 4—Some volatile metals may be lost using the test indicated in 7.4.1. ASTM Subcommittee D20.70 is currently developing a test method (project X70-9201) for metals, including heavy metals, that will include sample-preparation techniques to minimize the loss of volatile metals prior to analysis by X-ray fluorescence or spectroscopic techniques.

7.4.2 Ferrous (iron) contaminants can be removed with a magnet and aluminum contaminants are separated from plastic materials using density procedures in accordance with 8.3.

7.5 Thermal Analysis:

7.5.1 Since most polymers exhibit unique temperatures for melting or other phase transitions, measurement of these transition temperatures (Test Method D 3418) or the melting and crystallization temperatures (Test Method E 794) of a sample may provide useful information regarding the identity of polymeric components present in a recycled plastic material.

7.5.2 Both Test Methods D 3418 and E 794 involve thermal gravimetric analysis (TGA) or differential scanning calorimetry (DSC). These techniques utilize small samples (5 to 15 mg), so they may not be practical for use in characterization of potentially nonhomogeneous recycled plastic materials.

7.6 *Infrared Analysis*—Qualitative infrared analysis using the techniques of Practice E 1252 can be used to identify polymeric, chemical, and, in some cases, inorganic components of recycled plastic materials. Sample size considerations indicated in 7.5.2 may also apply to preparation of samples for infrared analysis.

7.7 *Chromatographic Analysis*—The principles of gas chromatography, described in Practice E 355, and liquid chromatography, described in Practice E 682, are useful for separation