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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:²

- D789 Test Methods for Determination of Solution Viscosities of Polyamide (PA)
- D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D883 Terminology Relating to Plastics

¹ This guide is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.95 on Recycled Plastics.

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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.

D1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics

D1193 Specification for Reagent Water

D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

D1457 Specification for Polytetrafluoroethylene (PTFE) Molding and Extrusion Materials

D1505 Test Method for Density of Plastics by the Density-Gradient Technique

D1898 Practice for Sampling of Plastics

D1925 NO TITLE

D3418 Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry

D4019 Test Method for Moisture in Plastics by Coulometric Regeneration of Phosphorus Pentoxide³

D5033 Guide for Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics³

D5227 Test Method for Measurement of Hexane Extractable Content of Polyolefins

E169 Practices for General Techniques of Ultraviolet-Visible Quantitative Analysis

E355 Practice for Gas Chromatography Terms and Relationships

E682 Practice for Liquid Chromatography Terms and Relationships

E794 Test Method for Melting And Crystallization Temperatures By Thermal Analysis

E1252 Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis

2.2 ISO Standards:⁴

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 D883 and Guide D5033.

³ Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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 **D1898**. 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 **D4019**), the standard test method for haze (Test Method **D1003**), Karl Fisher titration (Test Method **D789**), or a gravimetric procedure

(13.6.1 of Specification **D1457**) 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 **D1925** measures the yellowness index of clear acrylic plastics and the haze and the luminous transmittance procedure (Test Method **D1003**) characterizes the color of transparent unpigmented recycled plastic materials. These tests are not readily applied to pigmented plastic samples.

NOTE 2—Test Method **D1925** 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 **D1238**).

7.3 *Density or Specific Gravity*—The displacement method for specific gravity or relative density (Test Method **D792**) or the density-gradient procedure for density (Test Method **D1505**) are useful techniques to determine contamination of recycled plastic flakes or pellet samples with one or more other polymers.

NOTE 3—Test Method **D1505** 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 **D3418**) or the melting and crystallization temperatures (Test Method **E794**) 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 **D3418** and **E794** 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 **E1252** 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.