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Standard Specification for Polyethylene Plastics Molding and Extrusion Materials[1]

This standard is issued under the fixed designation D 4976; 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.

ϵ^1 NOTE—Editorially corrected 11.2 to add missing text in July 2003.

INTRODUCTION

This specification is not intended for the selection of materials, but only as a means to call out plastic materials to be used for the manufacture of parts. The selection of these materials is to be made by personnel with expertise in the plastics field where the environment, inherent properties of the materials, performance of the parts, part design, manufacturing process, and economics are considered. This specification does not specify the source of the resin to be used for the fabrication of any given article.

1. Scope*

1.1 This specification provides for the identification of polyethylene plastics molding and extrusion materials in such a manner that the supplier and the user can agree on the acceptability of different commercial lots or shipments. The tests involved in this specification are intended to provide information for identifying materials according to the groups, classes, and grades covered. It is not the function of this specification to provide specific engineering data for design purposes.

1.2 Other requirements may be necessary to identify particular characteristics important to specialized applications. These shall be agreed upon between the user and the supplier, by using the suffixes given in Section 1.3.

1.3 Ethylene plastic materials, being thermoplastic, are reprocessable and recyclable (see Note 1). This specification allows for the use of those ethylene plastic materials, provided that any specific requirements as governed by the producer and the end user are met.

NOTE 1—See Guide D 5033 for information and definitions related to recycled plastics.

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

1.5 The following precautionary caveat pertains to the test method portion only, Section 12, of this specification. *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.*

1.6 For information regarding plastic pipe materials see Specification D 3350. For information regarding wire and cable materials, see Specification D 1248. For information on polyethylenes with densities below 0.910 g/cm^3, see Classification D 5593.

NOTE 2—There is no similar or equivalent ISO standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 257 Test Methods for D-C Resistance or Conductance of Insulating Materials[2]

D 568 Test Method for Rate of Burning and/or Extent and Time of Burning of Flexible Plastics in a Vertical Position[3]

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[4]

D 635 Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position[4]

D 638 Test Method for Tensile Properties of Plastics[4]

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials[4]

D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement[4]

D 883 Terminology Relating to Plastics[4]

D 1238 Test Method for Flow Rates of Thermoplastics by

[1] This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials.

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[2] *Annual Book of ASTM Standards*, Vol 10.01.

[3] Discontinued. See the 1991 *Annual Book of ASTM Standards*, Vol 08.01.

[4] *Annual Book of ASTM Standards*, Vol 08.01.

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

Extrusion Plastometer[4]
D 1248 Specification for Polyethylene Plastics Molding and Extrusion Materials[4]
D 1505 Test Method for Density of Plastics by the Density-Gradient Technique[4]
D 1531 Test Methods for Relative Permittivity (Dielectric Constant) and Dissipation Factor by Fluid Displacement Procedures[2]
D 1600 Terminology for Abbreviated Terms Relating to Plastics[4]
D 1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics[4]
D 1898 Practice for Sampling of Plastics[5]
D 2565 Practice for Operating Xenon Arc-Type Light-Exposure Apparatus With and Without Water for Exposure of Plastics[6]
D 2951 Test Method for Resistance of Types III and IV Polyethylene Plastics to Thermal Stress-Cracking[6]
D 3350 Specification for Polyethylene Plastics Pipe and Fitting Materials[6]
D 3892 Practice for Packaging/Packing of Plastics[6]
D 4000 Classification System for Specifying Plastic Materials[6]
D 4703 Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets[7]
D 4883 Test Method for Density of Polyethylene by the Ultrasound Technique[7]
D 5033 Guide for the Development of Standards Relating to the Proper Use of Recycled Plastics[7]
D 5593 Classification for Thermoplastic Elastomers—Olefinic (TEO)[7]
E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[8]
F 1473 Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth on Polyethylene Pipes and Resins[9]
G 23 Practice for Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials[10]
G 53 Practice for Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials[10]

2.2 *Military Standard:*

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes[11]

2.3 *DOT Standard:*

Federal Motor Vehicle Safety Standard 302, Flammability of Interior Materials[12]

3. Terminology

3.1 *Definitions*—For definitions of technical terms pertaining to plastics used in this specification, see Terminology D 883 and Terminology D 1600.

3.2 Historical usage and user group conventions have resulted in inconsistent terminology used to categorize and describe polyethylene resins and compounds. The following terminology is in use in ASTM specifications pertaining to polyethylene:

3.2.1 *Specification D 1248*:

3.2.1.1 Type (I, II, III, IV) = density ranges (same, respectively, as Classes 1, 2, 3, and 4 in Specification D 4976).

3.2.1.2 Class (A, B, C, D) = composition and use.

3.2.1.3 Category (1, 2, 3, 4, 5) = melt index ranges (same as Grade in Specification D 4976).

3.2.1.4 Grade (E, J, D, or W followed by one or two digits) = specific requirements from tables.

3.2.2 *Specification D 3350*:

3.2.2.1 Type (I, II, III) = density ranges (same as Types I, II, and III in Specification D 1248 and Classes 1, 2, and 3 in Specification D 4976).

3.2.2.2 Class = a line callout system consisting of "PE" followed by six cell numbers from Table 1 plus a letter (A, B, C, D, E) denoting color and UV stabilizer.

3.2.2.3 Grade = simplified line callout system using "PE" followed by density and slow crack growth cell numbers from Table 1.

3.2.3 *Specification D 4976*:

3.2.3.1 Group (1, 2) = branched or linear polyethylene.

3.2.3.2 Class (1, 2, 3, 4) = density ranges (same, respectively, as Types I, II, III, and IV in Specification D 1248).

3.2.3.3 Grade (1, 2, 3, 4, 5) = melt index ranges (same as Category in Specification D 1248).

4. Classification

4.1 Unreinforced polyethylene plastic materials are classified into groups according to polymerization processes. These groups are subdivided into classes and grades as shown in Table PE (Basic Property Table).

[5] *Discontinued*—See 1997 *Annual Book of ASTM Standards*, Vol 08.01.
[6] *Annual Book of ASTM Standards*, Vol 08.02.
[7] *Annual Book of ASTM Standards*, Vol 08.03.
[8] *Annual Book of ASTM Standards*, Vol 14.02.
[9] *Annual Book of ASTM Standards*, Vol 08.04.
[10] *Annual Book of ASTM Standards*, Vol 14.04.

[11] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

[12] Available from United States Department of Transportation, National Highway Traffic Safety Administration, Office of Public Affairs and Consumer Participation, 400 7th St., SW, Washington, DC 20590.

TABLE PE Basic Requirement of Polyethylene Plastics

Group	Description	Class	Description	Grade	Flow Rate[A]	Tensile Strength at Yield[B], min, MPa	Elongation at Break, min, %	Secant Modulus[C], min, MPa
1	Branched	1	low density	1	>25	8	70	100
			. . .	2	>10 to 25	8	90	125
			0.910–0.925	3	>1 to 10	8.5	100	125
			. . .	4	>0.4 to 1	9.5	300	125
			. . .	5	to 0.4	9.5	400	150
			. . .	0	. . .	. . .	. . .	. . .
		2	medium density	1	>25	8	40	200
			. . .	2	>10 to 25	11	50	200
			>0.925–0.940	3	>1 to 10	11	70	200
			. . .	4	>0.4 to 1	11	200	250
			. . .	5	to 0.4	12	400	300
			. . .	0	. . .	. . .	. . .	. . .
		0	. . .	0	. . .	. . .	. . .	. . .
2	Linear	1	low density	1	>25	10	300	300
			. . .	2	>10 to 25	10	300	325
			0.910–0.925	3	>1 to 10	10	300	350
			. . .	4	>0.4 to 1	10	400	350
			. . .	5	to 0.4	12	500	400
			. . .	0	. . .	. . .	. . .	. . .
		2	medium density	1	>25	14	90	500
			. . .	2	>10 to 25	14	100	500
			>0.925–0.940	3	>1 to 10	14	100	550
			. . .	4	>0.4 to 1	15	200	600
			. . .	5	to 0.4	19	400	600
			. . .	0	. . .	. . .	. . .	. . .
		3	high density	1	>25	17	10	400
			. . .	2	>10 to 25	17	50	400
			>0.940–0.960	3	>1 to 10	18	200	450
			. . .	4	>0.4 to 1	19	400	500
			. . .	5	to 0.4	20	600	600
			. . .	0	. . .	. . .	. . .	. . .
		4	high density	1	>25	24	10	500
			. . .	2	>10 to 25	24	10	600
			>0.960	3	>1 to 10	25	30	800
			. . .	4	>0.4 to 1	28	300	900
			. . .	5	to 0.4	28	400	1000
			. . .	0	. . .	. . .	. . .	. . .
0		0	. . .	0	. . .	. . .	. . .	. . .

[A] Melt index = g/10 min at 190°C/2.16 kg.

[B] Type IV tensile bars at 500 mm/min (20 in./min) for materials with densities of 0.925 g/cm^3 and less; and 50 mm/min (2 in./min) for materials with densities greater than 0.925 g/cm^3.

[C] Secant Modulus at 2 % strain using Procedure B with 50.8-mm (2-in.) span on 3.18 × 12.7-mm (0.125 × 0.5-in.) specimens.

Cell Table A Detail Requirements[A] for Polyethylene Plastics

Designation Order Number	Property	Cell Limits									
		0	1	2	3	4	5	6	7	8	9
1	Tensile Strength at Yield, Test Method D 638, MPa[B], min	unspecified	4	8	12	16	21	30	35	. . .	specify value
2	Elongation at Break, Test Method D 638, %, min	unspecified	25	50	200	400	600	800	1000	. . .	specify value
3	Flexural Modulus, Test Methods D 790, MPa[A,C], min	unspecified	50	100	200	400	600	800	1000	. . .	specify value
4	Thermal stress-crack resistance, hours without cracking, min, Test Method D 2951	unspecified	24	48	96	168	. . .	. . .	. . .	. . .	specify value
5	Environmental stress-crack resistance,[D] min F_{50} h, Test Method D 1693	unspecified	24	48	96	168	336	672	1008	. . .	specify value

[A] It is recognized that detailed test values may not predict nor even correlate with performance of parts molded of these materials.

[B] MPa × 145 = psi.

[C] Using test specimens with a nominal cross section of 3.2 × 12.7 cross section and a span of 50.8 mm.

[D] F_{50} is the time required for failure of 50 % of the specimens tested in accordance with the graphical method described in Test Method D 1693. Class 1 polyethylenes shall be tested in accordance with Test Method D 1693, Condition A. Classes 2, 3, and 4 shall be tested in accordance with Condition B. Igepal concentration for all conditions is 100 %. Mold samples in accordance with Procedure C of Practice D 4703, Annex A1 (cooling rate of 15 ± 2°C/min).

Cell Table B Detail Requirements[A] for Polyethylene Plastics

Designation Order Number	Property	Cell Limits									
		0	1	2	3	4	5	6	7	8	9
1	Tensile Strength at Yield, Test Method D 638, MPa[B], min	unspecified	4	8	12	16	21	30	35	. . .	specify value
2	Elongation at Break, Test Method D 638, %, min	unspecified	25	50	200	400	600	800	1000	. . .	specify value
3	Flexural Modulus, Test Methods D 790, MPa[A,C], min	unspecified	50	100	200	400	600	800	1000	. . .	specify value
4	Thermal stress-crack resistance, hours without cracking, min Test Method D 2951	unspecified	24	48	96	168	. . .	. . .	. . .	. . .	specify value