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Standard Specification for Filled Compounds of Polytetrafluoroethylene (PTFE) Molding and Extrusion Materials[1]

This standard is issued under the fixed designation D 4745; 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 specification covers polytetrafluoroethylene (PTFE) filled molding compounds made with virgin PTFE resins defined in Specification D 4894~~, except Types I, IV, V, and VI.~~ , as Types II and III.

NOTE 1—This specification can be used as a model for other PTFE compounds having particulate fillers that can survive the sintering temperatures of PTFE as can those listed in this specification. This specification is restricted to virgin PTFE base resin for technical reasons. Recycled or reprocessed material cannot be processed successfully.

NOTE 2—The properties measured on commercially fabricated parts may differ from the listed values for samples prepared by the procedures given in this specification, depending on part geometry and processing parameters.

NOTE 3—There is no ISO equivalent to this specification.

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

1.3 The following statement applies to the test method portion, 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.* ~~See 9.5 and Note 4~~ See Note 5 for a specific warning statement.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D 618 Practice for Conditioning Plastics for Testing

D 638 Test Method for Tensile Properties of Plastics

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

D 883 Terminology Relating to Plastics

D 1600 Terminology for Abbreviated Terms Relating to Plastics ~~D1895Test Methods for Apparent Density, Bulk Factor, and Pourability of Plastic Materials~~

D 3892 Practice for Packaging/Packing of Plastics

D 4894 Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials

~~D5740Guide for Writing Material Standards in the Classification D 4000 Format~~

~~E11Specification for Wire Cloth and Sieves for Testing Purposes~~

~~E691Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method~~

IEEE/ASTM SI-10 Standard for Use of the International System of Units (SI): The Modern Metric System[3]

3. Terminology

3.1 *Definitions*—The terminology given in Terminology D 883 is applicable to this specification unless otherwise specified.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *bulk density*, *n*—the mass in kilograms per cubic metre of resin compound measured under the conditions of the test.

3.2.2 *filled compound*, *n*—blend of PTFE resin as the matrix and particulate fillers, generally glass, other inorganic, metallic, or polymeric materials that withstand the sintering temperature of PTFE (327 to 380°C).

3.2.3 *free-flow resins (pelletized)*, *n*— generally made by treatment of finely divided resins to produce free-flowing agglomerates.

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[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.

Current edition approved ~~Dec.~~Nov. 1, ~~2006.~~2008. Published December ~~2006.~~2008. Originally approved in 1991. Last previous edition approved in ~~2001~~2006 as D 4745 - 0~~1~~6.

[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.

[3] Available from ASTM International Headquarters, 100 Barr Harbor Drive, West Conshohocken, PA 19428

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

3.2.4 *lot*, *n*—one production run or a uniform blend of two or more production runs.

3.2.5 *pigmented compound*, *n*—a compound in which a pigment is added for colorant purposes only.

3.2.6 *standard flow resins (nonpelletized)*, *n*—finely divided resin with an average particle size less than 100 µm.

3.3 *Abbreviations*—Abbreviations are in accordance with Terminology D 1600. PTFE is the acronym for polytetrafluoroethylene.

4. Classification

4.1 This specification covers the following two types of PTFE compounds:

4.1.1 *Type I*~~—Nonpelletized material, for general-purpose compression molding.~~ —Standard flow resins (nonpelletized) material, for general-purpose compression molding.

4.1.2 *Type II*~~—Pelletized or free-flowing~~—Free-flow resins (pelletized) material, for compression molding, automatic molding, or ram extrusion.

~~4.2Thirteen grades~~ 4.2 Grades of each type distinguished by the nature of the filler(s) are listed in Tables ~~1-~~1 and ~~3~~2.

4.3 A one-line system ~~may be~~is used to specify materials covered by this specification. The system uses predefined cells to refer to specific aspects of this specification, as the following illustrates:

Standard Number Block	Type	Grade	Class	Special Notes
:	:	:	:	:
~~Example: Specification D 4745 – 97~~	~~II~~	~~2~~		
Example: Specification D 4745 – 08	II	2		

4.3.1 For this example, the line callout would be Specification ~~D4745–97, II~~ D 4745 – 08, Type II, Grade 2, and would specify a ~~pelletized or~~ free-flowing ~~filled~~(pelletized) composition of polytetrafluoroethylene that has all of the properties listed for that type, and grade in the appropriate specified properties, tables, or both, in the specification identified. A comma is used as the separator between the standard number and the type. Separators are not needed between the type, grade, and class.[4] ~~A provision for special notes is included so that other information can be provided when required. An example would be in Specification D3295–81a where dimensions and tolerances are specified for each AWG size within type and class. When special notes are used,~~

[4] See the *ASTM Form and Style Manual*, available from ASTM Headquarters.

TABLE 1 TFE Compounds, Type I, Standard Flow (Nonpelletized)

Grade		Raw Resin Bulk Density, min, g/L	Molded Parts (Molded and Sintered) Specific Gravity, min	Specific Gravity, max	Tensile Strength min, MPa	Tensile Strength min, psi	Elongation, min, %
~~1~~	~~15 % glass fiber~~	~~400~~	~~2.150~~	~~2.25~~	~~19.6~~	~~2840~~	~~250~~
1	15 % glass fiber	400	2.150	2.250	19.6	2840	220
~~2~~	~~25 % glass fiber~~	~~425~~	~~2.150~~	~~2.250~~	~~15.7~~	~~2270~~	~~200~~
2	25 % glass fiber	425	2.150	2.250	15.7	2270	180
~~3~~	~~35 % glass fiber~~	~~450~~	~~2.200~~	~~2.300~~	~~10.3~~	~~1500~~	~~150~~
3	35 % glass fiber	350	2.200	2.300	10.3	1500	150
~~4~~	~~5 % glass fiber and 5 % MoS_2~~	~~350~~	~~2.150~~	~~2.300~~	~~20.7~~	~~3000~~	~~250~~
4	5 % glass fiber and 5 % MoS_2	300	2.150	2.300	13.8	2000	200
~~5~~	~~15 % glass fiber and 5 % MoS_2~~	~~375~~	~~2.150~~	~~2.300~~	~~17.2~~	~~2500~~	~~200~~
5	15 % glass fiber and 5 % MoS_2	375	2.150	2.300	13.8	2000	150
~~6~~	~~10 % graphite~~	~~350~~	~~2.100~~	~~2.220~~	~~17.9~~	~~2600~~	~~225~~
6	10 % graphite	350	2.100	2.220	17.9	2600	120
~~7~~	~~15 % graphite~~	~~300~~	~~2.100~~	~~2.200~~	~~16.6~~	~~2400~~	~~100~~
7	15 % graphite	300	2.100	2.200	13.8	2000	100
~~8~~	~~25 % carbon and graphite~~	~~350~~	~~1.950~~	~~2.100~~	~~11.0~~	~~1600~~	~~80~~
8	25 % carbon and graphite	350	1.950	2.150	9.6	1400	20
~~9~~	~~32 % carbon and graphite~~	~~325~~	~~1.900~~	~~2.100~~	~~6.9~~	~~1000~~	~~50~~
9	32 % carbon and graphite	250	1.900	2.100	6.9	1000	20
~~10~~	~~40 % bronze~~	~~500~~	~~2.900~~	~~3.200~~	~~17.2~~	~~2500~~	~~175~~
10	40 % bronze	500	2.950	3.350	16.5	2400	100
~~11~~	~~60 % bronze~~	~~650~~	~~3.800~~	~~4.000~~	~~13.8~~	~~2000~~	~~140~~
11	60 % bronze	650	3.850	4.154	12.4	1800	50
12	55 % bronze and 5 % MoS_2	700	3.500	4.000	10.3	1500	80
~~13~~	~~50 % stainless steel~~	~~500~~	~~3.200~~	~~3.600~~	~~17.2~~	~~2500~~	~~150~~
13	50 % stainless steel	500	3.200	3.600	15.2	2200	120
0	As specified by customer and supplier		As specified by customer and supplier.				

TABLE 2 TFE Compounds, Type II, Free-Flow (Pelletized)

Grade		Raw Resin Bulk Density, min, g/L	Molded Parts (Molded and Sintered)				
			Specific Gravity, min	Specific Gravity, max	Tensile Strength		Elongation, min, %
					min, MPa	min, psi	
1	15 % glass fiber	625	2.150	2.25	13.8	2000	200
~~2~~	~~25 % glass fiber~~	~~625~~	~~2.150~~	~~2.250~~	~~12.4~~	~~1800~~	~~180~~
2	25 % glass fiber	625	2.150	2.250	12.4	1800	150
~~3~~	~~35 % glass fiber~~	~~650~~	~~2.200~~	~~2.300~~	~~8.3~~	~~1200~~	~~100~~
3	35 % glass fiber	650	2.150	2.250	8.3	1200	100
~~4~~	~~5 % glass fiber and 5 % MoS_2~~	~~575~~	~~2.150~~	~~2.300~~	~~17.2~~	~~2500~~	~~220~~
4	5 % glass fiber and 5 % MoS_2	575	2.150	2.300	17.2	2500	170
~~5~~	~~15 % glass fiber and 5 % MoS_2~~	~~600~~	~~2.150~~	~~2.300~~	~~13.8~~	~~2000~~	~~180~~
5	15 % glass fiber and 5 % MoS_2	600	2.150	2.300	13.8	1800	120
~~6~~	~~10 % graphite~~	~~600~~	~~2.100~~	~~2.220~~	~~13.8~~	~~2000~~	~~150~~
6	10 % graphite	600	2.070	2.190	13.8	2000	150
~~7~~	~~15 % graphite~~	~~550~~	~~2.100~~	~~2.200~~	~~10.3~~	~~1500~~	~~100~~
7	15 % graphite	550	2.100	2.200	10.3	1500	60
8	25 % carbon and graphite	500	1.950	2.100	8.3	1200	20
~~9~~	~~32 % carbon and graphite~~	~~500~~	~~1.900~~	~~2.100~~	~~6.9~~	~~1000~~	~~20~~
9	32 % carbon and graphite	400	1.900	2.200	6.9	1000	20
~~10~~	~~40 % bronze~~	~~750~~	~~2.900~~	~~3.200~~	~~13.8~~	~~2000~~	~~85~~
10	40 % bronze	750	2.950	3.250	13.8	2000	85
~~11~~	~~60 % bronze~~	~~900~~	~~3.800~~	~~4.000~~	~~10.3~~	~~1500~~	~~60~~
11	60 % bronze	900	3.800	4.000	10.3	1500	20
~~12~~	~~55 % bronze and 5 % MoS_2~~	~~900~~	~~3.500~~	~~4.000~~	~~6.9~~	~~1000~~	~~60~~
12	55 % bronze and 5 % MoS_2	900	3.500	4.000	6.9	1000	20
13	50 % stainless steel	850	3.200	3.600	13.8	2000	100
0	As specified by customer and supplier		As specified by customer and supplier.				

~~they should be preceded by a comma.~~ A provision for special notes is included so that other information can be provided when required. Precede special notes, when used, by a comma.

5. Ordering Information

5.1 The filled compounds of PTFE ~~may be~~are ordered using the type, (see 4.1) and the grade (see reference Table 1~~and Table 3), or they may be ordered using the designation of the suppliers.~~), or they are ordered using the designation of the suppliers.

6. Requirements

6.1 The PTFE compounds covered by this specification shall be uniform (filler and resin particles evenly distributed) and shall contain no foreign material.

6.2 The PTFE compounds shall conform to the requirements prescribed in ~~Tables 1-3~~ Tables 1 and 2 when tested by the procedures specified herein. Table 1 ~~and Table 3 list requirements for Type I.~~ lists requirements for Type I. Table 2 ~~and Table 3 reference requirements for Type II.~~

~~6.3Other PTFE compounds are commercially available, but are not described in this specification.~~ references requirements for Type II.

7. Sampling

7.1 Sampling shall be statistically adequate to satisfy the requirements of 13.4.

8. Number of Tests

8.1 Routine lot inspection tests shall consist of those carried out to determine the requirements specified in Table 1 ~~or Table 3 depending on type. Periodic tests shall include using all the tests to determine the requirements in Table 3, depending on type.~~ depending on type.

8.2 The requirements listed in ~~Tables 1-3~~Tables 1 and 2, as they apply, are sufficient to establish conformity of a material to this specification. When the number of test specimens is not stated in the test method, single determinations may be made. If more than single determinations are made on specimens from separate portions of the same sample, the results shall be averaged. The single or average result shall conform to the requirements prescribed in this specification.

9. Test Specimens

9.1 Test specimens shall ~~be~~ cut from ~~billets~~ a billet molded in accordance with the following procedures. An acceptable alternate procedure for molding ~~the~~a test plaque is described in Specification D 4894, subsection 9.1.1.

9.2 *Test Billets*:

9.2.1 Prior to molding, screen the material through a 2.0-mm hand sieve, if necessary.

9.2.2 Preform solid test billets in a mold (see Fig. 1) having a cross-sectional area not greater than 25.8 cm ^{2} ~~≤ [4 in.~~ ~~≤ (4 in.^{2}~~ ~~])~~ and of sufficient height to contain the sample. ~~Clearance should~~ End plug clearance shall be sufficient to ensure escape of entrapped air during pressing. ~~The billet length may be varied~~ It is acceptable to vary the powder charge weight in accordance with the ~~amount~~density of ~~testing to be done.~~ the material. A mold length of 250 mm ~~[9.8 in.]~~(9.8 in.) produces a billet approximately 75 mm ~~[2~~(2 to 3 ~~in.]~~in.) long. Powder-charge weight may be varied in accordance with the density of the material. The billet length ~~should~~shall not exceed 75 mm ~~[3 in.].~~ (3 in.).

9.2.3 ~~Assemble the mold. Add the resin to the mold, taking care not to fill within 13 mm [0.5 in.] of the top of the cavity. Insert the top plug and apply hand pressure, making certain that the pusher is centered in the mold. Place the mold in a hydraulic press and remove the support ring or spacers. Do not allow the two end plugs to bottom on the mold shell. Apply an initial load to the mold of 3.45 MPa [500 psi] ± 10% and hold for 1 to 2 min. Increase the loading smoothly to the final preforming pressure in 3 to 5 min. Use 20.7 MPa [3000 psi] for compounds containing up to 4% by weight filler. Use 34.5 MPa [5000 psi] for compounds containing 5 to 25% by weight or less filler and 68.9 MPa [10000 psi] for composite compounds containing more than 26% filler. Hold under maximum pressure for 2 to 5 min. Release the pressure gradually without apparent movement of the press platens. Then open the press, remove the top pusher from the mold, and force the preform vertically out of the mold, using a continuous, smooth movement.~~

~~9.2.4Place the preform in a sintering oven and sinter in accordance with the procedures in Table 4~~Assemble the mold. Add the resin to the mold. Insert the top plug and apply hand pressure, making certain that the pusher is centered in the mold. Place the mold in a hydraulic press and remove the support ring or spacers. Increase the loading smoothly to the final preforming pressure in 3 to 5 min. Use 20.7 MPa (3000 psi) for compounds containing up to 4 % by weight filler. Use 34.5 MPa (5000 psi) for compounds containing 5 to 25 % by weight and 68.9 MPa (10 000 psi) for compounds containing more than 26 % filler. Hold under maximum pressure for 2 to 5 min. Open the press, remove the top pusher from the mold, and force the preform vertically out of the mold, using a continuous, smooth movement.

9.2.4 Place the preform in a sintering oven and sinter in accordance with the procedure in Table 3. ~~Use Procedure B for compounds containing molybdenum disulfide filler.~~ .

9.2.5 *Safety Warning*—At normal processing temperatures, PTFE liberates harmful vapors. Provide adequate ventilation in areas where PTFE compounds are exposed to elevated temperatures. Avoid contaminating smoking materials with PTFE compounds.

9.3 *Sectioning Test Billet*:

~~9.3.1Remove and discard the top and bottom 2-mm [1⁄16 in.] section of the billet. Obtain transverse test specimens from as near the center of the billet as possible.~~

~~9.3.2Prepare five test specimens, 1 ± 0.25 mm [0.040 ± 0.010 in.] in thickness for the determination of tensile strength and elongation and cut a piece of suitable thickness for density measurements. This piece should be approximately cubical in shape, weighing at least 10 g. All surfaces must be smooth. Take care to avoid wedge-shape cuts.~~

~~9.4The alternative test billet is described in Specification D4894~~

9.3.1 Divide the test billet into sections by making transverse cuts by machining, or by a suitable alternate procedure, in accordance with Fig. 2.

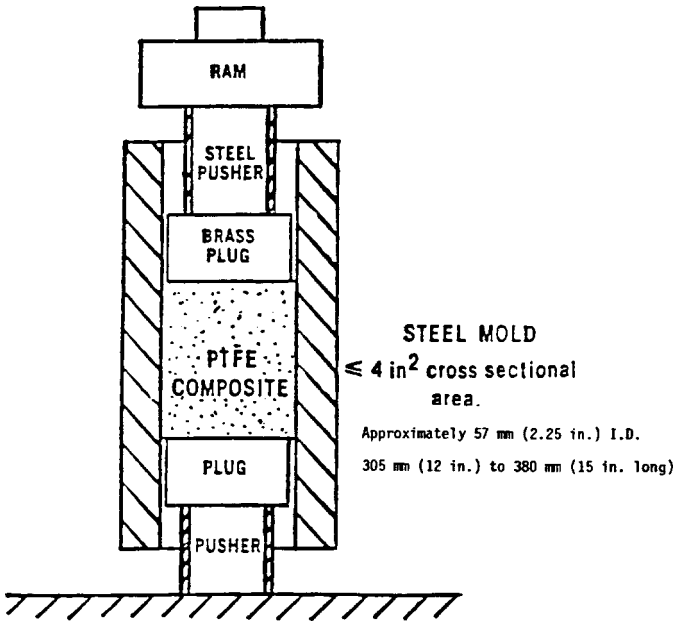

FIG. 1 Preforming of PTFE Composite Test Billet