Designation: D7194 – 19 (Reapproved 2024)

Standard Specification for Aerospace Parts Machined from Polychlorotrifluoroethylene (PCTFE)[1]

This standard is issued under the fixed designation D7194; 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 is intended to be a means of calling out finished machined parts ready for aerospace use. Such parts may also find use in selected commercial applications where there are clear benefits derived from the use of parts with high molecular weight, good molecular weight retention during processing, dimensional stability, controlled crystallinity, and tightly controlled engineering tolerances.

1.2 This specification establishes requirements for parts machined from virgin, unplasticized, 100 % polychlorotrifluoroethylene (PCTFE) homopolymers.

1.3 This specification does not cover parts machined from PCTFE copolymers, PCTFE film or tape less than 0.25-mm (0.010-in.) thick, or modified PCTFE (containing pigments or plasticizers).

1.4 This specification does not allow parts containing recycled material.

1.5 The specification does not cover PCTFE parts intended for general use applications, in which control of dimensional stability, molecular weight, and crystallinity are not as important. For machined PCTFE parts intended for general use, use Specification D7211.

1.6 This specification classifies parts into three classes based upon intended uses and exposures: oxygen-containing media, reactive media, and inert media.

1.7 *Application*—PCTFE components covered by this specification are virgin, 100 % PCTFE resin, free of plasticizers and other additives. The components are combustion resistant in oxygen, dimensionally stable, and meet other specific physical characteristics appropriate for their end use. They are used in valves, regulators, and other devices in oxygen, air, helium, nitrogen, hydrogen, ammonia, and other aerospace media systems. The components typically are used as valve seats, o-rings, seals, and gaskets. They are removed and replaced during normal maintenance procedures. The components provide reliable sealing surfaces resulting in proper closure of valves and related devices and no leakage from the system into the environment. They will experience static mechanical loading, cyclic mechanical loading, temperatures ranging from cryogenic to 71°C (160°F), and pressures up to 68.9 MPa (10,000, psig) for oxygen and air media, and 103.4 MPa (15,000 psig) for inert media.

1.8 The values stated in SI units are to be regarded as standard. The values in parentheses are for information only.

1.9 The following precautionary caveat pertains only to the test methods portion, Section 13, 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—There is no known ISO equivalent to this standard.

1.10 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D618 Practice for Conditioning Plastics for Testing
D638 Test Method for Tensile Properties of Plastics
D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D883 Terminology Relating to Plastics
D1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
D1430 Classification System for Polychlorotrifluoroethylene (PCTFE) Plastics

[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] 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.

D1600 Terminology for Abbreviated Terms Relating to Plastics (Withdrawn 2024)[3]
D1708 Test Method for Tensile Properties of Plastics by Use of Microtensile Specimens
D2512 Test Method for Compatibility of Materials with Liquid Oxygen (Impact Sensitivity Threshold and Pass-Fail Techniques) (Withdrawn 2023)[3]
D3045 Practice for Heat Aging of Plastics Without Load
D4591 Test Method for Determining Temperatures and Heats of Transitions of Fluoropolymers by Differential Scanning Calorimetry
D7211 Specification for Parts Machined from Polychlorotrifluoroethylene (PCTFE) and Intended for General Use
G86 Test Method for Determining Ignition Sensitivity of Materials to Mechanical Impact in Ambient Liquid Oxygen and Pressurized Liquid and Gaseous Oxygen Environments

2.2 *Federal Standards*[4]

NASA-STD-6001B Flammability, Offgassing, and Compatibility Requirements and Test Procedures—Mechanical Impact for Materials in Ambient Pressure LOX (Test 13A) and Mechanical Impact for Materials in Variable Pressure GOX and LOX (Test 13B)

3. Terminology

3.1 *Definitions:*

3.1.1 Terms are defined in accordance with Terminologies D883 and D1600 unless otherwise indicated.

3.1.2 *air media, n*—liquid air, pressurized air, and breathing air.

3.1.3 *cognizant engineering organization, n*—the company, agency, or other authority responsible for the system or component in which aerospace grade PCTFE is used. This, in addition to design personnel, may include personnel from material and process engineering, or quality groups and others as appropriate.

3.1.4 *inert media, n*—gaseous helium (GHe) and gaseous nitrogen (GN_2) up to 103.4 MPa (15,000 psig).

3.1.5 *oxygen media, n*—liquid oxygen (LOX) and gaseous oxygen (GOX) up to 68.9 MPa (10,000 psig).

3.1.6 *processing route, n*—the method whereby a thermoplastic is taken above its melting point and processed into a semifinished article, typically sheet or rod stock. For PCTFE, the common processing methods are extrusion and compression molding.

3.1.7 *reactive media, n*—ammonia (NH_3) up to 3.5 MPa (500 psig), gaseous hydrogen (GH_2) up to 46.2 MPa (6700 psig), and liquid hydrogen (LH_2) up to 2.8 MPa (400 psig).

4. Significance and Use

4.1 Given the thermal instability of PCTFE in the melt, the primary intention of this specification is to ensure adequate molecular weight retention during molding, whereby as-polymerized resin, typically powder or coarse granular material, is thermoformed into semi-finished rod or sheet stock, typically by extrusion or compression molding.

4.2 Given the relatively low glass transition temperature of PCTFE ($T_g \approx 55°C$ (130°F)), the second intention of this specification is to ensure good dimensional stability of finished articles subjected to temperature excursions during service that approach or exceed the T_g.

4.3 Because the crystallinity can vary widely in PCTFE, which in turn can affect the performance of a finished PCTFE part in its intended application, nonmandatory guidance is given in Appendix X1. This guidance cites recommended ASTM Test Methods that measure the specific gravity (X1.1.4), melting point (X1.1.5), and tensile properties (X1.1.6) of PCTFE. Control of these properties is used to established consistency between different lots of finished parts where either the starting resin, molding method, thickness of the semifinished article, or machining method change.

4.4 Finished parts are categorized based on whether annealing of the finished parts is not performed (*Method A*), or is performed (*Methods B and C*), depending on the dimensional stability of a statistical sample of unannealed finished parts.

5. Classification

5.1 Part shape and size shall be defined by the applicable purchase order.

5.2 The type of product shall be categorized by the intended use category:

5.2.1 *Type I* for use in air and oxygen media (see 3.1.2 and 3.1.5) at service pressures above 11.4 MPa (1650 psi) that require batch testing.

5.2.2 *Type II* for use in *(1)* air and oxygen media (at service pressures below 11.4 MPa (1650 psi), or at service pressures above 11.4 MPa (1650 psi) that do not require batch testing); or *(2)* inert and reactive media up to the pressures specified in 3.1.4 and 3.1.7.

5.2.3 *Type III* for use in media other than air, oxygen, GHe, GN_2, ammonia, GH_2 and LH_2, at service pressures specified by the cognizant engineering organization.

6. Ordering Information

6.1 All parts covered by this specification shall be ordered by Specification D7194, Type, as listed in Section 5, or as listed on the purchase contract or order when Type is not specified explicitly.

7. Apparatus

7.1 *Oven*—A convection oven capable of maintaining a temperature of 100 to 200 ± 2°C.

8. Materials and Manufacture

8.1 Parts shall be made from as-polymerized resin meeting all requirements of Classification System D1430. Type *I*, *II* and *III* parts shall be fabricated from as-polymerized resin classified as meeting Classification System D1430, Group 01, Class 1, Grade 3.

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

[4] Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, http://www.access.gpo.gov.