SAE Aerospace
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AEROSPACE STANDARD

SAE AS4720

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Batch Qualification Procedure for Tensile Strength, Elongation and Specific Gravity of Polytetrafluoroethylene (PTFE) Resins, Virgin, Modified, Pigmented and Filled Compounds Used for Compression Molding

RATIONALE

This standard provides a PTFE resin batch qualification procedure for tensile strength, elongation and specific gravity to ensure AS9100 compliance. AS9100 requires that any material specification shall be representative of production material and/or parts made from that material. Current ASTM specifications for qualification of batches of PTFE resins limit the qualification procedure, preventing such compliance.

1. SCOPE

This SAE Aerospace Standard (AS) covers batch qualification procedure for virgin and compounded polytetrafluoroethylene (PTFE) resins used for compression molding. AS9100 requires virgin and modified PTFE as a testing material be representative of production PTFE and/or parts. The testing specified herein is limited to tensile strength, elongation and specific gravity. Any other tests required by the purchaser must be specified separately.

NOTE 1 Isostatic molding is regarded as compression molding. The test billet and test methods described in this standard may be used for qualification of resins and compounds for material that is isostatically molded in production provided the pressure molding and sinter cycles are representative of production. Where mold tooling described in this specification is not available, it is permissible to use the production process to produce material for qualification testing.

NOTE 2 Extrusion is not considered as compression molding and is not covered by this standard.

1.1 Safety - Hazardous Materials

While the materials, methods, applications, and processes described or referenced in this standard may involve the use of hazardous materials, this standard does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS 3660 Polytetrafluoroethylene (PTFE) Moldings, General Purpose Grade, As Sintered

AMS 3667 Polytetrafluoroethylene Sheet, Molded, General Purpose Grade, As Sintered

AMS 3668 Polytetrafluoroethylene (PTFE) Moldings, Premium Grade, As Sintered

AMS 3669 Polytetrafluoroethylene Sheet, Molded, Premium Grade, As Sintered

AMS 3678 Polytetrafluoroethylene (PTFE) Moldings and Extrusions Unfilled, Pigmented, and Filled Components

AMS 3756 Moldings, Glass Fiber Filled Polytetrafluoroethylene, 75 PTFE Resin, 25 Glass, As Sintered

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D 638 Standard Test Method for Tensile Properties of Plastics

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

ASTM D 4745 Standard Specification for Filled Compounds of Polytetrafluoroethylene (PTFE) Molding and Extrusion Materials

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

3. TECHNICAL REQUIREMENTS

3.1 Material

Shall be filled molding resin compounds using “low flow” virgin PTFE to ASTM D 4894 Type II, Type III, and “free flow” resin to ASTM D 4894 Type IV. Pigmented compounds are also included, although there are no ASTM specifications covering pigmented materials.

3.1.1 The purchaser or specifying authority shall (1) provide a material specification to specify compound constituents, (2) require at least tensile strength, elongation and specific gravity of molded and sintered material, and (3) include the properties for production moldings used for the manufacture of production parts. The test results obtained in compliance with this standard shall meet the physical properties listed in the material specification.

3.2 Test Billet

A material test billet, as described in ASTM D 4894, Figure 3, and ASTM D 4745, Figure 1, shall be compression molded to qualify the resin batch. The molding cylinder (see Figure 1) shall be approximately 2.250 in (57 mm) inside diameter by 12 in (305 mm) to 15 in (380 mm) long. The cylinder end plugs shall have sufficient clearance to allow air entrapped during the compression molding process to escape, but not too large a clearance as to adversely affect an effective molding process or the quality of the test billet. The molding cylinder, end plugs and pushers shall be designed to withstand the internal molding pressure and/or loads generated during the compression molding process with a safety factor compliant with local and federal safety regulations, as appropriate.

3.2.1 A molded or drilled hole in the test billet to facilitate outgassing during the sinter process may be necessary in some fillers, particularly polymeric fillers and/or when using Type III resin. When using Type III resin as the filled compound base, the low permeability of this base resin can result in voids in the test billet. A small molded hole (approximately 0.125 in (3.2 mm) to 0.250 in (6.4 mm)) longitudinally through the center of the test billet prior to sintering using a suitably sized rod (approximately 0.125 in (3.2 mm) to 0.250 in (6.4 mm)) as part of the mold tool assembly incorporating end plugs with appropriate matching holes (see Figure 2) is preferable. Drilling may leave machining marks (stress risers) that could lead to cracks propogating during sintering.

NOTE: A center hole is a departure from previous standards. This feature requires test coupons for tensile strength and elongation tests to be produced in a different configuration to the previously produced disc, see 4.1.2.

3.2.2 To mold a test billet, assemble the bottom plug in the mold cylinder and add sufficient material (approximately 2 to 3 in) to achieve the required number of tensile and specific gravity test samples. Assemble the top plug into the mold tool such that there is an engagement length of the plug of at least 0.5 in (13 mm) to ensure alignment, followed by the top pusher. It is permissible to hand load the pusher for a preliminary consolidation of material. Insert the assembly into a hydraulic press and apply load to achieve a minimum of 500 psi (3.45 MPa) resin pressure in the mold tool and hold for 1 to 2 min. Remove load and retract the movable platen, then turn the assembly over. This initial pressure should provide sufficient residual internal friction to prevent the molding cylinder falling. If this is not the case, apply an initial load representative of the production process. Add the second pusher, advance the movable platen and slowly and smoothly begin to apply more load. For guidance, the advance speed of the movable platen should be not more than 1 in/min. Continue to apply load until a mold pressure representative of the production process is achieved and hold for a period of time representative of the production process, usually between 2 to 5 min. Slowly release pressure in the hydraulic ram until a no-pressure condition is achieved, then retract the moveable platen to allow the assembly to be removed from the press. Finally, using suitable tooling, press the molded test billet out of the mold cylinder using smooth, continuous movement.

3.2.3 When no tooling exists per 3.2.2, it is permissible to use a production molding for the resin qualification test. This is to allow the manufacturer to confirm resin supplier or the compounder's qualification test.

3.2.4 To sinter a test billet, allow the green (un-sintered) test billet to stand for the minimum period as required in the material specification prior to commencing, if none is specified it shall default to 24 h.

NOTE: The standing period is to allow entrapped air to escape. If this procedure is not followed there would be serious risk of the molding cracking during sintering. This is particularly the case with ASTM D 4894 Type III resin (modified virgin PTFE) which has lower permeability than Type II resin.

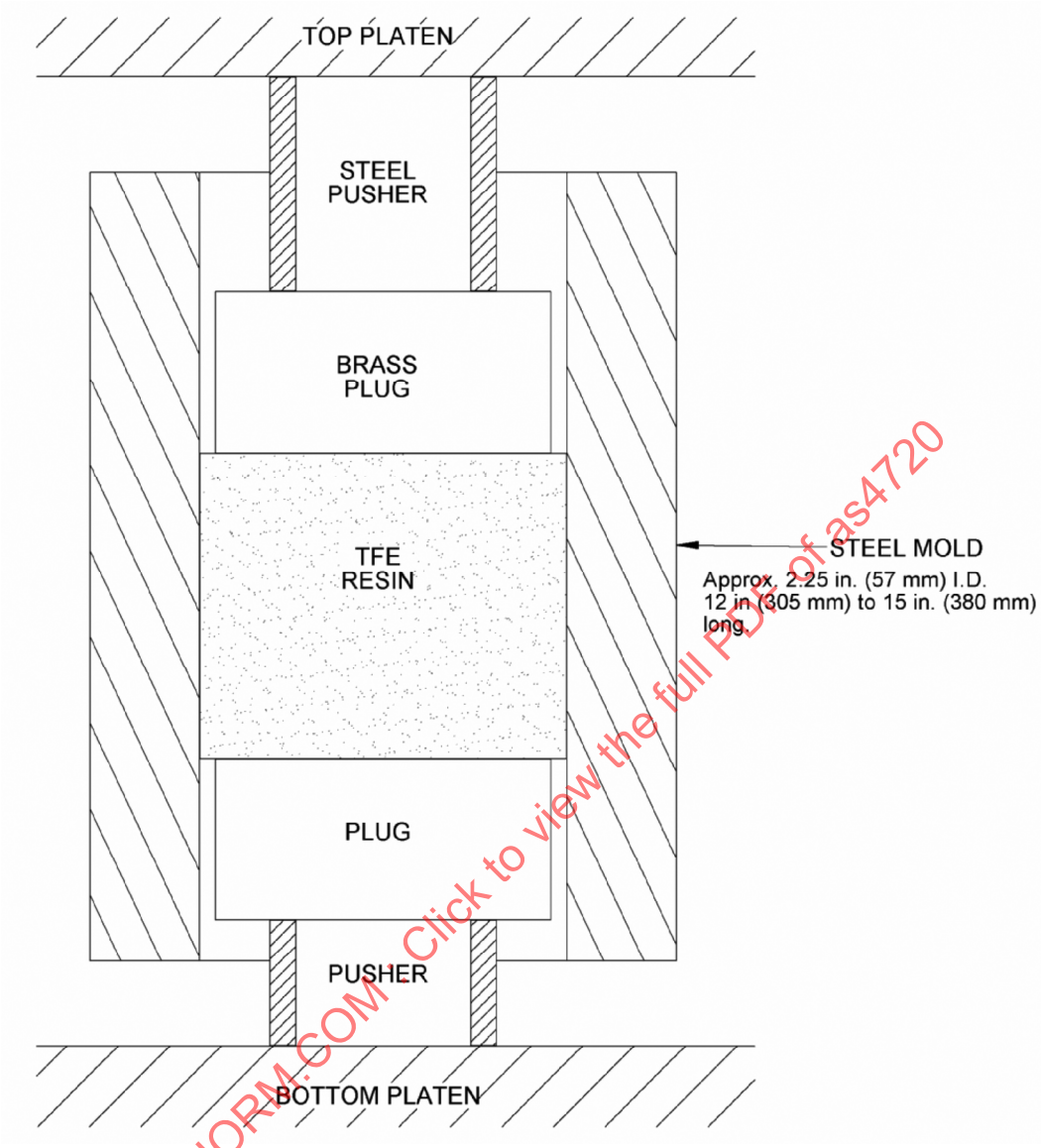

FIGURE 1 - PREFORMING OF PTFE TEST BILLET

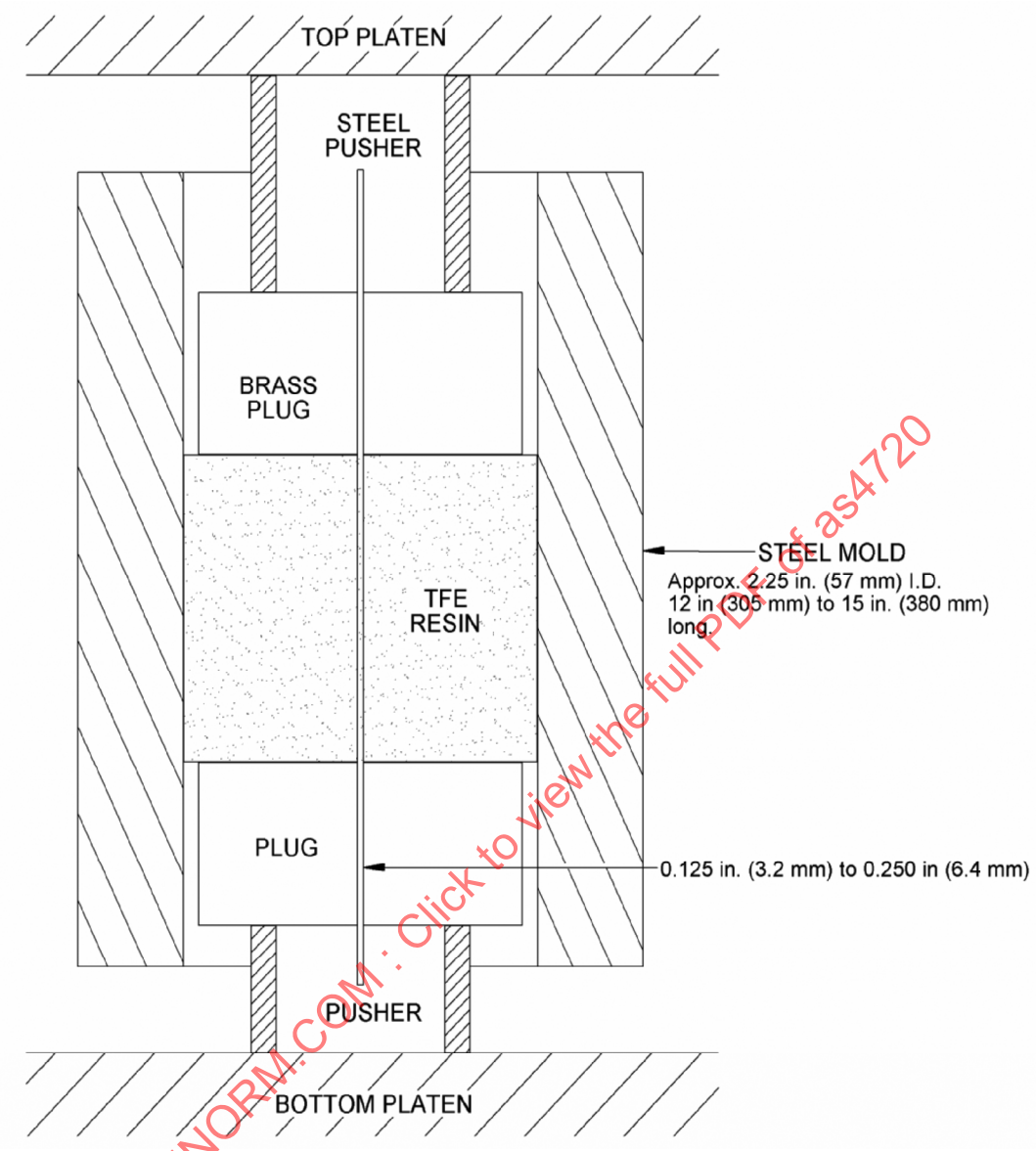

FIGURE 2 - PREFORMING OF PTFE TEST BILLET WITH CENTER HOLE

3.2.4.1 Use a sintering cycle representative of the production process as established and specified by the specifying authority or purchaser. The sinter cycle specified shall take into account the cross-section of the test billet per 3.2 and Figure 1 or Figure 2 to achieve a sample representative of production material. This includes appropriate time of heat transfer through the sample and temperature limitations of any filler in the resin compound.

4. TEST SAMPLES

4.1 Tensile Strength and Elongation Test Samples

Test billets may not be skived or sliced, introducing stresses, unless the finished product is skived tape or film. If production material is of a different thickness to that indicated in Table 1, production material may be substituted.

4.1.1 Solid Test Coupons

Test coupons shall be machined from test billets using a lathe. Discard at least 0.062 in (2 mm) from the end of the test molding. Next, machine sufficient discs of the required thickness to produce samples using a parting tool. It is not permissible to use a knife tool which would introduce internal stresses in the disc that would be detrimental to obtaining accurate test results. The sample surface should be flat, smooth and free of irregularities.

4.1.2 Center Hole Test Coupons

Where the billet has a center hole, test coupons are obtained by machining a thin wall tube close to the outside diameter (OD) of the test billet. To achieve this, use the following procedure. At least 0.125 in (2.0 mm) shall be machined essentially concentrically from the billet OD to remove the billet skin. This machined diameter shall be the OD of the test material and shall not be less than 2.000 in (50.8 mm). The tube shall have a radial wall of the required thickness to produce the tensile test coupons. The outside and inside diameters shall be essentially concentric and these surfaces should be smooth and free of irregularities to ensure accurate test results. The thin wall tube may then be cut axially and laid flat to permit the samples to be die-cut such that the material will be tested for tensile strength in the circumferential direction.

4.1.3 Production Molded Test Coupons

Where a production molding is used to produce the test coupons the molding shall be machined to the appropriate thickness and configuration to produce tensile test coupons configured to be tested in the transverse or circumferential direction (perpendicular to the direction of molding). If this cannot be achieved due to dimensional restrictions, the test coupons may be taken from any other convenient direction.

4.1.4 Skived Film or Tape Test Coupons

Where the final product is skived film or tape, test coupons may be produced using the methodology as described in ASTM D 4894, 9.3.4. The die-cut test coupon shall be cut such that the material will be tested for tensile strength in the circumferential direction, i.e. the direction of skiving.

4.1.5 Tensile Test

Test samples for tensile strength and elongation tests are shown in Table 1.