Designation: D 3419 – ~~93~~00

Standard Practice for In-Line Screw-Injection Molding Test Specimens From Thermosetting Compounds[1]

This standard is issued under the fixed designation D 3419; 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 practice covers ~~a~~ the general ~~procedure for screw-injection~~ principles to be followed when injection molding ~~thermosetting materials into~~ test specimens ~~for Izod or Charpy impact, flexure, tension, compression, water-absorption, heat-aging, electrical, modulus~~ of thermosetting materials. It is to be used to obtain uniformity in methods of describing the various steps of the injection molding process and in the reporting of those conditions. The exact molding conditions will vary from material to material, and should become part of the material specification or ~~flexure,~~ be agreed upon between the purchaser and ~~heat-deflection temperature tests.~~ the supplier.

NOTE 1—The utility of this practice has been demonstrated for the molding of thermosetting molding compounds exhibiting lower-viscosity non-Newtonian flow.

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

1.3 *This standard does not purport to address all of the safety problems, 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.*

1.4 This practice assumes the use of reciprocating screw injection molding machines.

NOTE 2—The~~is standar~~ed is similar in content (but not technically equivalent) to ISO ~~standards covering the primary subject of this practice.~~ 10724: 1994(E).

2. Referenced Documents

2.1 *ASTM Standards:*

D 883 Terminology Relating to Plastics[2]

[1] This practice is under the jurisdiction of ASTM Committee D~~-~~20 on Plastics and is the direct responsibility of Subcommittee D20.09 on Specimen Preparation.
Current edition approved ~~Feb. 15, 1993.~~ Nov. 10, 2000. Published ~~April 1993.~~ February 2001. Originally published as D 3419 – 75. Last previous edition D 3419 – 9~~2a~~3.

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

D 958 Practice for Determining Temperatures of Standard ASTM Molds for Test Specimens of Plastics[3]

2.2 *ISO Standards:*

ISO 10724: 1994(E)—Plastics—Thermosetting Moulding Materials—Injection Moulding of Multipurpose Test Specimens[4]

ISO 3167: 1993, Plastics—Multipurpose Test Specimens[4]

3. Terminology

3.1 *Definitions:*

3.1.1 *General*—Definitions of terms applying to this practice appear in Terminology D 883.

3.1.2 *injection molding*—the process of forming a material by forcing it, in a fluid state and under pressure, through a runner system (sprue, runner, and gate(s)) into the cavity of a closed mold.

3.1.3 *Discussion*—Screw-injection molding and reaction-injection molding are types of injection molding.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *breathing, v*—the operation of opening a mold or press for a very short period of time at an early stage in the process of cure.

3.2.2 *Discussion*—Breathing allows the escape of gas or vapor from the molding material and reduces the tendency of thick moldings to blister.

3.2.3 *cavity (of a mold), n*—the space within a mold to be filled to form the molded product.

3.2.4 *landing (of a cavity), v*—the practice of relieving the mold around the cavity (cavities), thus reducing the surface area of the flat mating surfaces of the mold halves. Typical lands are 4.5 mm (3⁄16 in.) to 6 mm (1⁄4 in.) in width. Landing pads should be incorporated to hold the mold open 0.0125 mm (0.0005 in.) to prevent damage to the lands.

4. Significance and Use

4.1 This practice is subject to the definition of injection molding given in 3.1.2 with the further provision that with in-line screw injection the plastic compound, heated in a chamber by conduction and friction, is fluxed by the action of a reciprocating screw and then is forced into a hot mold where it solidifies. Hereafter, in-line screw-injection molding will be referred to simply as injection molding.

4.2 The mold referenced in this ~~practice provides~~ section (Fig. 1) is generally useful, and describes what have been the most common specimens required for ~~a set~~ the testing of ~~five specimens. However, if only certain~~ thermosets. ISO specimens and testing are ~~desired,~~ gaining favor, however. ISO 10724 describes the ~~other cavities may be blocked by inserting gate blanks.~~ layout and practice for injection molding the multi-purpose specimens per ISO 3167.

4.3 Typically, injection-molded test specimens are made with shorter cycles than those used for similar moldings made by compression, and the cycle is equal to or faster than that for transfer molding.

4.4 Breathing of the mold is not usually required to release trapped volatile material as the gas is free to flow from the vent end of the mold. This is particularly advantageous for heat-resistant compounds and reduces the tendency for molded specimens to blister at high exposure temperatures.

4.5 Injection molding is intended for low-viscosity compounds. One set of processing parameters cannot be specified for all types of thermosetting materials, nor for samples of the same material having different plasticities.

4.6 Materials containing fibrous fillers such as glass roving, chopped cloth, or cellulosic fibers can be injection molded, but their properties will be affected depending upon how much fiber breakdown occurs as the compound is worked by the screw and as it passes through the system of runners and gates. The orientation of the fibers in the molded specimen will also affect injection-molded properties.

4.7 Flow and knit lines in a molded piece are often sites of mechanical or electrical weakness. The fluxed material passing through the gate wrinkles and folds as it proceeds into the mold cavity. Knit lines may be found to some degree throughout the molded piece; these knit lines affect end-test results. Fibers and other reinforcements in the molding compound align with the flow pattern and, consequently, may be perpendicular to the axis of the bar at its center and parallel at its surface.

4.7.1 Placement and size of gates and vents can be used to minimize flow and knit lines, for example, side gating of bars will minimize the tendency of the material to fold onto itself as the material front proceeds through the length of the mold.

4.8 The ~~I~~ izod impact strength of injection-molded specimens containing short fibers will generally be lower than the values obtained using compression molding methods. The impact strength may also vary along the axis of the bar due to molding parameters, flow patterns, and fiber orientation.

4.9 The flexural and tensile strength of injection-molded specimens of molding compounds containing short fibers will generally be higher than the values obtained using compression-molding methods. Flexural tests are particularly sensitive to injection molding due to the thin resin skin formed at the surface of the bar during final filling of the cavity and pressure buildup.

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

[3] ~~Mold comparison kits are available from the D-M-E Co., 29111 Stephenson Highway, Madison Heights, MI 48071.~~

[3] Discontinued 1995. See *1994 Annual Book of ASTM Standards*, Vol 08.01.

[4] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

4.10 At constant mold temperature the following parameters may cause an underfilled condition at the vented end of the cavity: incorrect plasticity, too low an injection pressure, insufficient material, too long an injection time, blocked vents, high stock temperature, or incorrect die temperature.

5. Apparatus

5.1 *In-Line, Screw-Injection Machine*— A device incorporating a hydraulically or electrically driven screw which, working against a predetermined back pressure, draws material from the feed hopper and by frictional and conducted heat works a charge of material into a hot plastic state. Following the plasticating step, the screw stops rotating, moves forward and forces the hot material through the nozzle, sprue, runner, and gate into the cavity. The machine should be capable of accurately delivering and maintaining suitable injection and clamp pressures within the range from 70 to 140 MPa (10 000 to 20 000 psi). Measurement of actual molding pressures can be made with pressure transducers placed strategically in the cavities.

5.1.1 The clamp force of the machine shall be sufficient to prevent excessive flashing under all operating conditions (see 5.2.5).

5.2 *Mold*—A five-cavity—The mold similar to that shown cavities and layout will depend on the specimens required by the tests in question. Fig. 1 has been found satisfactory, although molds with fewer cavities and/or different configurations of the tension specimen may be used. Specimens may be eliminated by blocking the Molds with multiple-identical-cavity layouts with symmetrical gates and runners are normally recommended. Single cavity molds are not recommended. In either case, it is important to particular cavities describe the mold in the report on the specimen preparation.

5.2.1 Family molds like the one shown in Fig. 1 require proper precautions to ensure that constant and reducing injection pressure and shot size accordingly. The gates for each uniform filling is achieved in all cavities.

5.2.2 Gate dimensions equal to two-thirds of the cavities in this mold width and height of end-gated specimens are recommended for specimens not greater than 4-mm (0.16-in.) thickness. For specimens over 4-mm (0.16-in.) thickness, or for other than end-gated specimens, gate dimensions of 8 mm (0.31 in.) wideth by 1.52 3 mm (0.12 in.) thickness are recommended. The gates should be as short as p (¼ossibyle, not exceeding 3 mm (0.06012 in.) in length.

5.2.3 Suitable venting must be provided from each cavity. Surfaces Dimensions of 4 to 6 mm (0.16 to 0.24 in.) width by 0.05 to 1 mm (0.002 to 0.004 in.) depth are recommended.

5.2.4 It is recommended that cavities be landed, so that if flashing does occur, the mold will re-close avfter the injection stroke. Typical lands are 4.5 mm (3⁄16 in.) to 6 mm (¼ in.) in width. Landing pads should be finished incorporated to SPI-SPE #2.[3] Chrome plating of hold the mold surface is recommended. Typically, mechanical or hydraulic knockout systems open 0.0125 mm (0.0005 in.) to prevent damage to the lands.

5.2.5 Full round runners, at least 6 mm (0.24 in.) diameter, are used recommended as they offer less resistance to flow.

5.2.6 Sharp cornemrs in gates and runners are to be avoided as they can cause hot spots and premature curing.

5.2.7 On larger specimens, such as discs or plaques, multiple gates can produce knit lines where the specimens from the mold.

NOTE 3—Although the mold shown material flows together. One larger gate is generally better than several smaller gates.

5.2.8 Mold surfaces should be finished to a roughness of 0.4 um to 0.8 um (SPI-SPE #2 or equivalent[5]), unless it is known that the particular test is not affected by a coarser surface finish. Chrome plating is recommended but not necessary. All cavity surfaces should be draw polished to facilitate specimen removal.

5.2.9 Hydraulic or mechanical knockout systems outside of the specimen test area may be used.

5.2.10 For specimens no greater than 4 mm (0.16 in.) thickness, a multiple-identical-cavity mold with maximum cavity draft angle of 1° should be used. For thicker specimens a symmetrical layout maximum cavity draft angle of runners and cavities. In either case, it 2° may be used.

5.2.11 It is important recommended that all mold cavities be marked to describe identify the mold in source of specimens. Such identifying marks shall not interfere with the report on testing of the specimen ps.

5.2.12 Interchangepable mold cavities and gate inserts are recommended to achieve the greatest flexibility in molding.

5.3 *Heating System*—Any convenient method of heating—The molds may be heated by conduction from heated platens, heaters inserted into the mold p itself, or by hot fluids circulated through passageways in the mold. The heating system shall be used, provided that capable of controlling the heat source is sufficient to maintain a uniform mold temperature within to ±3°C across (5°F) from point to point on the mold surface. and for the duration of the molding time.

5.4 *Temperature Indicator*—Typically, a surface pyrometer is used to measure the temperature of the molded surface as specified in Practice D 958.

6. Conditioning

6.1 Store the molding compound in moisture barrier containers and keep at standard room temperature at the time of molding. Compounds designed for screw-injection molding ordinarily are not preconditioned prior to molding. Mold the material as soon as possible after opening the container.

7. Procedure

7.1 Choose and set the temperatures of the mold based on the manufacturer's recommendation, the relevant material

[5] Mold comparison kits are available from the D-M-E Co., 29111 Stephenson Highway, Madison Heights, MI 48071.

specification, or previous experience with the particular type of material being used and its plasticity. Typically, the temperature will be in the range from 150 to 175°C (302 to 347°F).

7.2 Set barrel temperatures, back pressure, and screw speed to give a stock temperature between 90 and 120°C (195 to 250°F). The optimum molding conditions and stock temperature to be used for a particular compound are those which give consistent processing from one shot to the next and which yield test specimens that are completely filled out and free of any molded-in defects. Eliminate any unwanted cavity by blocking its runner system at the gate and adjusting injection pressure and shot size accordingly.

NOTE 43—It is generally preferable to heat the mold electrically.

7.2.1 The stock temperature (the temperature of the material after the plasticating step may be step) is determined by e injecting a slug of material out of the nozzle into an insulated cup and immediately inserting measuring the probe of temperature with a needle-type pyrometer into the slug. pyrometer.

7.3 The injection pressure selected is dependent upon the composition and plasticity of the material; the clamping material. A secondary or holding pressure must be adequate to prevent excessive flashing.

7.4 Determine of 50 % of the primary injection pressure is recommended. A secondary pressure lower than 30 MPa (4 300 psi) is not recommended.

7.4 Depending upon the number of cavities in the compound by starting at 5 s. If the molded parts are unsatisfactory, adjust the mold, an injection time of 4 to 9 s is recommended. The various molding parameters, including injection pressure and/or speed, shall be p adjusted to achieve this.

7.5 Cure time must be sufficient to give a blister- free part. A minimum cure time of 90 10 s beyond the blister free cure time of the thickest specimen is recommended. normally sufficient.

8. Report

8.1 Report the following information:
8.1.1 Type and description of material used,
8.1.2 Identification of mold, and
8.1.3 Molding conditions, as follows:
8.1.3.1 Mold temperature,
8.1.3.2 Stock temperature,
8.1.3.3 Injection pressure,
8.1.3.4 Injection time,
8.1.3.5 Clamp pressure, and
8.1.3.6 Cycle time.

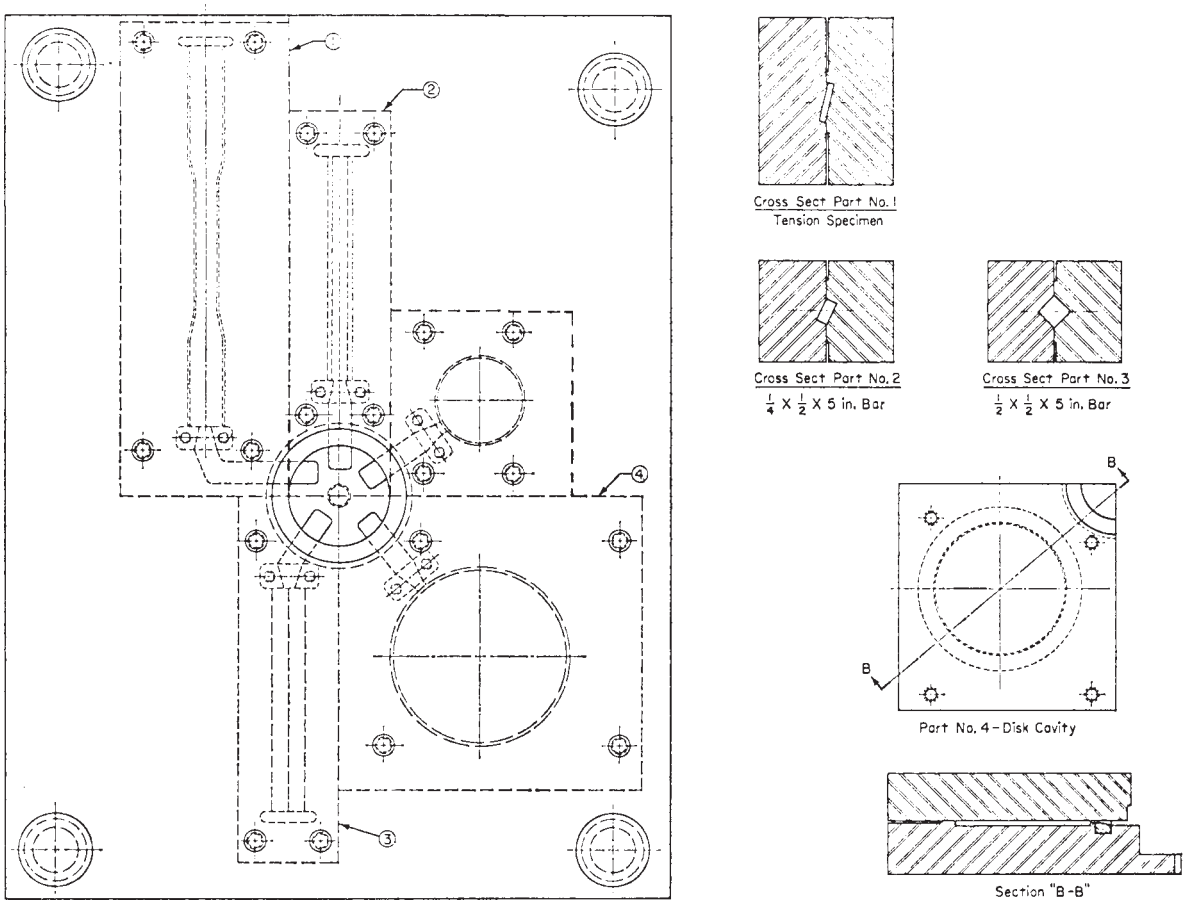
9. Keywords

9.1 in-line screw-injection-molding; injection molding; test specimens; thermosetting compounds

SUMMARY OF CHANGES

This section identifies the location of selected changes to this practice. For the convenience of the user, Committee D20 has highlighted those changes that may impact the use of this practice. This section may also include descriptions of the changes or reasons for the changes, or both.

D 3419-00:
(1) Standardized use of SI units with inch-pound units in parentheses.
(2) Added ISO equivalency statement.
(3) Extensively revised Sections 5 and 7 to enhance usefulness of the practice.
(5) Added 3.2.4, *landing (of a cavity).*



NOTE 1—Thermometer wells shall be 8 mm (5/16 in.) in diameter to permit use of a readily available thermometer.

FIG. 1 Five-Cavity Transfer Mold for Thermosetting Plastic Test Specimens (Steam Cores Not Shown)