Designation: D 3419 – 93

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 general procedure for screw-injection molding thermosetting materials into test specimens for Izod or Charpy impact, flexure, tension, compression, water-absorption, heat-aging, electrical, modulus in tension or flexure, and heat-deflection temperature tests.

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.*

NOTE 2—There are no ISO standards covering the primary subject of this practice.

2. Referenced Documents

2.1 *ASTM Standards:*

D 883 Terminology Relating to Plastics[2]

D 958 Practice for Determining Temperatures of Standard ASTM Molds for Test Specimens of Plastics[2]

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.

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 for a set of five specimens. However, if only certain specimens are desired, the other cavities may be blocked by inserting gate blanks.

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

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[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.

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

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.

4.8 The 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.

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.

5.2 *Mold*—A five-cavity mold similar to that shown in Fig. 1 has been found satisfactory, although molds with fewer cavities or different configurations of the tension specimen may be used. Specimens may be eliminated by blocking the runners to particular cavities and reducing injection pressure and shot size accordingly. The gates for each of the cavities in this mold are 6.4 mm wide by 1.52 mm deep (¼ by 0.060 in.). Suitable venting must be provided from each cavity. Surfaces of the cavity should be finished to SPI-SPE #2.[3] Chrome plating of the mold surface is recommended. Typically, mechanical or hydraulic knockout systems are used to remove the specimens from the mold.

NOTE 3—Although the mold shown is generally useful, it is preferred to use a multiple-identical-cavity mold with a symmetrical layout of runners and cavities. In either case, it is important to describe the mold in the report on the specimen preparation.

5.3 *Heating System*—Any convenient method of heating the mold platens may be used, provided that the heat source is sufficient to maintain a uniform mold temperature within ±3°C across the mold surface.

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 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. 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 4—The temperature of the material after the plasticating step may be determined by ejecting a slug of material out of the nozzle into an insulated cup and immediately inserting the probe of a needle-type pyrometer into the slug.

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

7.4 Determine the injection time of the compound by starting at 5 s. If the molded parts are unsatisfactory, adjust the injection time to mold acceptable parts.

7.5 Cure time must be sufficient to give a blister-free part. A minimum of 90 s is recommended.

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

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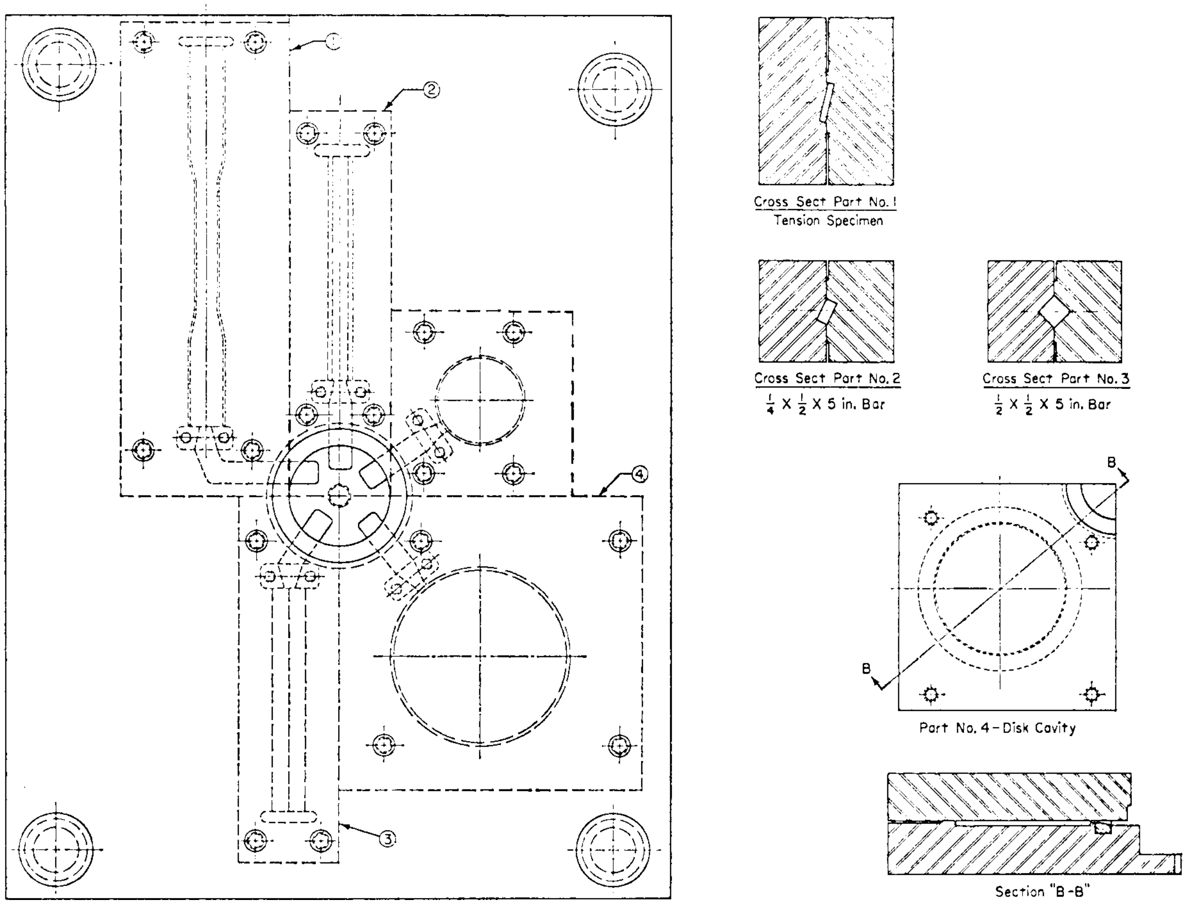
[3] Mold comparison kits are available from the D-M-E Co., 29111 Stephenson Highway, Madison Heights, MI 48071.



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)