Designation: D 1896 – 99

Standard Practice for Transfer Molding Test Specimens of Thermosetting Compounds[1]

This standard is issued under the fixed designation D 1896; 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 the transfer molding of mechanical and electrical test specimens of thermosetting molding materials.

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

1.2 The values stated in either SI or inch-pound units are to be regarded separately as standard. The vlaues stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with this practice.

1.3 *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.*

NOTE 2—There is no similar, or equivalent, ISO standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 731 Test Method for Molding Index of Thermosetting Molding Powder[2]

D 883 Terminology Relating to Plastics[2]

D 957 Practice for Determining Surface Temperature of Molds for Plastics[2]

D 3123 Test Method for Spiral Flow of Low-Pressure Thermosetting Molding Compounds[3]

D 3795 Test Method for Thermal Flow and Cure Properties of Thermosetting Plastics by Torque Rheometer[3]

3. Terminology

3.1 *Definitions:*

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

3.1.2 *transfer molding*, *n*—a method of forming articles by fusing a plastic material in a chamber and then forcing essentially the whole mass into a hot mold where it solidifies.

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 *clamp pressure*, *n*—the pressure applied to the mold to keep it closed, in opposition to the fluid pressure of the compressed molding material.

3.2.5 *fill time*, *n*—the time required to fill each cavity used in the mold. Fill times can be critical to well molded parts (see Note 3 under 4.4).

3.2.6 *minimum plunger pressure*, *n*—the minimum pressure, on the ram, required to just fill each cavity used in the mold at a specified temperature and reasonable fill time.

3.2.7 *vent*, *n*—a hole, slot, or groove provided in a mold or machine to allow air and gas to escape during molding, extrusion, or forming.

4. Significance and Use

4.1 Transfer molding is particularly suited to thermosetting materials of intermediate plasticity. Fixed molding parameters cannot be specified for each type of material. Molding compounds of the same type come in many different plasticities measured in accordance with Test Methods D 731, D 3123, and D 3795. For this reason, a material may mold satisfactorily under one set of fixed parameters, while the same type of material with a different plasticity may require a different set of parameters to produce satisfactory test specimens.

4.2 The mold shown 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, breathing of the mold may not be required to release trapped volatile matter as the gas is free to flow from the vent end of the mold. This is a particular advantage for heat-resistant compounds and reduces the tendency for molded specimens to blister at high exposure temperatures.

[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.

[3] *Annual Book of ASTM Standards*, Vol 08.02.

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

4.4 Flow and knit lines in a molded piece are often sites of mechanical or electrical weakness. Knit lines may be found in some degree of severity throughout the molded piece. The semisolid molding compound passing through the gate is subject to non-Newtonian flow and, consequently, wrinkles and folds as it travels down the mold cavity. Fibers and other reinforcements in the molding compound align with the flow pattern and, consequently, may mold perpendicular to the axis of the bar at the center and parallel at the surface of the bar. Mold temperature, thermal conductivity and plasticity of the molding compound, degree of preheat, and plunger pressure are parameters that influence the time to fill the mold cavities and the formation of knit lines.

NOTE 3—If the temperature of the mold is held constant and the plunger pressure varied for a designated thermosetting molding compound, two extreme characteristic conditions can be obtained. If the pressure is low, then the vent end of the cavity will not fully fill, and weld lines will form by incomplete knitting of the material. If the pressure is too high, the mold cavity will fill fast, the outside of the specimen will case harden while the pressure is still forcing material out the vent, and a ball-and-socket grain structure will be obtained. A ball-and-socket structure is an indication of the molding condition, and lower test data will result.

4.5 Thermosetting compounds containing long-fiber fillers such as glass roving, chopped cloth, or shavings can be used but are not recommended for transfer molding. These filler materials tend to break, tear, or ball in passing through the gates of the mold, thereby not optimizing their potential strength.

4.6 The Izod impact strength of transfer molded specimens of molding compounds containing short fibers will generally be lower than the values obtained using compression-molding methods. Quite often the impact strength will vary along the axis of the bar due to molding parameters, flow pattern, and fiber orientation.

4.7 The flexural and tensile strength of transfer 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 transfer molding due to the thin resin skin formed at the surface of the bar during the final filling of the cavity and pressure buildup.

5. Apparatus

5.1 *Press*—A hydraulic press designed to develop and maintain accurately any desired pressure between 7 and 85 MPa (1000 and 12 000 psi) on the plunger to ±1 MPa (±150 psi) and have a minimum plunger loading capacity of 230 cm^3 (14 $in.^3$) (see Note 4). The clamp pressure shall be at least 20 % higher than the plunger pressure.

NOTE 4—Plunger molding pressure under actual molding conditions is a variable that is difficult to control. Pressure standardization should be carried out on an empty cavity with the plunger against the mold-stop plate. The speed of the moveable platen is not important as the mold is closed before the plunger operates. A ram speed of 3.6 m/min (140 in./min) and a plunger speed of 2.2 m/min (85 in./min) have been found satisfactory when the mold is not loaded. The plunger speed is subject to the flow properties of the molding material when the plunger cavity is loaded with molding compound.

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.[4] Chrome plating of the mold surface is recommended.

NOTE 5—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 press platens and plunger cavity may be used, provided the heat source is constant enough to maintain the mold and plunger temperature within ±3°C (5°F).

5.4 *Temperature Indicator*—Typically, a surface pyrometer is used to measure the temperature of the mold surface as specified in Practice D 957.

5.5 *Preforming*—Any preforming equipment or press may be used that will provide a satisfactory preform of material for the plunger and ease of handling in the electronic preheater.

6. Conditioning

6.1 Molding compounds are generally preformed, electronically preheated, and molded from the compound in the as-received condition.

6.2 Condition molding compounds known to contain a high percentage of moisture for 30 min at 90 ± 3°C (194 ± 5°F) in a forced-draft oven and preform immediately afterward. The depth of the molding compound in the oven tray should not exceed 15 mm (0.6 in.). Store the preformed material in a desiccator over anhydrous calcium chloride at room temperature until ready to preheat and mold.

6.3 In the case of a referee test, prepare the preform material as indicated in 6.2.

7. Procedure

7.1 Choose and set the temperatures of the mold and plunger cavity 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 Uniformly preheat the desired shot size of preformed material of the compound to the preheat temperature specified by the manufacturer or the relevant material specification.

NOTE 6—The temperature of the preformed material after electronic preheating may be determined by a needle-type pyrometer of low thermal capacity.

7.3 Immediately remove the preheated preformed material from the preheater, place it in the plunger cavity, close the press, and apply molding pressure within a period of 5 s after completion of preheating.

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