Designation: D 731 – 95 (Reapproved 1999)

Standard Test Method for Molding Index of Thermosetting Molding Powder[1]

This standard is issued under the fixed designation D 731; 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 test method covers the measurement of the molding index of thermosetting plastics ranging in flow from soft to stiff by selection of appropriate molding pressures within the range from 4.1 to 31.9 MPa.

1.2 The values stated in SI units are to be regarded as standard.

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 1—There is no ISO standard equivalent to this test method.

2. Referenced Documents

2.1 *ASTM Standards:*

D 256 Test Methods for Impact Resistance of Plastics and Electrical Insulating Materials[2]

D 883 Terminology Relating to Plastics[2]

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

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method[3]

3. Terminology

3.1 *Definitions:* Definitions are in accordance with Terminology D 883, unless otherwise specified.

4. Summary of Test Method

4.1 A cup mold is mounted in a semi-automatic type press. A predetermined quantity of test sample is charged into the mold, controlled at a temperature dependent upon the test material. The minimum force required to mold a cup having a flash or fin thickness within a specified tolerance is determined. This force along with the mold closing time is reported as molding index.

5. Significance and Use

5.1 This test method provides a guide for evaluating the moldability of thermosetting molding powders. This test method does not necessarily denote that the molding behavior of different materials will be alike and trials may be necessary to establish the appropriate molding index for each material in question.

5.2 The sensitivity of this test diminishes when the molding pressure is decreased below 66 MPa, so pressures lower than this are not ordinarily recommended. This is due to the friction of moving parts and the insensitivity of the pressure switch actuating the timer at these low pressures.

6. Apparatus

6.1 *Mold*—A cup mold[4] of the flash type, to produce a molded cup as shown in Fig. 1, operated under controlled pressure and temperatures and provided with stops so that flash or fin thickness cannot be less than 0.14 mm. The area of the mold casting creating the molded flash shall be located on top of the cup, flat, perpendicular to the axis of the cup, and in the form of an annular ring 3.17 mm (0.125 in.) in width.

6.2 *Thermometer*—A 32-mm partial-immersion mercury thermometer having a diameter just under 4.8 mm and a temperature scale of not more than 20°C/25.4 mm of length. A pyrometer may be used to determine the temperature of the mold surfaces. For properly measuring mold temperatures, reference should be made to Practice D 957.

6.3 *Heating System*—Any conventional means for heating the press platens, provided the heat source is constant enough to maintain the molding temperature within ±1°C of the specified temperature (see 9.2).

6.4 *Pressure System*—A semiautomatic press with a fixed mold and fully insulated to minimize heat losses shall be used. The use of hand molds is not recommended but may be used to give an estimate of the molding index. The hydraulic system shall be provided with a means of pressure regulation so that the load on the mold shall differ by not more than ±56.2 N from the stated value. The capacity of the hydraulic system shall permit a ram travel of approximately 25 mm/s. It is recommended that the ram diameter not exceed 100 mm.

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[1] This test method is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D 20.30 on Thermal Properties (Section D20.30.08).

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

[3] *Annual Book of ASTM Standards,* Vol 08.03.

[4] A detailed drawing of the mold design is available from ASTM Headquarters. Order Adjunct: ADJD0731.

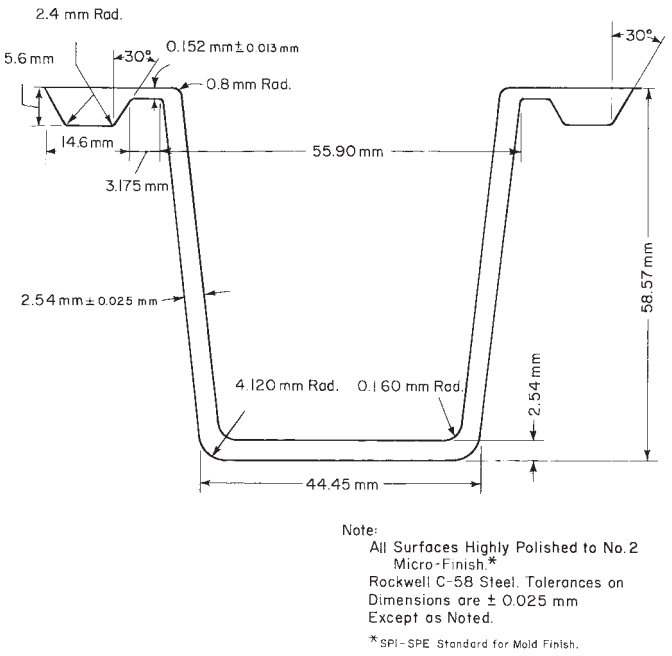

FIG. 1 Cup Mold

7. Test Specimen

7.1 To determine the weight of the test specimen for materials having an Izod impact strength of 27 J/m of notch, or less, a cup having a flash or fin thickness of 0.15 to 0.20 mm shall be molded (see Note 3). The adhering fin shall be removed and the cup weighed to the nearest 0.1 g. This weight multiplied by 1.1 shall be the weight of the test specimen used. For materials having an impact above 27 J/m of notch, the specimen weight is determined in a similar manner, except that cup flash shall not be more than 0.66 mm or less than 0.51 mm and the amount of material shall be 1.05 times the weight of this cup. The test specimen shall be in the form of loose powder unless preforming is necessary for materials of high bulk. Minimum pressure shall be employed in the preforming operation to minimize the increase in closing time resulting from the use of preforms.

NOTE 2—While the mold is provided with stops so that the flash or fin thickness cannot be less than 0.15 ± 0.013 mm, the molded cup itself may have a flash thickness of 0.15 to 0.20 mm as the micro switch controlling the closing time must have a tolerance in which to operate.

8. Conditioning

8.1 Materials are normally tested in the "as received" condition, except in referee tests, when they shall be conditioned in accordance with 8.2 (see Note 2).

8.2 For referee testing, all materials shall be shipped and stored in sealed moisture barrier containers. These materials shall be stored for a minimum period of 48 h at standard laboratory temperature before breaking the seal on the carton. A representative sample shall be taken from this carton immediately after opening and tested within 3 min in order to preserve the original moisture content. Alternative methods of conditioning samples may be used provided they are mutually agreed upon between the manufacturer and the purchaser.

NOTE 3—Conditioning may alter the moisture content of most materials and thereby change their molding index or molding behavior.

9. Procedure

9.1 Mount the mold in a press of the semi-automatic type. Past experience has shown that the rate of flow is sensitive to the condition of the mold surfaces; preceding materials may have deposited a film that influences the mold surfaces to the extent that erroneous results may be obtained unless properly conditioned prior to testing. A suggested procedure is to discard the first few cups molded and accept the flow time as correct when two successive cups molded under test do not differ by more than 1 s in time of flow.

9.2 The preferred mold temperature for testing the molding index for the following materials shall be:

	°C
Phenolic	165 ± 1
Melamine	155 ± 1
Urea	150 ± 1
Epoxy	150 ± 1
Diallyl phthalate	150± 1
Alkyd	150 ± 1

Other temperatures may be used as agreed upon between the manufacturer and the purchaser.

9.3 First determine the proper weight to be used as outlined in 6.1. Then begin the test with a load sufficient to close the mold to the fin thickness specified for the type of material being tested as defined in 6.1. For example, if a 2248 N load is applied on the mold to make the initial cup and the required fin thickness is obtained, the next lower load, 1686 N is applied as indicated in the following table. If the mold closes to the required thickness again, then the 1124 N load is applied. If the mold then does not close, the "molding index" is the closing time obtained with the 1686 N load. It is recommended that the mold loads used be selected from the following table:

Total Load N	Molding Pressure MPa
1112	4.6
1601	6.6
1124	9.0
1686	13.6
2248	18.0
3372	21.2
4496	36.3
11 120	45.4

9.4 The time of flow in seconds shall be measured from the instant that the hydraulic gage indicates an applied load of 454 kg to the instant that the fin has reached 0.20 mm in thickness for materials with an Izod impact strength of 27 J/m of notch, or less, and 0.66 mm for materials with an impact above 27 J/m of notch.

NOTE 4—The molding pressure is calculated by dividing the total load by the projected area of the mold cavity.

NOTE 5—A convenient method for determining fin thickness is to indicate the final movement of the platen with a dial micrometer.

10. Report

10.1 Report the following information:

10.1.1 A statement indicating the nature of the material tested and the manufacturer's material number and batch number,

TABLE 1 Molding Index in Seconds

NOTE 1—S_r is the within-laboratory standard deviation of the average, S_R is the between-laboratories standard deviation of the average, $r = 2.8\ S_r$, and $R = 2.8\ S_R$.

Material	Average	Load, N	S_r	S_R	r	R
Polyester (B)[B]	4.78	1124	0.025	0.909	0.070	2.545
Glass-Filled (B)[A]	8.99	1124	0.038	0.727	0.106	2.036
Polyester (A)[B]	9.63	1124	0.072	0.577	0.202	1.616
Mineral Filled (A)[A]	11.54	1124	0.072	0.881	0.202	2.467
Mineral Filled (B)[B]	11.57	1124	0.098	1.736	0.274	4.861
General Purpose (B)[B]	11.78	1124	0.041	1.264	0.115	3.539
DAP (B)[B]	12.64	1124	0.054	0.892	0.151	2.498
Impact Type (B)[B]	14.92	1686	0.090	0.965	0.252	2.702
Glass-filled (A)[A]	16.06	2248	0.083	0.912	0.232	2.554
General Purpose (A)[A]	18.37	1686	0.056	1.331	0.157	3.727

[A] Sample B obtained from Occidental Chemical Corp., Fort Green, Ontario, Canada.
[B] Sample A obtained from Occidental Chemical Corp., Tonawanda, NY.

10.1.2 The molding index expressed as the total minimum force in newtons required to close the mold, with the closing time in seconds as a subscript (for example, 3372_{18} N),

10.1.3 Temperature of the mold,

10.1.4 Weight of the test sample in grams, and form of sample (loose powder or preform),

10.1.5 Thickness of flash or fin measured to the nearest 0.025 mm (0.001 in.),

10.1.6 Description of any unusual characteristics of the test sample, such as discoloration and sticking,

10.1.7 Details of conditioning,

10.1.8 Impact strength of the material expressed as Izod in joules per metre of notch in accordance with Test Methods D 256, and

10.1.9 Indicate if preforms were necessary to run the test.

11. Precision and Bias [5]

11.1 Table 1 is based on a round robin conducted in 1988 in accordance with Practice E 691 involving ten test samples. The test results in Table 1 were from 4 laboratories with each laboratory obtaining four test results for each sample.

NOTE 6—**Caution:** The following explanations of r and R (11.3 through 11.3.3) are only intended to present a meaningful way of considering the approximate precision of this test method. The data in Table 1 should not be rigorously applied to the acceptance or rejection of material, as those data are specific to the round robin and may not be representative of other lots, conditions, materials, or laboratories. In particular with data from less than six laboratories, the between-laboratories results are likely to have a very high degree of error.

11.2 Users of this test method should apply the principles outlined in the 1987 edition of Practice E 691 to generate data specific to their laboratory and materials or between specific laboratories. The principles of 11.3 through 11.3.3 would then be valid for such data.

11.3 *Concept of r and R*—If S_r and S_R have been calculated from a large enough body of data, (use Table 1 with caution as only four laboratories participated) and for test results that were averages from testing four specimens.

11.3.1 *Repeatability Limit, r*—Comparing two test results for the same material, obtained by the same operator using the same equipment on the same day, the two test results should be judged not equivalent if they differ by more than the r value for that material.

11.3.2 *Reproducibility Limit, R*—Comparing two test results for the same material, obtained by different operators using different equipment on different days, the two test results should be judged not equivalent if they differ by more than the R value for that material.

11.3.3 Any judgment in accordance with 11.3.1 and 11.3.2 would have an approximate 95 % (0.95) probability of being correct.

11.4 Bias is systematic error that contributes to the difference between a test result and a true (or reference) value. There are no recognized standards on which to base an estimate of bias for this test method.

12. Keywords

12.1 molding index; thermosets

[5] Supporting data are available from ASTM Headquarters. Request RR: D-20 - 1163.