Association of Rotational Molders

Test Method for Flowability (Dry Flow Rate) and Apparent Density (Bulk Density) of Polyethylene Powders

Version 2.1

November 2011

Contents:

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Version 2.1 – November 2011

This test was developed by the Association of Rotational Molders (ARM) from a variety of sources, all of which ARM and its members believe to be reliable. While ARM has made reasonable efforts to confirm the completeness and accuracy of the data on which this test method is based, ARM and its members make no guarantees, warranties, or other representations as to the data's completeness and accuracy, nor do ARM and its members assume any responsibility or liability for any loss or damage suffered from the use of this test.

As with any procedure of this nature, use appropriate safety devices. Good safety practices and compliance to OSHA standards are the responsibility of the tester.

1. Scope

1.1 This test method is used to evaluate the flowability (dry flow rate) and apparent density (bulk density) of polyethylene (PE) powders for the purpose of rotational molding. Experience over many decades indicates that PE powders need acceptable dry flow and bulk density characteristics to be handlable and rotomoldable.

1.2 The test method is based on ASTM D1895-96 and ISO R60, with conditions adapted and refined to be specific for use in rotational molding.

1.3 The test method is based on the use of a funnel and measuring cup of specified dimensions and characteristics.

1.4 Units are stated in both SI and those normally used in United States.

1.5 *This standard does not purport to address all of the safety or environmental problems, if any, associated with its use. It is the responsibility of the user of the standard to establish appropriate safety, health and environmental practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards
D 1895-96 Apparent Density, Bulk Factor and Pourability of Plastic materials

2.2 ISO Standards
R 60 Determination of Apparent Density of Moulding Materials that can be poured from a Specified Funnel

2.3 Other References
Laws, R,D., *Rotation*, January – February 2004

3. Summary of Test Method

3.1 This test method consists of measuring the length of time for a standard quantity of powder to completely empty from a specified funnel.

3.2 This test method consists of measuring the apparent density of a standard quantity of powder to completely fill a specified cylinder.

4. Significance and Use

4.1 This test method does not purport to interpret results or measurements. Such interpretation is left to the parties involved in the commissioning and reporting of the test results.

4.2 This test method is intended to provide an indication of the performance of PE powders with respect to their handling and their performance during the rotomolding process.

4.3 Flowability characterizes the handling properties of a finely divided plastic material. It is a measure of the readiness with which such materials will flow through hoppers and feeding devices and deliver uniform weights of material.

4.4 Flowability also characterizes the rotomolding properties of a finely divided plastic material. It is a measure of the readiness with which the powder flows evenly across all surfaces of the mold. A PE powder with poor flowability may create defects in the final molded product such as bridging, uneven wall thickness, rough internal surface, pinholing and pigment swirling.

4.5 Conditions that can affect flowability results include: funnel shape and dimensions, surface condition / roughness of the inside of the funnel and powder temperature.

4.6 Apparent density also characterizes the handling properties of a finely divided plastic material. It is a measure of the weight per unit volume with which such materials can be transferred into molds or storage containers.

4.7 Conditions that can affect apparent density results include: powder temperature and particle morphology.

5. Definitions

5.1 *Flowability* – a measure of the time required for a standard quantity of material to flow through a funnel of specified dimensions and other characteristics.

5.2 *Apparent Density* – a measure of the weight per unit volume of a material, including voids inherent in the material as tested.

5.3 *Powders* – may include pulverized material, microspheres and other small particles suitable for rotomolding.

6. Apparatus

6.1 Flow funnel of specified dimensions and characteristics (see Appendix A) mounted vertically and outlet level with the horizontal. Note that a protective collar around the exit orifice is incorporated into the design and does not affect the dry flow time. The protective collar should be flush with the funnel outlet.

6.1.1 The exit orifice dimension should be checked periodically using a machined “Go / No Go” gauge (see Appendix C).

6.1.2 The roughness of the inside surface of the funnel has been shown to be critical to the flowability measured (Reference 2.3). It has been found that a rougher surface *promotes* powder flow by holding powder to the sides of the funnel and allowing material to flow initially from the centre (“rat-holing”). It is most important that the original inside surface finish (as specified in Appendix A) is preserved throughout the lifetime of the funnel. Damage by scraping, cleaning or polishing must be avoided. Note that the funnel design incorporates anodizing (blue) the inside surface in order to prolong its' finish.

6.2 Stopwatch or timer of comparable accuracy.

6.3 Measuring cup of specified dimensions and characteristics (see Appendix B)

6.4 Stand suitable of holding the flow funnel 38 mm above the top of the measuring cup.

7. Safety Precautions

7.1 As with any procedure of this nature, use appropriate safety equipment and devices. Good safety procedures and compliance to OSHA standards are the responsibility of the tester.

8. Sampling and Conditioning

8.1 Samples for flowability and apparent density measurement should be taken from the bulk in a way that prevents any segregation or sorting of powder fractions that would affect its homogeneity.

8.2 If the powder sample is warm, it should be allowed to cool before flowability or apparent density is measured; it should be within the range of 20 - 25 ℃ (68 - 77 ℉) when tested. Rapid cooling may be promoted by spreading the powder sample out in a thin layer, provided subsequent homogeneity of the sample is preserved.

8.3 The addition of flow promoters, or any other additives and reagents, to the powder sample is not in accordance with this standard, which is intended to test the quality of the powder supplied to the rotomolding process.

9. Procedure

9.1 A funnel and measuring cup may be calibrated from time to time by running a reference material through it and checking that the flowability and apparent density measured is in accordance with that specified for the standard material. Reference material may be obtained by application to the Association of Rotational Molders.

9.2 With the apparatus defined as in sections 6.1 to 6.3, funnel outlet level with the horizontal, 38 mm above the top surface of the measuring cup and funnel exit orifice centered over the measuring cup, close the end of the funnel with a suitable flat strip (e.g. clean piece of card or spatula). Use of a finger or hand is not recommended as it may affect the result. Pour 100±1 g of the sample powder lightly into the funnel, avoiding any tendency to pack it. Open the bottom of the funnel quickly and start the stopwatch or timer at the same instant. Allow the material to run from the funnel freely into the measuring cup. Stop the watch or timer at the instant the last of the material leaves the funnel.

9.3 In the rotomolding industry, it is not unusual for the funnel to be tapped with a pencil or similar object to promote material flow. The application of taps or other such vibrations is not in accordance with this standard and the need for exterior assistance to promote flow should be viewed as an indicator of unacceptable powder properties.

9.4 After all of the material has passed through the funnel, immediately scrape off the excess of the top of the measuring cup with a straightedge (e.g. spatula) without shaking the measuring cup. Weigh the material in the cup to the nearest 0.1g. Calculate the weight in grams of 1 cm^3 of the material.

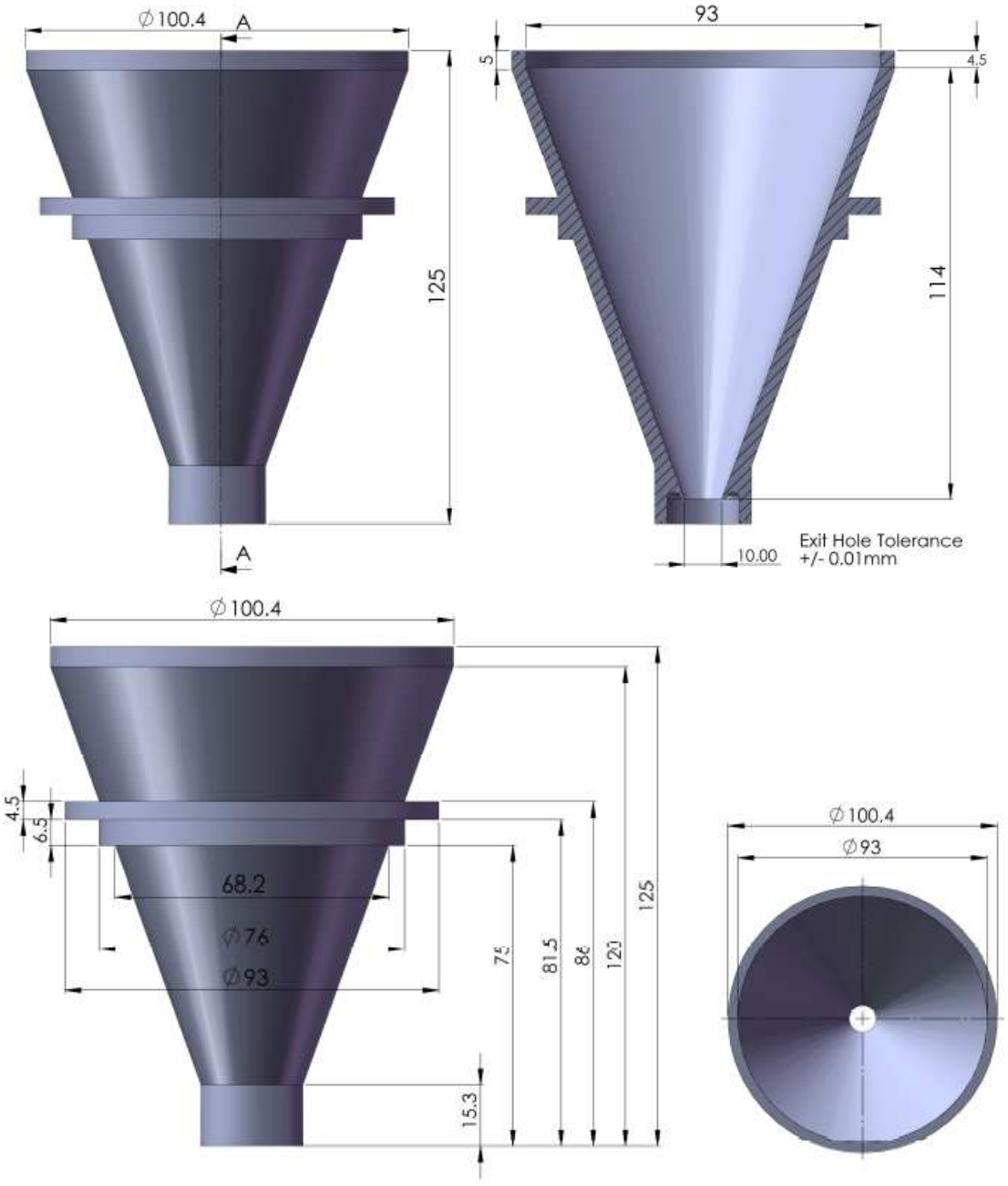
9.5 The temperature of the powder at the time of the test has been shown to affect the flowability measured (see 8.2).

10. Report

10.1 Report the time in seconds required for the funnel to discharge, to the nearest 0.1 s; or, if so found, that the material will not run freely through the funnel.

10.2 Report the apparent density of the powder to the nearest 0.01 g/cm^3.

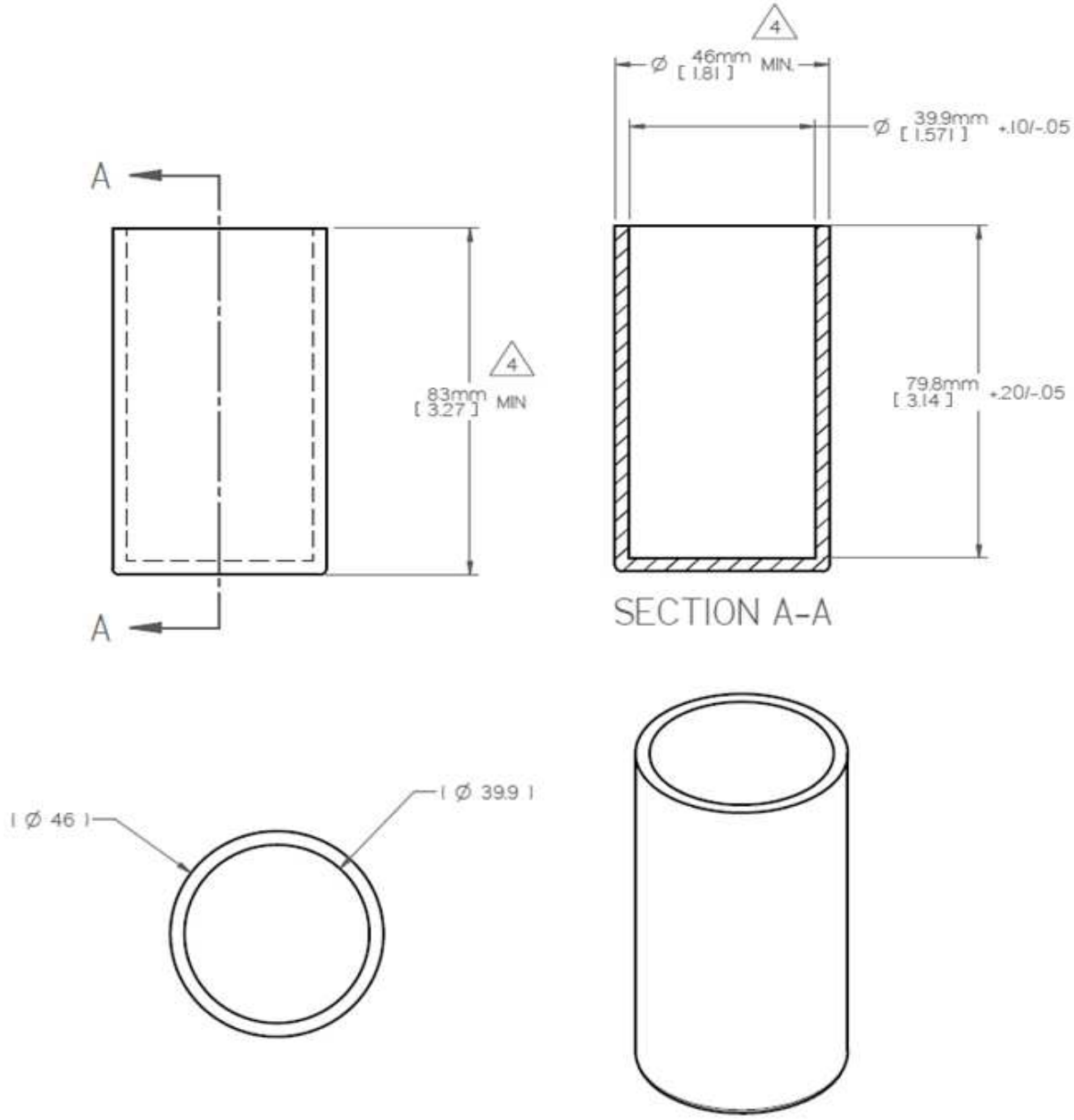
Appendix "A"
Funnel Specifications



Material: Aluminum Alloy
Inside Finish: Sulphuric Anodized
Measurements: mm

Drawings courtesy of the Association of Rotational Moulders Australasia (ARMA)

Appendix "B"
Measuring Cup Specification



Material: Aluminum Alloy
Inside Finish: Sulphuric Anodized
Measurements: mm
Internal Volume Shall Be 100 ± 0.5 cm^3
4 Recommended Dimension to Maintain Structural (Volumetric) Integrity of Cup

Appendix "C"
Go / No Go Gauge