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**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

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Rotational moulding - Test method for powder flowability

滚塑成型 粉末流动性的试验方法

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Table of Contents

Foreword...	3
1 Scope...	4
2 Normative References...	4
3 Terms and Definitions...	4
4 Principle...	5
5 Instruments and Equipment...	5
6 Specimen...	7
7 Standard Environment for the Test...	8
8 Test Procedures...	9
9 Results and Characterization...	9
10 Precision...	10

1 Scope

China's national test method for the flowability of rotational moulding powders. Rotational moulding makes hollow parts - tanks, containers, kayaks, playground equipment - by tumbling a measured charge of polymer powder inside a heated mould until it melts and coats the walls. Unlike every other plastics process there is no pressure and no shear: the powder must reach every part of the mould by flowing under gravity alone as the mould rotates, and then sinter and coalesce without anything forcing it. Flowability is therefore the property that determines whether a part forms at all. A powder that flows poorly bridges in corners and leaves the part thin or unfilled there, and the defect is invisible from outside a closed hollow article. The property depends on particle size distribution and on shape - the grinding process that makes the powder is what sets both - which is why it is measured on the powder rather than inferred from the resin.

This Document specifies test methods for the flowability of powders for rotational molding. This Document applies to free-flowing powder materials for rotational molding, with particle size $D_{98} \leq 1\text{mm}$, and apparent density $D_a \geq 0.21\text{g/mL}$.

2 Normative References

The provisions in following documents become the essential provisions of this Document through reference in this Document. For the dated documents, only the versions with the dates indicated are applicable to this Document; for the undated documents, only the latest version (including all the amendments) is applicable to this Document.

GB/T 1636 Plastics - Determination of apparent density material that can be poured from a specified funnel

GB/T 1957 Tolerances and general features for plain limit gauges

GB/T 2035-2008 Terms and definitions for plastics

GB/T 2547-2008 Plastic resins - Sampling

GB/T 2918 Plastics - Standard atmospheres for conditioning and testing

GB/T 6284 Chemical products for industrial use - General method for determination of water content - The loss of mass on drying method

GB/T 16418 Particle system - Vocabulary

3 Terms and Definitions

For the purposes of this Document, the terms and definitions given in GB/T 2035-2008, GB/T 16418 and the following apply.

3.1 Rotational moulding The processing method that puts the resin molding material into the mold; heats the mold and make it rotate continuously at low speed; the resin in the mold is gradually coated and adhered to the inner surface of the mold under the action of gravity and heat to form the required shape; and the plastic product is obtained after cooling.

[SOURCE: GB/T 2035-2008, 2.873, modified]

3.2 Powder flowability; dk The rate at which a dry powder flows through a defined funnel under the action of gravity only.

4 Principle

4.1 The principle of this test method is to characterize the free-flowing ability of the powder only under its own gravity by measuring the time it takes for a unit mass of powder sample to flow out of a funnel of specified size.

4.2 This test method can be used to characterize the following properties: - the performance of powdery materials suitable for rotational molding process; - the conveying performance of the powdery material, that is, the performance of the powdery material passing through the hopper or feeding device evenly; - The performance of the powdery material to flow evenly on all surfaces of the mold. NOTE 1: Materials with poor powder flowability may cause defects such as bridging, uneven wall thickness, rough inner surface, pinholes and color swirls in rotationally molded products. NOTE 2: The conditions that affect the powder flowability results include: the shape, size, inner surface condition, inner surface roughness of the funnel and powder temperature.

4.3 Combined with the apparent density data measured in GB/T 1636, the basis for judging

that powdery materials are suitable for rotational molding can refer to Appendix A.

5 Instruments and Equipment

5.1 Funnel The funnel used in the test shall meet the following conditions:

8 Test Procedures

The test is carried out in the following procedures.

- a) Close the outflow port of the funnel with a baffle.
- b) Weigh the mass of the specimen, the unit is gram, and retain one digit after the decimal point.
- c) Gently pour the specimen into the funnel along the wall of the funnel to prevent compaction and avoid any tilting. The funnel shall not be vibrated to promote the accumulation of the specimen.
- d) Quickly open the baffle; and press the timer at the same time to start counting. Use a pen or ruler to gently tap the funnel to promote flow. The tap shall not cause the position of the funnel to move, but fixed mechanical vibration device that can promote flow shall not be used.
- e) Observe from the top of the funnel and stop timing when the outflow port is visible.
- f) Observe the flow pattern of the specimen:
 - Continuous flow: the specimen flows out continuously until it completely flows out of the funnel, denoted by c;
 - Intermittent flow: the specimen flows out intermittently until it completely flows out of the funnel, represented by i;
 - No flow: The specimen does not flow out of the funnel or stops flowing out of the funnel during of the test.
- g) Use the same specimen to repeat the measurement for 3 times. For hygroscopic specimen, the measurement shall be completed within 5min.
- h) After each measurement, any residue adhering to the inner wall of the funnel shall be cleaned.

9 Results and Characterization

9.1 Powder outflow time Take the arithmetic mean of 3 measurements as the measurement result of the powder outflow time. The result is rounded off to one digit after the decimal point. If one of the three measurements is "no flow", the test result should be "NG".

9.2 Powder flowability The powder flowability is calculated according to the Formula (1), and the result is rounded off to one digit after the decimal point. NOTE: For powders whose powder outflow time is "NG", the powder flowability test is not conducted. Where: d_k - powder flowability, in s/100g; k represents the flow type. If k takes c, it shall mean continuous flow; if k takes i, it shall mean intermittent flow; t - the powder outflow time, in s; m - the mass of the specimen, in g. EXAMPLE: 100.2g of a certain powder is used for testing; the measured values of powder outflow time are 25.7s, 26.1s and 25.5s; and the flow type is continuous flow. Calculated powder flow time $t = (25.7s + 26.1s + 25.5s) / 3 = 25.8s$, powder flowability $d_c = 100 \times 25.8s / 100.2g = 25.7s/100g$.

10 Precision

In the same laboratory, the same operator uses the same equipment, according to the same test method, and tests the same measured object independently within a short period of time, and the absolute difference between the obtained two independent test results does not exceed the repeatability limit (r); the repeatability limit (r) is calculated according to the Formula (2): Where: d_k - the average value of two measured values, in s/100g. In different laboratories, different operators use different equipment, according to the same test method, the absolute difference between the obtained two independent test results by independently testing the same measured object is no greater than the reproducibility limit (R) 2.808; on the premise that the cases greater than the reproducibility limit (R)