GB

NATIONAL STANDARD OF THE

PEOPLE'S REPUBLIC OF CHINA

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GB/T 2999-2016

Replacing GB/T 2999-2002

Refractory materials - Determination of bulk density of granular materials

[ISO 8840:1987, Refractory materials - Determination of bulk density of granular materials (grain density), MOD]

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Standardization Administration of the People's Republic of China.

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Foreword

This Standard was drafted in accordance with the rules given in GB/T 1.1-2009.

This Standard replaces GB/T 2999-2002 *Refractory materials - Determination of bulk density of granular materials*. Compared with GB/T 2999-2002, the major content changes are as follows:

— MODIFY the relevant contents in normative references (SEE Chapter 2 of this Standard, Chapter 2 of 2002 edition);

— MODIFY the method of wiping the immersion liquid on the surfaces of saturated test pieces (SEE Section 8.4.2 of this Standard, Section 8.4.2 of 2002 edition);

— DELETE the Annex A (SEE Annex A of 2002 edition).

This Standard was redrafted by reference to ISO 8840:1987 *Refractory materials - Determination of bulk density of granular materials (grain density)* after modification.

Compared with ISO 8840:1987, this Standard has made many structural adjustments. The contrast table for the section numbers of this Standard and ISO 8840:1987 is listed in Annex A.

There are technical differences between this Standard and ISO 8840:1987. For the list of technical differences between this Standard and ISO 8840:1987 and corresponding causes, SEE Annex B.

Some of the elements of this document may be the subject of patent rights. The issuing authorities of this document shall not be held responsible for identifying any or all such patent rights.

This Standard was proposed by and shall be under the jurisdiction of the National Technical Committee for Standardization of Refractory Materials (SAC/TC 193).

Main drafting organizations of this Standard: Central Research Institute of Building and Construction Co., Ltd, Jiaozuo Jinxin Hengtuo High-temperature Materials Co., Ltd, and Luoyang Institute of Science and Technology.

Main drafters of this Standard: Tian Zhihong, Zhang Xiuhua, Huang Jiangwen, Wang Li, Mei Minghua, Xue Hongyan, Tian Jingjing, Yang Jing, Liu Xiang and Sun Lijun.

The previous released editions substituted by this Standard are as follows:

Refractory materials - Determination of bulk density of granular materials

1 Scope

This Standard specifies two methods for the determination of the bulk density of granular refractory materials (grain density) with a grain size of larger than 2mm:

— Method 1: Weighing method;

— Method 2: Burette method.

Method 1 is intended as the referee method.

Depending on the nature of the material tested, the two methods may give different results. Any statement of the value of a bulk density shall therefore be accompanied by an indication of the method used or to be used in case of dispute. The same method shall be used for the determination of the volume of the sample, for selecting and preparing the sample, for calculating the bulk density and for presenting the test report.

This Standard **is applicable to** the determination of the bulk density, water absorption and apparent porosity of granular refractory materials.

2 Normative references

The following documents are essential to the application of this document. For dated references, only the editions with the dates indicated are applicable to this document. For undated references, only the latest editions (including all the amendments) are applicable to this document.

GB/T 2997 *Test method for bulk density, apparent porosity and true porosity of dense shaped refractory products*

GB/T 6005 *Test sieves - Metal wire cloth, perforated metal plate and electroformed sheet - Nominal sizes of openings*

GB/T 8170 *Rules of rounding off for numerical values & expression and judgement of limiting values*

8.1.5 Non-absorbent fiber cloth, such as polyester fiber cloth, nylon fiber cloth, etc.

8.1.6 Vessel.

8.1.7 Vacuum equipment: It can decrease the absolute pressure to not greater than 2,500MPa, and shall also be able to measure the absolute pressure value.

8.1.8 Immersion liquid: tap water or kerosene.

8.1.9 Mesh basket: It refers to the mesh basket with a handle, which is made of sieve with a pore diameter of 1mm.

8.1.10 Vessel with an overflow pipe.

8.1.11 Cotton gauze: The dimension is about 60cm × 60cm.

8.1.12 Weighing bottle: with a diameter of 60mm and a height of 30mm.

8.1.13 Hydrostatic balance or hydrometer: with a division value of 0.001 g/cm^3.

8.2 Test piece immersion

After weighing, carefully PLACE the test pieces on a piece of non-absorbent fiber cloth (SEE Section 8.1.5). USE a string to wrap them firmly. PLACE in a vessel (SEE Section 8.1.6). PLACE the vessel in the vacuum equipment (SEE Section 8.1.7). VACUUM until the absolute pressure is less than 2,500MPa. KEEP the test pieces at this degree of vacuum for 5min. Slowly INJECT the immersion liquid (SEE Section 8.1.8) for absorption of test pieces within 5min, until the test pieces are completely immersed. KEEP vacuuming for 5min. STOP air exhaust. TAKE out the vessel. LET it stand in air, until the liquid inside comes up to room temperature.

8.3 Determination of the apparent mass of saturated test pieces (m_2)

HANG the mesh basket (SEE Section 8.1.9) on the balance hook so that the mesh basket can completely immerse into the liquid. ZERO the balance. TAKE out the mesh basket for standby application. OPEN the wrapping cloth. Carefully SCRAPE the saturated test pieces into the mesh basket. Rapidly MOVE the mesh basket into the immersion liquid in the vessel with an overflow pipe. After the test pieces completely immerse into the immersion liquid, MOVE the mesh basket up and down for several times so that the residual bubbles can escape. HANG the mesh basket on the balance hook for weighing. ACCURATE to 0.01g.

8.4 Determination of the mass of saturated test pieces (m_3)

9.2 Determination of the test piece volume

After drying and weighing, PLACE the test pieces (SEE Chapter 7) into a beaker (SEE Section 9.1.1). ADD the immersion liquid at room temperature until the test pieces are completely submerged in it.

Before each use, REMOVE the grease in the burette (SEE Section 9.1.2). FLUSH the burette afterwards until it becomes clean. ADD the immersion liquid until it comes up to 20mL to 25mL. LET it stand for 1min. USE a magnifier (SEE Section 9.1.3) to estimate the reading to 0.05mL. PLACE a funnel (SEE Section 9.1.4) on the burette.

Before each determination, FOLD the cotton gauze (SEE Section 8.1.11) into a square which is 4 to 8 layers thick. USE immersion liquid for saturation. WRING dry the cotton gauze by hands (SEE Section 8.4.1).

SOAK the test pieces for at least 2min. COVER a piece of glass on the beaker afterwards to block the test pieces. POUR out all of the immersion liquid as far as possible. UNFOLD the wringed wet cotton gauze. PLACE the test pieces and non-absorbent fiber cloth flat on the left side of the cotton gauze to form a thin layer. FOLD the right side of the cotton gauze. COVER it on the granular test pieces. Gently PAT and PRESS to absorb the immersion liquid on the surfaces of the test pieces. TRY not to damage the edges of the granular test pieces as far as possible. Slowly OPEN the cotton gauze. PLACE the test pieces and non-absorbent fiber cloth flat on the right side of the cotton gauze. REPEAT this procedure until the grains do not adhere to each other, and the immersion liquid adhered to the grain surfaces is invisible (however, do not absorb the immersion liquid in the pores). FOLD the fabric cloth next so that the test pieces can be put into the burette through the funnel. USE a magnifier to estimate the reading of the final liquid level. ESTIMATE to 0.05mL.

The difference of the burette's final and initial readings refers to the test piece volume.

9.3 Result calculation

CALCULATE the bulk density of the test pieces according to the Equation (4):

$$\rho_R = \frac{m_1}{V_R} \qquad \cdots\cdots(4)$$

Where:

ρ_R - Bulk density of the test pieces, in unit of gram per cubic centimeter (g/cm^3);

m_1 - Mass of the dry test pieces, in unit of gram (g);

Annex B

(Informative)

Technical differences between this Standard and ISO 8840:1987 and corresponding causes

For the technical differences between this Standard and ISO 8840:1987 and the corresponding causes, SEE Table B.1.

Table B.1 Technical Differences between This Standard and ISO 8840:1987 and Corresponding Causes

Section No. of this Standard	Technical difference	Cause
2	DELETE the reference standards ISO 383, ISO 385-1 and ISO 5018 in ISO 8840:1987; USE GB/T 17617-1998 to substitute ISO 8656-1:1988; ADD the reference standards GB/T 2997, GB/T 6005 and GB/T 8170.	For the ease of use
3.2 ~ 3.3	ADD the definitions of two terms “water absorption” and “apparent mass”.	It is necessary to indicate the water absorption indicator in China’s refractory raw material product standards. Furthermore, since this Standard uses the weighing method to measure the test piece volume, it is necessary to determine the apparent mass of the test pieces during the determination.
6.1 ~ 6.2	ADD the following provision: After taking test pieces from large numbers of raw materials, DIVIDE them to 200g to 500g or so after breaking. USE two parallel test pieces instead of three. DELETE Section 6.3 of 2002 edition.	Since there are no provisions on the number of test pieces taken from large numbers of raw materials, it is not easy to operate. Furthermore, after testing under our test conditions, we believe that two parallel test pieces are enough as long as the test is conducted in strict accordance with standard procedures. The contents in Section 6.3 in this International Standard has been combined with Chapter 7 of this Standard.
7	WEIGH 40g to 60g of test pieces instead of 50g.	After verifying by the test, 40g to 60g is suitable in actual operations.
8	USE weighing method to replace the mercury method with vacuum.	There are following disadvantages in the mercury method with vacuum: (1) Mercury causes environmental pollution; (2) It is difficult to clean up

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