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Replacing GB/T 5072-2008

**Refractory Products - Determination of Cold Compressive
Strength**

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[ISO 8895:2004 Shaped Insulating Refractory Products - Determination of Cold
Crushing Strength; ISO 10059-1:1992 Dense, Shaped Refractory Products -
Determination of Cold Compressive Strength - Part 1: Referee Test without Packing
& ISO 10059-2:2003 Dense, Shaped Refractory Products - Determination of Cold
Compressive Strength - Part 2: Test with Packing, MOD]

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Foreword

This document was drafted in accordance with the rules provided in GB/T 1.1-2020 *Directives for Standardization - Part 1: Rules for the Structure and Drafting of Standardizing Documents*.

This document serves as a replacement of GB/T 5072-2008 *Refractory Products - Determination of Cold Compressive Strength*. In comparison with GB/T 5072-2008, apart from structural adjustments and editorial modifications, the main technical changes are as follows:

- a) The Scope is modified (see Chapter 1; Chapter 1 of Version 2008);
- b) In the Principle chapter, “until it is broken or compressed to 90% of the former height” is modified to “until it is broken or compressed to 90% of the original height”; “average cross-sectional area under pressure” is modified to “average pressure surface area” (see Chapter 4; Chapter 4 of Version 2008);
- c) Some requirements for the pressure plate are modified, and the content of the note is modified to the main text (see 5.1; 5.1 of Version 2008);
- d) Technical requirements for the micrometer, triangular plate, feeler gauge and steel ruler are added, and requirements for the hardened filter paper are also added (see 5.2, 5.4, 5.5, 5.8, 5.9);
- e) The sampling and preparation contents of the test sample for the test without packing are added (see 6.1.1, 6.1.2);
- f) The content of the note is modified to the main text (see 6.1.4; 6.1.2 of Version 2008);
- g) The requirements for the range of the testing machine during the test are deleted (see 6.2 and 7.3.3 of Version 2008);
- h) The test contents of the amorphous test sample are deleted (see Chapters 7 and 8 of Version 2008);
- i) The sampling and preparation requirements of the test sample for the test with packing are modified (see 7.2.1 and 7.2.2; 7.2.1 of Version 2008);
- j) The size of half a standard brick is added [see 7.2.3 d)];
- k) “The test sample shall be cut or drilled from the product, and the pressure surface of the test sample shall be as parallel as possible and as perpendicular to the pressure direction as possible.” is deleted (see 7.2.4 of Version 2008);
- l) The area size of the packing plate is modified (see 7.3.2; 7.3.2 of Version 2008);

Refractory Products - Determination of Cold Compressive Strength

1 Scope

This document specifies the principle, instruments and equipment, test samples, test steps, result calculation and test report of the determination of cold compressive strength for refractories.

This document is applicable to the determination of cold compressive strength for dense shaped refractory products and shaped insulating products.

2 Normative References

The contents of the following documents constitute indispensable clauses of this document through the normative references in the text. In terms of references with a specified date, only versions with a specified date are applicable to this document. In terms of references without a specified date, the latest version (including all the modifications) is applicable to this document.

GB/T 7321 Sample Preparation for Testing of Shaped Refractory Products

GB/T 8170 Rules of Rounding off for Numerical Values & Expression and Judgement of Limiting Values

GB/T 10325 Shaped Refractory Products - Sampling and Acceptance Testing (GB/T 10325-2012, ISO 5022:1979, NEQ)

GB/T 18930 Terminology for Refractories (GB/T 18930-2020, ISO 836:2001, MOD)

3 Terms and Definitions

The terms and definitions defined in GB/T 18930 and the following ones are applicable to this document.

3.1 Cold Compressive Strength

The ultimate pressure per unit area that a refractory can withstand before it is damaged when pressurized under specified conditions at room temperature.

[Source: 2.5.10 of GB/T 18930-2020].

3.2 Dense Shaped Refractory Product

A refractory product with a true porosity of less than 45% and a certain size.

[Source: 2.2.26 of GB/T 18930-2020].

3.3 Shaped Insulating Product

A shaped refractory with a true porosity of not less than 45%.

[Source: 2.2.56 of GB/T 18930-2020].

4 Principle

Under specified conditions, a load is applied to a test sample of known size at a constant pressure rate until it is broken or compressed to 90% of the original height, and the maximum load is recorded. The cold compressive strength is calculated based on the maximum load and the average pressure surface area of the test sample.

5 Instruments and Equipment

5.1 Compression Testing Machine

A device capable of measuring the pressure applied to the test sample shall be equipped, with an indication error within $\pm 2\%$. The testing machine shall be able to apply load evenly at a specified rate. The range of the testing machine shall meet the requirement that the expected breaking load value applied to the test sample is greater than 10% of the force sensor range.

The pressure plate of the testing machine shall meet the following requirements:

- a) The Rockwell hardness is greater than 58 HRC;
- b) The flatness error of the contact surface with the test sample is 0.03 mm;
- c) The surface roughness (average roughness value Ra) is $0.8\ \mu\text{m} \sim 3.2\ \mu\text{m}$.

Both pressure plates of the testing machine shall be ground. The upper pressure plate shall be mounted on a spherical seat to compensate for the slight deviation between the parallelism of the test sample and the pressure plate. The lower pressure plate shall be engraved with marks to facilitate the placement of the test sample in the center of the pressure plate. When the bearing surface size (diameter or side length, see 6.1.3 and 7.2.3) of the test sample is less than 50 mm, the area of the upper pressure plate should not exceed $100\ \text{cm}^2$. When the size of the upper pressure plate does not meet the above requirements of the testing machine, an auxiliary test sample adapter (see Figure 1) can be used in conjunction with it and mounted in the center of the upper and lower pressure plates of the testing machine. The adapter pressure plate shall meet the requirements of a) to c) and have a thickness of at least 10 mm.

5.6 Drying oven, with temperature controlled at $110^{\circ}\text{C} \pm 5^{\circ}\text{C}$.

5.7 Packing plate, non-corrugated cardboard or hardboard with a thickness of 3 mm ~ 7 mm.

5.8 Steel ruler, with a graduation value of 0.5 mm.

5.9 Hardened filter paper, with a thickness of 0.15 mm.

6 Method 1: Compressive Strength of Dense Shaped Refractory Products - Referee Test without Packing (Arbitration method)

6.1 Test Sample

6.1.1 Sampling shall be carried out in accordance with GB/T 10325, and the sampling plan may also be determined by negotiation between the relevant parties.

6.1.2 The test sample preparation shall be carried out in accordance with the provisions of GB/T 7321. Prepare one test sample from each brick. The number of test samples can also be determined by negotiation between the two parties and noted in the test report.

6.1.3 The test sample is a cylinder with a diameter of $50\text{ mm} \pm 0.5\text{ mm}$ and a height of $50\text{ mm} \pm 0.5\text{ mm}$. If the size of the test sample does not meet the requirements, a cylinder with a diameter of $36\text{ mm} \pm 0.3\text{ mm}$ and a height of $36\text{ mm} \pm 0.3\text{ mm}$ may also be used.

6.1.4 The test sample shall be drilled from the product's molded pressure surface. When preparing the sample, the original position of the test sample in the product shall be recorded. Test samples with cracks or obvious defects shall be recorded and discarded.

The pressure surfaces at both ends of the cylindrical test sample shall be ground flat and kept parallel to each other. To ensure the flatness of the upper and lower pressure surfaces of the test sample, press each end face one by one on a horizontal plate lined with carbon paper and hardened filter paper with a pressure of $3\text{ kN} \pm 1\text{ kN}$. If the indentation on the pressure surface is incomplete or unclear, it shall be re-ground (see Figure 2 to Figure 5).

A steel ruler can be used to assist in checking the surface. Fire clay shall not be used to smooth the surface.

7 Method 2: Compressive Strength of Dense Shaped Refractory Products - Test with Packing

7.1 General

This method is only applicable to daily quality control and not to testing the true value of the cold compressive strength. Method 1 shall be used to determine the true value of the cold compressive strength.

NOTE 1: The test results of test samples of different sizes cannot be directly compared.

NOTE 2: The test results of this method cannot be directly compared with those of Method 1.

7.2 Test Sample

7.2.1 Sampling shall be carried out in accordance with GB/T 10325, and the sampling plan may also be determined by negotiation between the relevant parties.

7.2.2 The test sample preparation shall be carried out in accordance with the provisions of GB/T 7321. Prepare one test sample from each brick. The number of test samples can also be determined by negotiation between the two parties and noted in the test report.

7.2.3 The size of the test sample is one of the following:

- a) A cylinder with a diameter of $50\text{ mm} \pm 2\text{ mm}$ and a height of $50\text{ mm} \pm 2\text{ mm}$;
- b) A cube with a side length of $50\text{ mm} \pm 2\text{ mm}$;
- c) A cube with a side length of $65\text{ mm} \pm 2\text{ mm}$ or $75\text{ mm} \pm 2\text{ mm}$;
- d) Half a standard brick, $114\text{ mm} \times 114\text{ mm} \times 75\text{ mm}$ or $114\text{ mm} \times 114\text{ mm} \times 65\text{ mm}$.

If the size of the test sample cannot meet the above requirements, use the largest possible cylinder (height equal to diameter) or cube.

7.2.4 The test sample shall be cut or drilled from the pressure surface of the product so that the pressure direction during the test is consistent with the pressure direction of molding (except in special cases). Test samples with cracks or obvious defects shall be recorded and discarded.

7.2.5 The parallelism of the pressure surface of the test sample is checked by measuring the height values at 4 points. For cylindrical test samples, the measuring points are located at both ends of the two diameters that are perpendicular to each other. For cubic test samples, the measuring point is located in the middle of the four sides of the pressure surface. The height difference between any two measuring points shall not exceed 2% of the height.

7.2.6 Check the verticality of the test sample. Place the test sample and one right-angled side of the triangular plate on a horizontal workbench at the same time, and use a feeler gauge to measure the gap between the other right-angled side of the triangular plate and the four height measuring points of the test sample. Each measurement shall not exceed 2% of the height.

7.2.7 Place the prepared test sample in a drying oven at $110^{\circ}\text{C} \pm 5^{\circ}\text{C}$ and dry to constant weight. Then cool the test sample to room temperature in a desiccator for later use to prevent moisture.

7.3 Test Steps

7.3.1 Use a vernier caliper to measure the two mutually perpendicular diameters or midlines of the two pressure surfaces of the test sample, and accurate to 0.1 mm. According to the average of the four diameters or midline measurements of the two pressure surfaces, calculate the average pressure surface area A_0 .

7.3.2 Install the test sample at the center of the upper and lower pressure plates or adapters of the testing machine. Insert a packing plate between each pressure surface of the test sample and the pressure plate, and the packing plate shall extend at least 10 mm beyond the edge of the pressure surface.

7.3.3 Apply load continuously and evenly at a rate of $1.0 \text{ MPa/s} \pm 0.1 \text{ MPa/s}$ until the test sample breaks, that is, until the test sample cannot withstand the load. Record the maximum load indicated.

8 Method 3: Determination of Compressive Strength of Shaped Insulating Products

8.1 Test Sample

8.1.1 Sampling shall be carried out in accordance with GB/T 10325, and the sampling plan may also be determined by negotiation between the relevant parties.

8.1.2 The test sample preparation shall be carried out in accordance with the provisions of GB/T 7321. Prepare one test sample from each brick. The number of test samples can also be determined by negotiation between the two parties and noted in the test report.

8.1.3 Each test sample is usually half a standard brick, such as $114 \text{ mm} \times 114 \text{ mm} \times 75 \text{ mm}$ or $114 \text{ mm} \times 114 \text{ mm} \times 65 \text{ mm}$. The pressure surface is $114 \text{ mm} \times 114 \text{ mm}$.

8.1.4 For products of special shapes, dry-cut test samples according to any size specified in 8.1.3.

NOTE: If possible, indicate the relationship between the loading direction and the compression molding direction of the test sample in the test report.

$$\sigma = \frac{F_{\max}}{A_0} \dots\dots\dots (1)$$

Where:

σ -- Cold compressive strength, in megapascals (MPa);

$F_{\max}$ -- The maximum load during the test, in Newtons (N);

A_0 -- Average pressure surface area of the test sample, in square millimeters (mm²).

For dense shaped refractory products, the results shall be retained to 3 significant figures; for shaped insulating products, the results shall be retained to 2 decimal places. The numerical rounding shall be carried out in accordance with GB/T 8170.

10 Test Report

The test report shall include the following contents:

- a) Sample description (manufacturer, brand, material, size, etc.);
- b) Number of samples;
- c) The number of test samples taken from each sample and the size of the test sample;
- d) Sampling location and pressure direction;
- e) Location of defective test samples;
- f) Number of this document;
- g) Indicate the loading rate for shaped insulating products;
- h) Strength value of each test sample;
- i) The average strength value of each sample [different from the value in Item h)] and the average strength value of the batch of samples;
- j) Differences from the prescribed test procedures (if necessary);
- k) Abnormal phenomena observed during the test (if necessary);
- l) Test personnel; and
- m) Test date.

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