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NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

GB/T 13241-2017

Replacing GB/T 13241-1991

Iron ores - Determination of reducibility

铁矿石 还原性的测定方法

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1 Scope

GB/T 13241-2017 is the Chinese national standard on iron ores - determination of reducibility, in the field of mining and minerals. The /T suffix marks it as a recommended standard: it is not compulsory by itself, but it becomes binding as soon as a contract, a tender or a customer specification calls it up - which in practice is how most foreign buyers meet it. It was issued on 7 September 2017 by the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China; Standardization Administration of China, and has been in force since 1 June 2018. Classification: ICS 73.060.10, CCS D31. This page is published from the official record of the standard held by the Chinese standards administration: the identification, the dates, the classification and the issuing body are taken from there. The clause text, the tables and the numeric limits are in the document itself, which is delivered complete in English translation.

This Standard specifies the test conditions, test equipment, specimen preparation, test steps, result calculation and test report for determination of reducibility of iron ores. NOTE: The characteristics of the specified test method are: In a fixed bed, use a mixed gas of CO and N2 to conduct isothermal reduction. The specimen has a certain size range. This Method is applicable to the determination of the reducibility of iron ores (including natural iron ore, sintered ore, pellet ore, hereinafter referred to as iron ore) expressed in terms of

reduction degree and reduction rate.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 6003.1, Test sieves - Technical requirements and testing - Part 1: Test sieves of metal wire cloth

GB/T 6003.2, Test Sieves - Technical Requirements and Testing - Part 2: Test Sieves of Perforated Metal Plate

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

GB/T 6730.5, Iron ores - Determination of total iron content - Titanium (III) chloride reduction methods

GB/T 6730.8, Iron ores - Determination of iron (II) content - Potassium dichromate titrimetric method

5 Test conditions

5.1 General conditions The gas volume and flow rate used in this Standard adopt the volume and flow rate in the standard state (0°C and 101.325kPa).

5.3 Purity of reducing gas (volume fraction) CO>=99.9% N2>=99.99%

5.4 Reduction gas flow During the whole test period, the standard flow rate of the reducing gas shall be maintained at 15L/min±0.5L/min.

5.5 Test temperature The iron ore sample is subjected to isothermal reduction at 900°C. During the entire test, the temperature of the gas entering the material layer is maintained at 900°C±5°C.

6 Test equipment

6.1 Gas purification and configuration system The gas purification and configuration system include:

a) N2 mass flow controller: range is 20L/min, accuracy is not less than ±1.5%F.S.

b) CO mass flow controller: range is 5L/min, accuracy is not less than ±1.5%F.S.

c) Gas washing + gas distribution chamber volume: <=5L. (When the CO generator is used to generate CO, the CO purification system is excluded.) The mass flow controller is

calibrated at least once a year. Where there is no bottled CO, it can refer to the CO generator and purification system in Annex A

6.6.5 Counting machine: particle size range Phi10.0mm~Phi12.5mm.

7 Specimen preparation

7.1 Sampling and preparation Test specimen shall be sampled and prepared in accordance with the provisions of GB/T 10322.1. Test specimen shall be dried at 105°C±5°C. Drying time is not less than 2h, then cooled to room temperature and stored in a desiccator.

7.2 Specimen for reduction test

7.2.1 Total amount of specimen The total amount of test specimen is not less than 2.5kg, calculated on a dry basis.

7.2.2 Pellet mine The specimen with a particle size range of 10.0mm~12.5mm obtained by screening is not less than 2.5kg.

7.2.3 Natural iron ore and sinter Sieve out specimens larger than 12.5mm. And carefully break the part larger than 12.5mm. Until all passes the 16.0mm sieve. Then combine the parts for screening. Screen out the parts larger than 12.5mm and less than 10.0mm from specimens. Then mix the obtained 10.0mm~12.5mm specimen. Ensure that the specimen of 10.0mm~12.5mm is not less than 2.5kg.

7.3 Division of test material The specimen is divided into 4 parts by a divider. Take 100g of each part and mix them into a specimen, about 400g, as the specimen for measuring TFe and FeO. The rest are kept in separate seals and used as reducibility test specimens.

8 Test steps

8.1 Experiment determination times For the same specimen, it shall at least conduct the test twice.

8.2 Amount of test material 7 - Reducing gas regulator; 8 - Flowmeter; 9 - System control cabinet; 10 - Three-point temperature control thermocouple; 11 - Thermogravimetric balance; 12 - Lower heating section; 13 - Middle heating section; 14 - Upper heating section; 15 - Reduction furnace body; 16 - Electric lifting mechanism; 17 - Reaction tube. Figure 4 -- Process flow chart of iron ore medium temperature reduction experiment

8.3.2 The reduction furnace starts to heat up. Heating rate shall not be greater than 10°C/min. At 200°C ~900°C, it is protected by nitrogen and the flow rate is 5L/min. At 900°C, increase the nitrogen flow to 15L/min. At a constant temperature 30min. Weigh the total mass of the test material and reduction tube, to the nearest of 0.1g. Record as m1. Then, replace the protective nitrogen with 15L/min±0.5L/min reducing gas and reduce it for 180min. Use thermogravimetric balance to continuously record the total mass of test

material and reduction tube during the reduction process, to the nearest of 0.1. Record as mt. During the reduction process, ensure that the temperature of the gas entering the test material layer and the overall temperature of the test material layer are kept within 900°C±5°C.

8.3.3 After the reduction is completed, cut off the reducing gas. Access with nitrogen at a flowrate of 15L/min. Eliminate reducing gas in test equipment pipeline and reaction tube. After 5min, turn off the nitrogen, the reduction tube comes out, and the test is over.

9 Result calculation

9.1 Calculation of degree of reduction degree Use formula (1) to calculate the degree of reduction Rt at time t. When calculating Rt, t is 180min. Based on the state of trivalent iron, express in mass fraction (%). Where, K - Constant that depends on y (%). When y is 50%, K = 20.0; when y is 55%, K = 26.5. NOTE 1: Atomic ratio O/Fe=0.9, equivalent to a reduction degree of 40%. NOTE 2: See Annex B for the derivation of the formula.

9.3 Tolerance and test times Tolerance of reduction index RI: For a pair of test results, the difference between the two results, not more than 5% (absolute value) for sintered ore, not more than 3% (absolute value) for pellet ore and the one for natural ore shall be agreed between the supplier and the purchaser. If the difference between the two results is within the above range, the test can be ended. If it is not within the above range, it shall be carried out according to the procedures specified in Annex C.

9.4 Expression of final results The reduction index RI shall be reported according to the average number of experimental results as specified in Annex C, in %, to the nearest of one decimal place, rounded off according to GB/T 8170. The value of the test result of reduction velocity index RVI is consistent with the value of reduction index RI and shall be reported by its average, in %/min, to the nearest of 0.01%/min. Use the 3h reduction index RI as the evaluation index, the reduction velocity index RVI as a reference index.

10 Test report

The test results of this Standard shall be considered in conjunction with other tests, especially those indicating other metallurgical properties of iron ore during reduction. The test report shall contain the following information:

a) Test organization;

b) Date of test report;

c) Reference to this Standard;

d) Specimen description (including total iron and ferrous content before reduction);

e) Test material mass and number of particles;