INTERNATIONAL STANDARD

ISO 3852

Third edition
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Iron ores for blast furnace and direct reduction feedstocks — Determination of bulk density

Minerais de fer pour charges de hauts fourneaux et pour procédés par réduction directe — Détermination de la masse volumique apparente

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 3852 was prepared by Technical Committee ISO/TC 102, *Iron ore and direct reduced iron*, Subcommittee SC 3, *Physical testing*.

This third edition cancels and replaces the second edition (ISO 3852:1988), which has been revised to homogenise with other physical test standards.

Introduction

This is one of a number of physical test methods that have been developed to measure various physical parameters and to evaluate the behaviour of iron ores including reducibility, disintegration, crushing strength, apparent density, etc. This method was developed to provide a uniform procedure, validated by collaborative testing, to facilitate comparisons of tests made in different laboratories.

The results of this test should be considered in conjunction with other tests used to evaluate the quality of iron ores as feedstocks for blast furnace and direct reduction processes.

This International Standard may be used to provide test results as part of a production quality-control system, as a basis of a contract, or as part of a research project.

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CAUTION — This International Standard may involve hazardous operations and equipment. This International Standard does not purport to address all of the safety issues associated with its use. It is the responsibility of the user of this International Standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to its use.

1 Scope

This International Standard specifies two methods of determining the bulk density of iron ores.

Method 1 is applicable to natural iron ore and processed iron ore having a nominal top size of 40 mm.

Method 2 is applicable to any natural iron ores and processed ores, regardless of size.

NOTE The measured density does not necessarily represent the bulk density of compacted or stockpiled iron ores.

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.

ISO 3082:2000, *Iron ores — Sampling and sample preparation procedures*[1)]

ISO 3087:1998, *Iron ores — Determination of moisture content of a lot*

ISO 4701:—[2)], *Iron ores and direct reduced iron — Determination of size distribution by sieving*

ISO 11323:2002, *Iron ore and direct reduced iron — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 11323 apply.

4 Principle

A test portion is introduced into a container of known volume until its surface is level. The bulk density is calculated as the ratio of the mass of the sample to the internal volume of the container.

1) Under revision to incorporate ISO 10836, *Iron ores — Method of sampling and sample preparation for physical testing*.

2) To be published. (Revision of ISO 4701:1999)

5 Sampling, sample preparation and preparation of test portions

5.1 Sampling and sample preparation

In the case of method 1, sampling of a lot and preparation of a test sample shall be in accordance with ISO 3082. A test sample of at least 600 kg of natural and processed iron ore shall be obtained.

The test sample may be carried out using an as-received, air-dried or oven-dried sample. If the test is made on an oven-dried basis, dry the sample to constant mass at 105 °C ± 5 °C and cool it to room temperature before preparation of the test portions.

NOTE 1 Constant mass is achieved when the difference in mass between two subsequent measurements becomes less than 0,05 % of the initial mass of the test sample.

In the case of method 2, the test sample shall have a minimum mass of 35 tonnes, the recommended mass being 50 tonnes.

NOTE 2 A test sample of mass 35 tonnes has a volume of approximately 14 m^3 to 23,6 m^3, according to the material.

5.2 Preparation of test portions

In the case of method 1, the test portions shall be obtained from the test sample using the division methods given in ISO 3082.

At least 4 test portions, each of 150 kg ± 0,15 kg, shall be prepared from the test sample.

In the case of method 2, the test sample itself is used as a test portion.

6 Apparatus

6.1 General

The test apparatus shall comprise

a) ordinary laboratory equipment, such as an oven, hand tools and safety equipment,

b) small container,

c) large container, and

d) a weighing device.

6.2 Method 1

6.2.1 Small container, made of metal, cylindrical in form, and having an internal diameter of 400 mm ± 2 mm and an internal height of 400 mm ± 2 mm (inner volume: approximately 0,05 m^3). The container wall and bottom shall have sufficient thickness to ensure their rigidity during the test. The container shall be reinforced by a steel band around the outside periphery at the top, and shall have two handles, 180° apart, attached to the outer surface by welding. A carriage or other suitable device may be provided to facilitate its transportation within the laboratory. The volume of the container shall be determined with a precision of 0,1 L using potable water of known density.

6.2.2 Weighing device, capable of weighing the test sample and test portions and having a sensitivity of 1/1 000 or better.

6.3 Method 2

6.3.1 Large container, such as a truck or railway wagon, of regular geometrical shape, with smooth inner surfaces of the walls and bottom, and in good general condition. The container shall have sufficient capacity to hold, when filled, a minimum of 10 t of test sample and a minimum height of the test sample bed of 500 mm. The minimum length, width and height shall be 10 times the maximum particle size of the test portion.

6.3.2 Weighing device, preferably of platform type, capable of weighing the mass to be determined to a sensitivity of $1/200$.

7 Procedure

7.1 Number of determinations for the test

Carry out the test as many times as required by Annex A. Simultaneously with the test, the moisture content and the size distribution should be determined in accordance with the procedures specified in ISO 3087 and ISO 4701, respectively.

7.2 Density determination

7.2.1 Method 1 — Small container

Weigh the dried container (6.2.1) and record the mass (m_0) to the nearest 0,2 kg.

Fill the container with the sample of as-received, air-dried or oven-dried material, using a proper shovel. Empty the shovel from a height not exceeding 50 mm above the surface of the material in the container. Fill the container carefully, in order to prevent evident segregation.

After filling the container to overflowing, draw a straight-edge across the top of the container to make the heaped surface level.

Transfer the filled container to the weighing device (6.2.2) without loss of sample from the container. Weigh the filled container and record the mass (m_1) to the nearest 0,2 kg.

7.2.2 Method 2 — Large containers

Measure the length, width and height of the container (6.3.1) with a precision of $\pm$0,5 % and then calculate and record its volume (V). Weigh the empty container and record the mass (m_0).

With the container on a level surface, discharge the sample into it manually or by mechanical means, taking care to avoid breakage or segregation of particles. Level off the upper surface across the top of the container, verifying by visual inspection and removing or pushing down any particles which would appear to obstruct the passage of a straight-edge if it were pulled across the top of the container.

Weigh the filled container and record the mass (m_1).

8 Expression of results

8.1 Calculation of the bulk density (ρ_{ap})

The bulk density, ρ_{ap}, expressed in kg/m^3, is calculated from the following formula:

$$\rho_{ap} = \frac{m_1 - m_0}{V}$$