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Iron ores — Determination of bulk density

Minerais de fer — Détermination de la masse volumique apparente

Reference number
ISO 3852 : 1988 (E)

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 3852 was prepared by Technical Committee ISO/TC 102, *Iron ores.*

This second edition cancels and replaces the first edition (ISO 3852 : 1977) and ISO 5464 : 1980, and includes the determination of bulk density for particles greater than 40 mm.

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Iron ores — Determination of bulk density

1 Scope

This International Standard specifies two methods for measuring the bulk density of natural and processed iron ores.

Method 1 is applicable to iron ores having a maximum particle size of 40 mm or smaller.

Method 2 is applicable to iron ores having any maximum particle size.

NOTE — The measured bulk density does not necessarily represent the bulk density of compacted or piled-up natural and processed iron ores.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3081 : 1986, *Iron ores — Increment sampling — Manual method.*

ISO 3082 : 1987, *Iron ores — Increment sampling and sample preparation — Mechanical method.*

ISO 3083 : 1986, *Iron ores — Preparation of samples — Manual method.*

ISO 3087 : 1987, *Iron ores — Determination of moisture content of a consignment.*

ISO 4701 : 1985, *Iron ores — Determination of size distribution by sieving.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 maximum particle size: The particle size expressed in terms of the aperture of the sieve on which approximately 5 % (m/m) of an iron ore is retained.

3.2 bulk density: The mass in air of a unit volume of an iron ore, including the voids within and between the particles.

4 Apparatus

4.1 Method 1

4.1.1 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 shall be constructed of metal of sufficient thickness to ensure the rigidity of the walls and the base of the container under the conditions of 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 transportation of the container within the laboratory.

The volume of the container, V, in litres, shall be determined with a precision of 0,1 litre using potable water of known density.

4.1.2 Weighing device, having a sensitivity of 1/1 000 or better, and a capacity adequate for the masses to be determined.

4.1.3 Drying oven, suitably ventilated, capable of being controlled at 105 °C ± 5 °C and of sufficient size to accommodate the test sample.

4.1.4 Increment shovel, No. 50, as specified in table 6 of ISO 3081.

4.2 Method 2

4.2.1 Container(s), 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 tonnes of sample and a minimum height of the sample bed of 500 mm. The minimum length, width and height of the containers should be 10 times the maximum particle size of the sample.

4.2.2 Weighing device, preferably of the platform type, having a sensitivity of 1/200 or better and a capacity adequate for the masses to be determined.

5 Sample

The sample shall be representative of the ore and should be taken and prepared in accordance with the procedure agreed upon between the parties concerned.

NOTE — Principles of ISO 3081, ISO 3082, and/or ISO 3083 should be respected in taking and preparing samples according to the purposes of the test.

The quantity of sample should be sufficient to fill the container three times, with a small overflow, and to provide for the determination of size distribution and moisture content, the two main factors which affect bulk density.

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

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

6 Procedure

Carry out the test in duplicate in both methods. Simultaneously with the test, the moisture content and the size distribution should be determined in accordance with the procedure specified in ISO 3087 and ISO 4701, respectively.

6.1 Method 1

The test 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 at 105 °C ± 5 °C to constant mass.

6.1.1 Weigh the dried container (4.1.1) and record the mass, m_0, to the nearest 0,2 kg.

6.1.2 Fill the container with the sample of as received, air-dried or oven-dried material, using the shovel (4.1.4). 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.

6.1.3 Transfer the filled container to the weighing device (4.1.2) without loss of sample from the container. Weigh the filled container and record the mass, m_1, to the nearest 0,2 kg.

6.1.4 Repeat the test on a further charge of material or by recharging the same material, using the same container.

6.2 Method 2

6.2.1 Measure the length, width and height of the container (4.2.1) with a precision of ± 0,5 % and then calculate and record its volume, V. Weigh the empty container and record the mass, m_0.

6.2.2 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.

6.2.3 Weigh the filled container and record the mass, m_1.

6.2.4 Repeat the test using the same or a second container of similar capacity, which also has been determined according to 6.2.1.

7 Expression of results

7.1 Calculation

The bulk density, ϱ_{ap}, expressed in kilograms per cubic metre, is given by the equation

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

where

m_0 is the mass, in kilograms, of the empty container;

m_1 is the mass, in kilograms, of the container plus sample;

V is the volume, in cubic metres, of the container.

Round off the result to four significant figures.[1)]

NOTE — The SI unit for density is kg/m^3. However the use of units outside the SI which are accepted by the CIPM will be practical under certain circumstances. If the unit tonne/m^3 is used, the result of the test should be expressed to two decimal places.

1 000 kg/m^3 = 1 tonne/m^3 = 1 kg/l

7.2 Repeatability and acceptance of test results

The difference between the results of duplicate tests shall not differ by more than the value given in the table.

Table — Repeatability of the test

Method	Repeatability
1	5 % relative to the mean value
2	100 kg/m^3

1) Annex B *(Guide for the rounding of numbers)* to ISO 31-0 : 1981, should be applied.