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Iron ores for blast furnace and direct reduction feedstocks — Determination of the tumble and abrasion indices

Minerais de fer pour charges de hauts fourneaux et pour procédés par réduction directe — Détermination des indices de cohésion et d'abrasion

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information.

The committee responsible for this document is ISO/TC 102, *Iron ore and direct reduced iron*, Subcommittee SC 3, *Physical testing*.

This fifth edition cancels and replaces the fourth edition (ISO 3271:2007), of which it constitutes a minor revision to contemplate the care needed during hand sieving, to introduce the mechanical sieving, and to exclude the reference to ISO 4701.

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Introduction

This International Standard concerns 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 have to 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 can 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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Iron ores for blast furnace and direct reduction feedstocks — Determination of the tumble and abrasion indices

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 determine the applicability of regulatory limitations prior to its use.

1 Scope

This International Standard specifies a method to provide a relative measure for evaluating the resistance of iron ores to size degradation by impact and abrasion. It covers the determination of the tumble and abrasion indices.

This International Standard is applicable to lump ores, sinters, and hot-bonded pellets.

2 Normative references

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

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ISO 3082, *Iron ores — Sampling and sample preparation procedures*

ISO 3310–1, *Test sieves — Technical requirements and testing — Part 1: Test sieves of metal wire cloth*

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ISO 3310–2, *Test sieves — Technical requirements and testing — Part 2: Test sieves of perforated metal plate*

ISO 11323, *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

The test portion is tumbled in a circular drum for a total of 200 revolutions, at 25 r/min. The product material is sieved with test sieves having square openings of 6,30 mm and 500 µm. The tumble index is expressed as the mass percentage of material greater than 6,30 mm and the abrasion index as the mass percentage of material less than 500 µm.

5 Sampling, sample preparation, and preparation of test portions

5.1 Sampling and sample preparation

Sampling of a lot and preparation of a test sample shall be in accordance with ISO 3082.

The size range for pellets shall be −40,0 mm + 6,30 mm.

The size range for sinters and lump ores shall be −40,0 mm + 10,0 mm.

A test sample of at least 60 kg, on a dry basis, of the sized material shall be obtained.

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Oven-dry the test sample to constant mass at 105 °C ± 5 °C and cool it to room temperature before preparation of the test portions.

NOTE 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.

5.2 Preparation of test portions

The test portions shall be obtained from the test sample using the division methods given in ISO 3082.

For pellets, at least four test portions, each of 15 kg ± 0,15 kg mass shall be prepared.

For sinters and lump ores, the test sample shall be separated into four fractions by sieving through 25,0 mm, 16,0 mm, and 10,0 mm sieves. From the material on the three sieves, at least four test portions, each of 15 kg ± 0,15 kg mass, shall be reconstituted by taking a proportionate mass of material from each of the fractions. Register the mass of each test portion on its recipient label.

6 Apparatus

6.1 General

The test apparatus shall comprise the following:

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

b) tumble drum and rotation equipment;

c) test sieves;

d) weighing device.

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6.2 Tumble drum, made of steel plate at least 5 mm in thickness, having an internal diameter of 1 000 mm and an internal length of 500 mm. Two equally spaced L-shaped steel lifters 50 mm flat × 50 mm high × 5 mm thick and 500 mm long shall be solidly attached longitudinally inside the drum by welding, in such a manner as to prevent accumulation of material between the lifter and drum. Each lifter shall be fastened so that it points towards the axis of the drum, with its attached leg pointing away from the direction of rotation, thus providing a clear unobstructed shelf for lifting the sample. The door shall be so constructed as to fit into the drum to form a smooth inner surface. During the test, the door shall be rigidly fastened and sealed to prevent loss of the sample. The drum shall be rotated on stub axles attached to its ends by flanges welded so as to provide smooth inner surfaces. The drum shall be replaced, in any case, when the thickness of the plate is reduced to 3 mm in any area. The lifters shall be replaced when the height of the shelf is reduced to less than 47 mm.

Figure 1 shows an example of a tumble drum.

6.3 Drum rotation equipment, capable of ensuring that the drum attains full speed in one revolution, rotates at a constant speed of 25 r/min ± 1 r/min, and stops within one revolution. The equipment shall be fitted with a revolution counter and with an automatic device for stopping the drum after a predetermined number of revolutions.

6.4 Test sieves, conforming to ISO 3310–1 or ISO 3310–2 and having square apertures of the following nominal sizes: 6,30 mm and 500 µm.

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

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7 Procedure

7.1 Number of determinations for the test

Carry out the test as many times as required by the procedure in Annex A.

7.2 Tumbling

Take, at random, one of the test portions prepared in 5.2, record its mass (m_0), and place it in the tumble drum (6.2). Tightly fasten the door and rotate the drum at 25 r/min ± 1 r/min for a total of 200 revolutions. Stop the drum and keep the door fastened for at least 2 min before opening, to allow the dust to settle.

DANGER — Tumbling can be noisy and care should be taken to protect the hearing of the operator.

It is recommended that putty or modelling clay be used to seal the door to prevent the loss of fines from the drum.

7.3 Sieving

Remove all the material carefully from the drum and hand sieve it with care on the 6,30 mm and 500 µm sieves (6.4). Determine and record the mass of each fraction retained on the 6,30 mm (m_1) and 500 µm (m_2) sieves to the nearest 0,1 g. Material lost during sieving shall be considered to be part of the −500 µm fraction.

NOTE 1 Scalping sieves can be used to lessen the load on the critical sieves.

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NOTE 2 Equivalent mechanical sieving can be used provided that preliminary test programme is carried out according to ISO 3086, being the hand sieving the reference method.

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NOTE 3 Sieving results are influenced by the sieve shaker characteristics. Therefore, in cases in which two or more laboratories need to compare their results for commercial or research purposes, they can adjust the sieving conditions until they obtain identical results for the same test sample.

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The difference between the initial mass of the test portion and the total mass of the fractions shall not exceed 1,0 %. If this difference exceeds 1,0 %, the test shall be rejected.

8 Expression of results

8.1 Calculation of the tumble index (TI) and abrasion index (AI)

The tumble index, TI, and the abrasion index, AI, expressed as percentages by mass, are calculated from Formula (1) and Formula (2), respectively:

$$\mathrm{TI} = \frac{m_1}{m_0} \times 100 \tag{1}$$

$$\mathrm{AI} = \frac{m_0 - \left(m_1 + m_2\right)}{m_0} \times 100 \tag{2}$$

where

m_0 is the mass, in kilograms, of the test portion as weighed out and placed in the tumble drum;

m_1 is the mass, in kilograms, of +6,30 mm fraction of the tumbled test portion;

m_2 is the mass, in kilograms, of −6,30 mm + 500 µm fraction of the tumbled test portion.

Record each result to one decimal place.

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