INTERNATIONAL STANDARD

ISO 7992

Fourth edition
2022-05

Iron ores for blast furnace feedstocks — Determination of reduction under load

Minerais de fer pour charges de hauts fourneaux — Détermination de la réduction sous charge

Reference number
ISO 7992:2022(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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.

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This fourth edition cancels and replaces the third edition (ISO 7992:2015), which has been technically revised to adjust the apparatus described in the previous edition according to the original text.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document 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 processes.

This document 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.

Iron ores for blast furnace feedstocks — Determination of reduction under load

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

1 Scope

This document specifies a method to provide a relative measure for evaluating the structural stability of iron ores when reduced under conditions resembling those prevailing in the reduction zone of a blast furnace.

This document is applicable to lump ores and hot-bonded pellets.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 2597-1, *Iron ores — Determination of total iron content — Part 1: Titrimetric method after tin(II) chloride reduction*

ISO 2597-2, *Iron ores — Determination of total iron content — Part 2: Titrimetric methods after titanium(III) chloride reduction*

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

ISO 9035, *Iron ores — Determination of acid-soluble iron(II) content — Titrimetric method*

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.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Principle

The test portion is isothermally reduced in a fixed bed, at 1 050 °C, under static load, using a reducing gas consisting of CO, H_2 and N_2, until a degree of reduction of 80 % is obtained. The differential gas pressure across the bed and the change in the test bed height are measured at 80 % reduction.

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 and lump ores shall be –12,5 mm +10,0 mm.

A test sample of at least 6,0 kg, on a dry basis, of the sized material shall be obtained.

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

Collect each test portion by taking ore particles at random.

NOTE Manual methods of division recommended in ISO 3082, such as riffling, can be applied to obtain the test portions.

At least five test portions, each of approximately 1 200 g (±the mass of one particle) shall be prepared from the test sample: four test portions for testing and one for chemical analysis.

Weigh the test portions to the nearest 1 g and register the mass of each test portion on its recipient label.

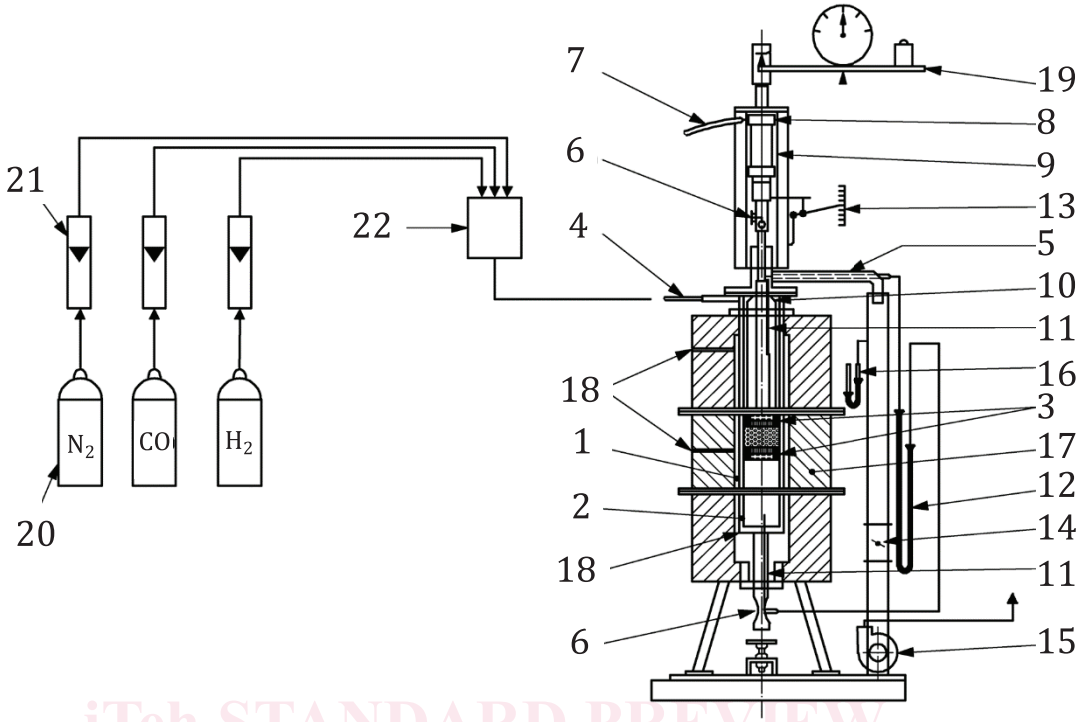
6 Apparatus

The usual laboratory apparatus and, in particular, the following shall be used.

6.1 Ordinary laboratory equipment, such as an oven, hand tools, a time-control device and safety equipment.

6.2 Reduction tube, with a double wall made of non-scaling, heat-resistant metal to withstand temperatures higher than 1 050 °C and resistant to deformation. The internal diameter of the inner reduction tube shall be 125 mm ± 1 mm. A removable perforated plate, made of non-scaling, heat-resistant metal to withstand temperatures higher than 1 050 °C, shall be mounted in the reduction tube to support the test portion and to ensure uniform gas flow through it. The perforated plate shall be 10 mm thick, with a diameter 1 mm less than the internal diameter of the tube. The holes in the plate shall be 3 mm to 4 mm in diameter, at a pitch centre distance of 5 mm to 6 mm. The internal diameter of the outer reduction tube shall be enough to allow gas flow preheating before entering the inner reduction tube.

Figure 1 shows an example of the test apparatus.



Key

Reduction tube

1 outer reduction tube
2 inner reduction tube
3 upper and lower perforated plates comprising test portion
4 gas inlet
5 gas outlet
6 thermocouple for measuring the reduction temperature

Loading device

7 compressed air inlet
8 pressure cylinder
9 frame for pressure cylinder
10 loading ram

Device for measuring differential gas pressure

11 differential gas pressure upper and lower probes
12 differential gas pressure manometer

Height-measuring device

13 linear scale

Waste gas

14 throttle valve
15 waste-gas fan
16 suction gauge

Furnace

18 electrically heated furnace
19 furnace wall thermocouples
20 balance

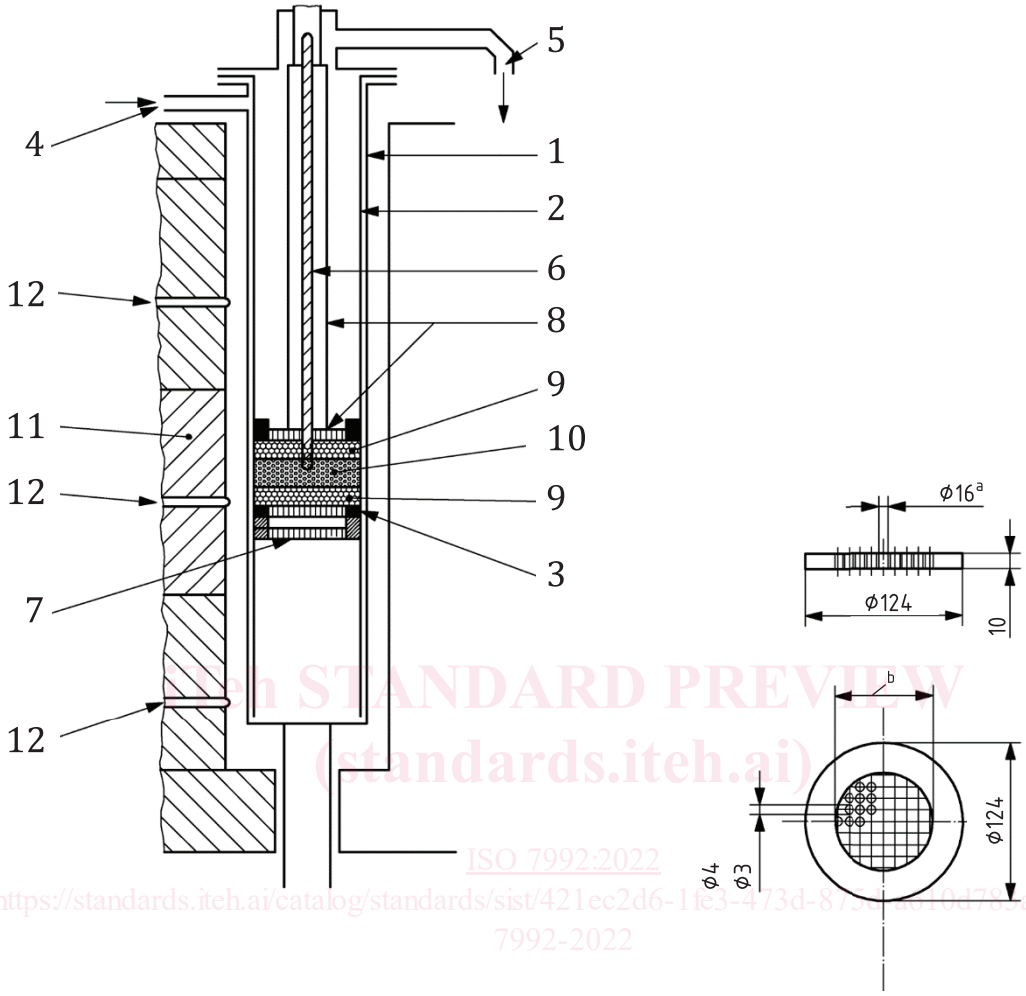
Gas supply system

20 gas cylinders
21 gas flow meters
22 mixing vessel

Figure 1 — Example of the test apparatus (schematic diagram)

Figure 2 shows an example of a reduction tube.

Dimensions in millimetres



Key

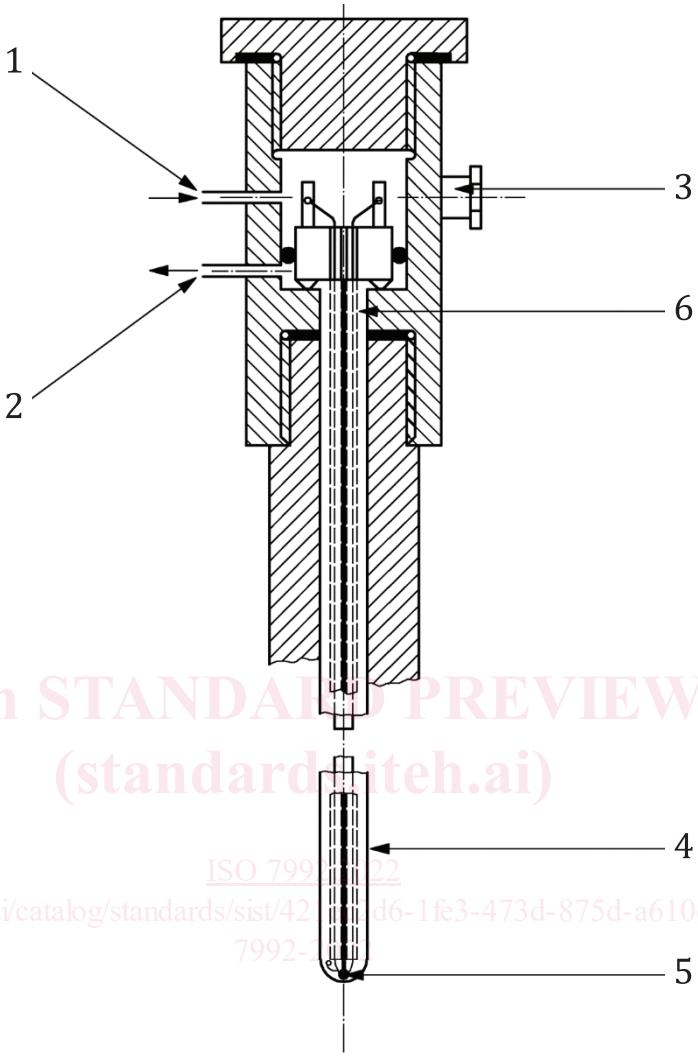
Reduction tube

1	outer reduction tube	8	loading ram with rigid perforated footplate
2	inner reduction tube (Ø 125 mm)	9	porcelain balls (two layers)
3	removable perforated plate	10	test portion (1 200 g)
4	opening for gas inlet	11	furnace wall
5	opening for gas outlet	12	furnace wall thermocouples (upper, medial and lower)
6	thermocouple for measuring the reduction temperature	a	Ø 16 for thermocouple entrance.
7	perforated support	b	14 holes × 5 or 6 pitch.

NOTE Key numbers do not coincide with the ones in Figures 1 and 3.

Figure 2 — Example of a reduction tube (schematic diagram)

Figure 3 shows the principle for oxygen flushing of thermocouples to avoid mismeasurement due to carbon deposition.



Key

1 oxygen inlet
2 oxygen outlet
3 thermocouple exit
4 protective tube
5 thermocouple tip
6 inner tube with four borings

NOTE Key numbers do not coincide with the ones in Figures 1 and 2.

Figure 3 — Principle of oxygen flushing of thermocouples to avoid mismeasurement due to carbon deposition

6.3 Loading device, capable of supplying a total static load of 50 kPa ± 2 kPa evenly to the test portion. The load shall be transferred by means of a ram with rigid perforated footplate, so as to distribute it evenly to the surface of the porcelain balls placed on top of the test portion. The footplate shall be 10 mm thick, with a diameter 1 mm less than the internal diameter of the tube. The holes in the plate shall be 3 mm to 4 mm in diameter, at a pitch centre distance of 5 mm to 6 mm.