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**INTERNATIONAL STANDARD**



**3271**

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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

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## **Iron ores — Determination of tumbler strength**

*Minerais de fer — Essai au tambour*

**First edition — 1975-02-15**

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**UDC 553.31 : 620.178**

**Ref. No. ISO 3271-1975 (E)**

**Descriptors :** iron ores, tests, sieve analysis, abrasion number, cohesion number.

Price based on 5 pages

## FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

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.

International Standard ISO 3271 was drawn up by Technical Committee ISO/TC 102, *Iron ores*, and circulated to the Member Bodies in January 1974.

It has been approved by the Member Bodies of the following countries:

Austria	Iran	Sweden
Belgium	Italy	Thailand
Bulgaria	Japan	Turkey
Canada	Mexico	United Kingdom
Czechoslovakia	Romania	U.S.A.
France	South Africa, Rep. of	U.S.S.R.
Germany	Spain	Yugoslavia

No Member Body expressed disapproval of the document.

# Iron ores – Determination of tumbler strength

## 1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies a method for evaluating the resistance of iron ore pellets, sinters and sized iron ores to degradation by impact and abrasion, by determining the tumbler index and abrasion index of the material.

## 2 REFERENCES

ISO 565, *Test sieves – Woven metal wire cloth and perforated plate – Nominal sizes of apertures.*

ISO 3081, *Iron ores – Increment sampling – Manual method.*

ISO 3082, *Iron ores – Increment sampling – Mechanical method.*<sup>1)</sup>

ISO 3083, *Iron ores, – Preparation of samples.*

ISO . . . , *Iron ores – Determination of size distribution – Sieving method.*<sup>1)</sup>

## 3 DEFINITIONS

For the purpose of this International Standard, the following definitions apply :

**3.1 tumbler index :** A relative measure of the resistance of the material to breakage or degradation by impact.

**3.2 abrasion index :** A relative measure of the degradation of the material by abrasion.

**3.3 sample for tumbler test :** The sample taken for the determination of tumbler strength of a lot or part of a lot.

## 4 PRINCIPLE

The sample for tumbler test is placed in a tumbler drum, which is rotated after the door has been tightly closed. When the specified number of revolutions has been completed, the sample is removed and sieved by means of the sieves specified for this particular test. The tumbler and

abrasion indices are calculated from the percentage distribution of the material on these sieves.

## 5 APPARATUS

**5.1 Tumbler test apparatus,** as shown in the figure, consisting of a circular drum of internal diameter 1 000 mm and internal length 500 mm, constructed of steel plate at least 5 mm in thickness. The drum shall be replaced whenever the thickness of the plate is reduced by wear to 3 mm in any area.

Two equally spaced steel angle lifters, of section 50 mm X 50 mm X 5 mm, of length 500 mm (i.e. equal to the internal length of the drum) shall be solidly attached longitudinally inside the drum by welding in such a manner as to prevent accumulation of material between lifter and drum. One of the lifters shall be attached to the door for ease of sample removal. The other shall be positioned at 180° from the first. Each lifter shall be fastened so that it points toward 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 lifters shall be replaced when the width of the shelf is reduced by wear to less than 47 mm.

The door shall be so constructed as to fit into the drum to form a smooth inner surface. During the test it shall be capable of being rigidly fastened and sealed to prevent loss of the sample.

The drum shall be rotated on stub axles attached to its ends by means of flanges, welded so as to provide smooth inner surfaces.

The apparatus shall be fitted with a revolution counter and with an automatic device for stopping the drum after a predetermined number of revolutions. The apparatus shall operate on a power supply of a minimum of 1,5 kW to ensure that the drum attains full speed in one revolution, rotates uniformly, and stops within one revolution.

**5.2 Test sieves** having square apertures of the following nominal sizes :

40,0 mm, 25,0 mm, 16,0 mm, 10,0 mm, 6,30 mm and 500 µm (selected from the R 20 size series of ISO 565).

1) In preparation.

**5.3 Three weighing devices**, having capacities of 100 kg, 15 to 20 kg and 1 kg respectively, each having a sensitivity of at least 1/1 000.

**5.4 Riffle divider**, having an opening of 50 mm, in accordance with ISO 3083. For material over 22,4 mm size, riffling may be replaced by coning and quartering or some other approved method of sample division, as specified in ISO . . . .

## 6 SAMPLE PREPARATION

### 6.1 General

The sample for tumbler test shall be prepared according to ISO 3083 and ISO . . . from the sample for physical testing which has been taken in accordance with ISO 3081 or ISO 3082. The divided sample shall be oven-dried at  $105 \pm 5^\circ\text{C}$  and cooled to room temperature before testing.

### 6.2 Pellets

The sample prepared as in 6.1 shall be sufficient to provide at least 60 kg of pellets that will pass a 40,0 mm sieve and be retained on a 6,30 mm sieve. From this sample, the final sample for tumbler test of  $15 \pm 0,15$  kg shall be prepared.

### 6.3 Sinters and sized iron ores

The sample prepared as in 6.1 shall be sufficient to provide at least 60 kg of sinter or sized iron ore that will pass a 40,0 mm sieve and be retained on a 10,0 mm sieve. This sample shall be separated into four fractions by sieving through 25,0, 16,0, and 10,0 mm sieves. From the material on the three sieves, samples for tumbler test of mass  $15 \pm 0,15$  kg shall be reconstituted by taking a proportionate mass of material from each of the three fractions. The mass of the individual fractions shall be recorded.

## 7 PROCEDURE

Place the 15 kg sample in the tumbler drum. Tightly fasten the door and rotate the drum at  $25 \pm 1$  rev/min for a total of 200 revolutions. Remove all the material from the drum and proceed as follows :<sup>1)</sup>

Place the material on a special nest of four sieves which shall include a 6,30 mm and a 500  $\mu\text{m}$  sieve and shake for 3 min by hand. Mechanical sieving may be used provided that preliminary tests give results similar to those obtained by hand sieving, within the permissible tolerance of 1 % absolute.

Determine and record the mass of the fraction retained on the 6,30 mm sieve, the fraction retained on the 500  $\mu\text{m}$  sieve, and the fraction passing the 500  $\mu\text{m}$  sieve.

The overall procedure is indicated in diagrammatic form in the annex.

NOTE — It is considered that the set of sieves used for sieving after the tumbler test should include sieve of suitable aperture size between 6,30 mm and 500  $\mu\text{m}$  (for example 2,00 mm or 1,00 mm) in order to improve the efficiency of the 500  $\mu\text{m}$  sieve by decreasing the sample mass retained on it. It could also be claimed to be advantageous for works control and ease of sieving to include an aperture size above 6,30 mm, for example either 10,0 mm or 8,00 mm.

## 8 EXPRESSION OF RESULTS

### 8.1 Sieve analysis

The sieve analysis after the tumbler test shall be reported, to the nearest 0,1 %, as the percentage retained on the 6,30 mm sieve and the percentage retained on, and the percentage passing, the 500  $\mu\text{m}$  sieve.

NOTE — The tumbler and abrasion indices are influenced by the amount of handling to which the material is subjected. It is therefore recommended that the sampling point be reported with the test results.

### 8.2 Calculation

The tumbler index,  $T$ , and the abrasion index,  $A$ , are given, as percentages by mass, by the formulae :

$$T = \frac{m_1}{m_1 + m_2 + m_3} \times 100$$

$$A = \frac{m_3}{m_1 + m_2 + m_3} \times 100$$

where

$m_1$  is the mass, in grams, of the sample fraction retained on the 6,30 mm sieve;

$m_2$  is the mass, in grams, of the sample fraction passing the 6,30 mm sieve and retained on the 500  $\mu\text{m}$  sieve;

$m_3$  is the mass, in grams, of the sample fraction passing the 500  $\mu\text{m}$  sieve.

Each index shall be reported to the nearest 0,1 % by rounding off to the first decimal place.

### 8.3 Number of tests

A duplicate test shall be carried out on each sample of pellets, sinters and sized iron ores. If the difference between the results of the two determinations falls within the permissible tolerance given in clause 9, the mean value shall be reported.

1) This procedure shall be adopted until such time as the method specified in ISO . . . for sieving is approved and published.

If the difference between the results of the two determinations exceeds the permissible tolerance, two further determinations shall be carried out. If the difference between the results of these two determinations does not lie within the permissible tolerance, all four values shall be individually reported together with their average.

## 9 PERMISSIBLE TOLERANCES AND PERMISSIBLE LOSS OF MASS

### 9.1 Permissible tolerances

The difference between the results of duplicate determinations shall fall within the tolerance given in the following table.

TABLE – Permissible tolerance in absolute percentage  
(Pellets, sinters and sized iron ores)

Tumbler strength	Permissible tolerance
Tumbler index, $T$ (+ 6,30 mm)	$\Delta T = -0,03 \bar{T} + 3,8$
Abrasion index, $A$ (– 500 $\mu\text{m}$ )	$\Delta A = 0,03 \bar{A} + 0,8$

### 9.2 Permissible loss of mass

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

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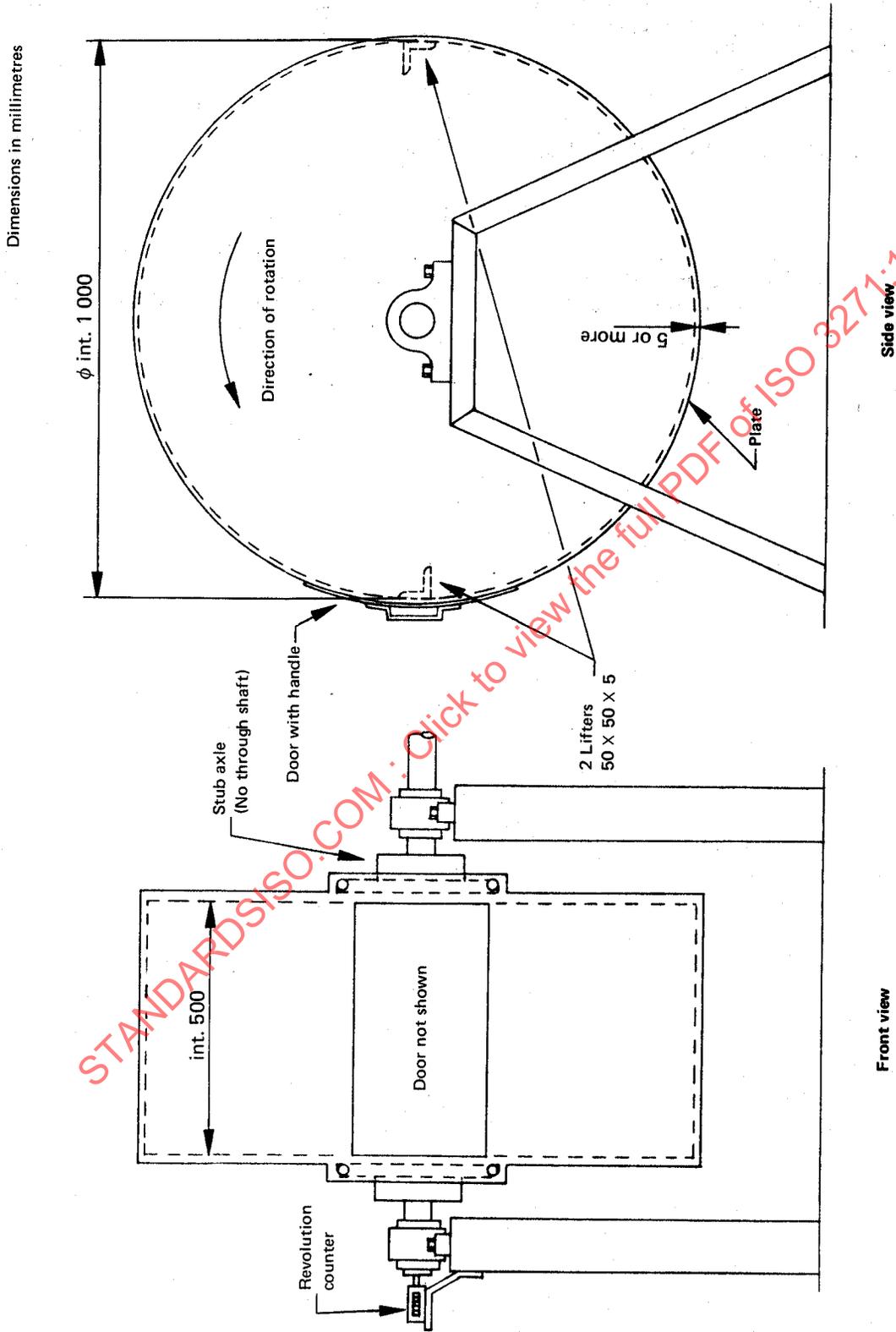


FIGURE — Example of tumbler test apparatus