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Iron ore fines — Method for presentation of the results of sintering tests

Particules de minerais de fer — Méthode de présentation des résultats d'essais de frittage

Reference number
ISO 8263:1992(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 voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 8263 was prepared by Technical Committee ISO/TC 102, *Iron ores*, Sub-Committee SC 3, *Physical testing*.

Annex A forms an integral part of this International Standard.

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

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Introduction

Sintering tests can be conducted for several different purposes, for example, the assessment of the sintering behaviour of a particular iron ore fines, for production and quality control purposes at a sinter plant, or for research purposes concerned with the sintering process or sintering technology.

From the results of these sintering tests, the sintering behaviour of an iron ore, or iron ore mix, is determined in terms of production rate, fuel consumption rate and sinter quality. The purpose of this International Standard is to establish the terminology and method for presentation of these results, for use when sintering test data is required to be exchanged between separate parties, such as will be the case where a particular iron ore fines has been assessed for commercial reasons, or where research or production results are to be published.

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Iron ore fines — Method for presentation of the results of sintering tests

1 Scope

This International Standard specifies a method for presentation of the results of sintering tests. It is applicable to all iron ore fines that are agglomerated by the sintering process.

2 Definitions

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

2.1 ore mix: The blend of iron ores, and other iron bearing raw materials, such as mill scale, basic oxygen steel making slag, dust, etc., used in the tests. It does not include return sintered fines, fluxes, coke or other solid fuel.

2.2 sinter mix: The mix of materials charged to the sintering test apparatus, which includes the ore mix, fluxes, coke or other fuel, and return sintered fines.

2.3 mixing times: The time, in minutes, taken for blending and granulating the various constituents of the sinter mix.

2.4 moisture content of sinter mix: The moisture content, as a percentage by mass, determined by drying the granulated sinter mix, as charged to the sintering test apparatus, at 105 °C ± 5 °C.

2.5 moisture content for maximum permeability: The moisture content of the granulated sinter mix at which maximum permeability is obtained.

2.6 bulk density of sinter mix: The mass per unit volume of the wet sinter mix as charged.

2.7 hearth layer: A layer of previously made and sized sinter, or other iron ore material, which is placed on the grate before the sinter mix is charged.

2.8 grate area: The area of the grate of the sintering test apparatus.

2.9 net bed height: The height of the bed of sinter mix above the hearth layer, prior to the application of suction and ignition.

2.10 suction: The air suction measured at the wind box or at the entrance of the main blower of the sintering test apparatus.

2.11 ignition intensity: The heat supplied per unit of grate area per unit time of ignition.

2.12 ignition temperature: The maximum temperature attained at or immediately above the surface of the sinter bed during the ignition process.

2.13 sintering time: The time from the start of ignition until the exhaust gas temperature reaches a maximum.

2.14 sinter cake: The total mass of sinter produced, including the hearth layer and the material collected from the bottom of the wind box.

2.15 sinter handling treatment: The tumbling and/or shatter treatment given to the sinter cake, obtained in a sinter pot to simulate the effects of handling and transportation in a sinter plant.

2.16 return sintered fines: The undersize fines separated from the sinter cake by sieving after the handling treatment.

2.17 sinter product: The sinter acceptable size for charging to the blast furnace.

2.18 productivity: The mass of sinter product, produced per unit grate area per unit of time (see 3.1.1).

2.19 fuel consumption: The dry mass(es) of solid fuel(s) consumed per unit mass of sinter product after deducting the hearth layer (see 3.1.2).

2.20 yield: The proportion (percentage) of sinter product in relation to the sinter cake, excluding the hearth layer (see 3.1.3).

2.21 return sintered fines balance: The ratio of the mass of return sintered fines charged to the mass of undersize sintered fines produced (see 3.1.4).

3 Sintering tests

For reference, an example of sintering test equipment is illustrated in figure 1, while figure 2 gives a flow-sheet of a typical sinter test procedure.

The International Standards covering test methods for determining the chemical analyses, sieving analyses, and sinter quality indices are listed in annex A. If any of these International Standards are not available, the respective national or regional standard should be used.

3.1 Calculation of results

3.1.1 Productivity

The productivity P, in tonnes of sinter per square metre per hour, is calculated from the equation

$$P = \frac{m_1 - m_2}{1\,000} \times \frac{1}{A} \times \frac{60}{t}$$

where

m_1 is the total mass, in kilograms, of sinter of acceptable size produced (including the hearth layer);

m_2 is the mass, in kilograms, of the hearth layer;

A is the area of grate, in square metres;

t is the sintering time, in minutes.

NOTE 1 Productivity may also be reported in terms of tonnes of iron contained in sinter of acceptable size per square metre per hour, to reflect changes in the grade of the sinter product.

The productivity P_{Fe}, in tonnes of iron in sinter per square metre per hour, is calculated from the equation

$$P_{Fe} = \frac{P \times w_{Fe}}{100}$$

where w_{Fe} is the percentage iron content in the sinter.

3.1.2 Fuel consumption

The fuel consumption C is calculated from the equation

$$C = \frac{m_3}{m_1 - m_2} \times 1\,000$$

where

m_1 is the total mass, in kilograms, of sinter of acceptable size produced (including the hearth layer);

m_2 is the mass, in kilograms, of the hearth layer;

m_3 is the dry mass of solid fuel in the sinter mix consumed.

3.1.3 Yield

The yield Y, as a percentage by mass, is calculated from the equation

$$Y = \frac{m_1 - m_2}{m_4 - m_2} \times 100$$

where

m_1 is the total mass, in kilograms, of sinter of acceptable size produced;

m_2 is the mass, in kilograms, of the hearth layer;

m_4 is the total mass, in kilograms, of sinter cake.

3.1.4 Return sintered fines balance

The return sintered fines balance B is calculated from the equation

$$B = \frac{m_5}{m_6}$$

where

m_5 is the mass of return sintered fines charged (input);

m_6 is the mass of undersize sintered fines produced (output).

NOTE 2 In a sinter pot test, this is normally maintained within limits of $1 \pm 0{,}05$, for results to be representative of actual practice.

The percentage of return sintered fines F may also be recorded, and is calculated from the equation

$$F = \frac{m_4 - m_1}{m_4 - m_2} \times 100$$

4 Method for reporting results

The results of sintering tests shall be reported according to schedules 1 to 6 as follows.

Schedule 1: Chemical analyses (dry basis) and size distribution of the various ores included in the ore mix.

Table 1 lists the chemical analysis and size distribution of each iron ore contained in the ore mix used in the tests.

A separate column is used for each ore, or iron bearing material, included in the ore mix. It is not necessary to actually name each ore source which can be referred to as ore A, B, C, etc.

Schedule 2: Composition of the ore mix.

Table 2 shows the percentage of each iron ore, or iron bearing material, contained in the ore mix for each test. These percentages are calculated on a dry basis.

Schedule 3: Chemical analyses (dry basis) and size distributions of fluxes, fuels and return sintered fines.

Table 3 is similar to table 1, but lists the chemical analyses and size distributions of all the other materials included in the sinter mix, such as the coke or alternative fuels used, each of the fluxes used, and the return sintered fines. The coke or fuel analyses give the percentage of ash as well as fixed carbon and volatile matter.

If a hearth layer other than sized sinter is utilized, then the type and composition of the material used should be listed in table 3.

Schedule 4: Composition of the sinter mix.

Table 4 shows the percentage of each constituent of the sinter mix, including the ore mix, fluxes, coke or other fuel, and the return sintered fines.

NOTE 3 From tables 1 and 2, the overall weighted composition of the ore mix can be calculated and used as the basis for calculation of flux quantities.

Schedule 5: Sintering test results.

Table 5 gives the conditions under which the sintering tests were done and the results of the tests.

Schedule 6: Sinter product quality data.

In table 6 the results of chemical and physical tests undertaken on the sinter product are recorded.

Table 1 — Chemical analyses (dry basis), moisture content and size distributions of the various ores included in the ore mix

	Ore A %	Ore B %	Ore C %	Ore D %	Mill scale and/or other surface coatings %	Test ore %
Chemical analysis						
Fe (total)						
FeO						
SiO_2						
Al_2O_3						
CaO						
MgO						
MnO						
S						
P						
Na_2O						
K_2O						
C						
TiO_2						
Loss on ignition						
Combined water						
Moisture content						
Size distribution						
+ 8,0 mm						
− 8,0 mm + 5,6 mm						
− 5,6 mm + 4,0 mm						
− 4,0 mm + 2,0 mm						
− 2,0 mm + 1,0 mm						
− 1,0 mm + 500 µm						
− 500 µm + 250 µm						
− 250 µm + 125 µm						
− 125 µm + 63 µm						
− 63 µm						
Method of size analysis: wet/dry sieving						

Table 2 — Composition of the ore mix

Values in percentage by mass [% (m/m)] (dry basis)

Constituents of ore mix	Test No. 1	Test No. 2	Test No. 3	Test No. 4	Test No. 5	Test No. 6
Ore A						
Ore B						
Ore C						
Ore D						
Mill scale and/or other surface coatings						
Test ore						

Table 3 — Chemical analyses (dry basis), moisture content and size distributions of fluxes, fuels and return sintered fines

	Coke or other fuel %	Flux Limestone %	 Dolomite %	 Siliceous %	 Other %	Return sintered fines %
Chemical analysis						
Fe (total)						
FeO						
SiO_2						
Al_2O_3						
CaO						
MgO						
MnO						
S						
P						
Na_2O						
K_2O						
C						
TiO_2						
C (fixed)						
Ash						
Volatile Matter (VM)						
Combined water						
Moisture content						
Size distribution						
+ 8,0 mm						
− 8,0 mm + 5,6 mm						
− 5,6 mm + 4,0 mm						
− 4,0 mm + 2,0 mm						
− 2,0 mm + 1,0 mm						
− 1,0 mm + 500 µm						
− 500 µm + 250 µm						
− 250 µm + 125 µm						
− 125 µm + 63 µm						
− 63 µm						
Method of size analysis: wet/dry sieving						

Table 4 — Composition of the sinter mix

Values in percentage by mass [% (m/m)] (dry basis)

Constituents of sinter feed	Test No. 1	Test No. 2	Test No. 3	Test No. 4	Test No. 5
Ore mix					
Return sintered fines					
Siliceous material					
Limestone					
Dolomite					
Other fluxes (if any)					
Coke					
Other fuel (if any)					

Table 5 — Sintering test results

Item	Test No. 1	Test No. 2	Test No. 3	Test No. 4	Test No. 5
Sinter mix					
Mass of hearth layer m_2 (kg)					
Size range of hearth layer material (mm)					
Mass of sinter mix charged wet (kg)					
Moisture content of feed (%)					
Moisture content for maximum permeability (%)					
Bulk density of wet sinter mix (t/m^3)					
Conditions of sinter test					
Mixing time:					
— 1st stage (min)					
— 2nd stage (min)					
Grate area (m^2)					
Height of hearth layer (mm)					
Net bed height (mm)					
Suction:					
— at ignition (kPa)					
— sinter bed (kPa)					
— cooling bed (kPa)					
Type of ignition fuel					
Ignition intensity (MJ/m^2/min)					
Ignition temperature (°C)					
Ignition time (min)					
Cooled:					
— in sinter pot					
— discharged hot					
Sinter handling treatment					
— tumble					
number of revolutions					
drum size length (mm) × diameter (mm)					
— shatter					
number of drops					
height dropped (m)					
Sieving aperture size for separating return sintered fines (mm)					

Item	Test No. 1	Test No. 2	Test No. 3	Test No. 4	Test No. 5
Sintering test results					
Mass of sinter cake m_4 (kg)					
Mass of return sintered fines produced (kg)					
Mass m_1 of sinter produced of acceptable size (kg)					
Sintering time t (min)					
Productivity (t/m²/h):					
— sinter					
— contained iron					
Fuel consumption:					
— kg/t sinter					
— kg/t contained iron in sinter					
Total thermal input (MJ/t)					
Return sintered fines (%):					
$\frac{m_4 - m_1}{m_4 - m_2} \times 100$					
Yield (%):					
$\frac{m_1 - m_2}{m_4 - m_2} \times 100$					
Return sintered fines balance					

Table 6 — Sinter product quality data

Item	Test No. 1	Test No. 2	Test No. 3	Test No. 4	Test No. 5
Chemical analysis of sintered product [% (*m*/*m*)]					
Fe (total)					
FeO					
SiO_2					
Al_2O_3					
CaO					
MgO					
MnO					
S					
P					
Na_2O					
K_2O					
Loss on ignition					
Basicity					
CaO/SiO_2 or $\frac{CaO + MgO}{SiO_2 + Al_2O_3}$					
Physical test results on sintered product					
ISO 3271: Tumbler strength					
% + 6,3 mm					
% – 0,50 mm					
ISO 4696: Reduction disintegration index					
% + 6,3 mm					
% + 3,15 mm					
% – 0,50 mm					
ISO 7215: Relative reducibility					
ISO 4695: Reducibility					
Other tests					
Size analysis of sintered product (%)					
+ 63 mm					
– 63 mm + 45 mm					
– 45 mm + 31,5 mm					
– 31,5 mm + 22,4 mm					
– 22,4 mm + 16 mm					
– 16 mm + 10 mm					
– 10 mm + 5 mm					
– 5 mm					

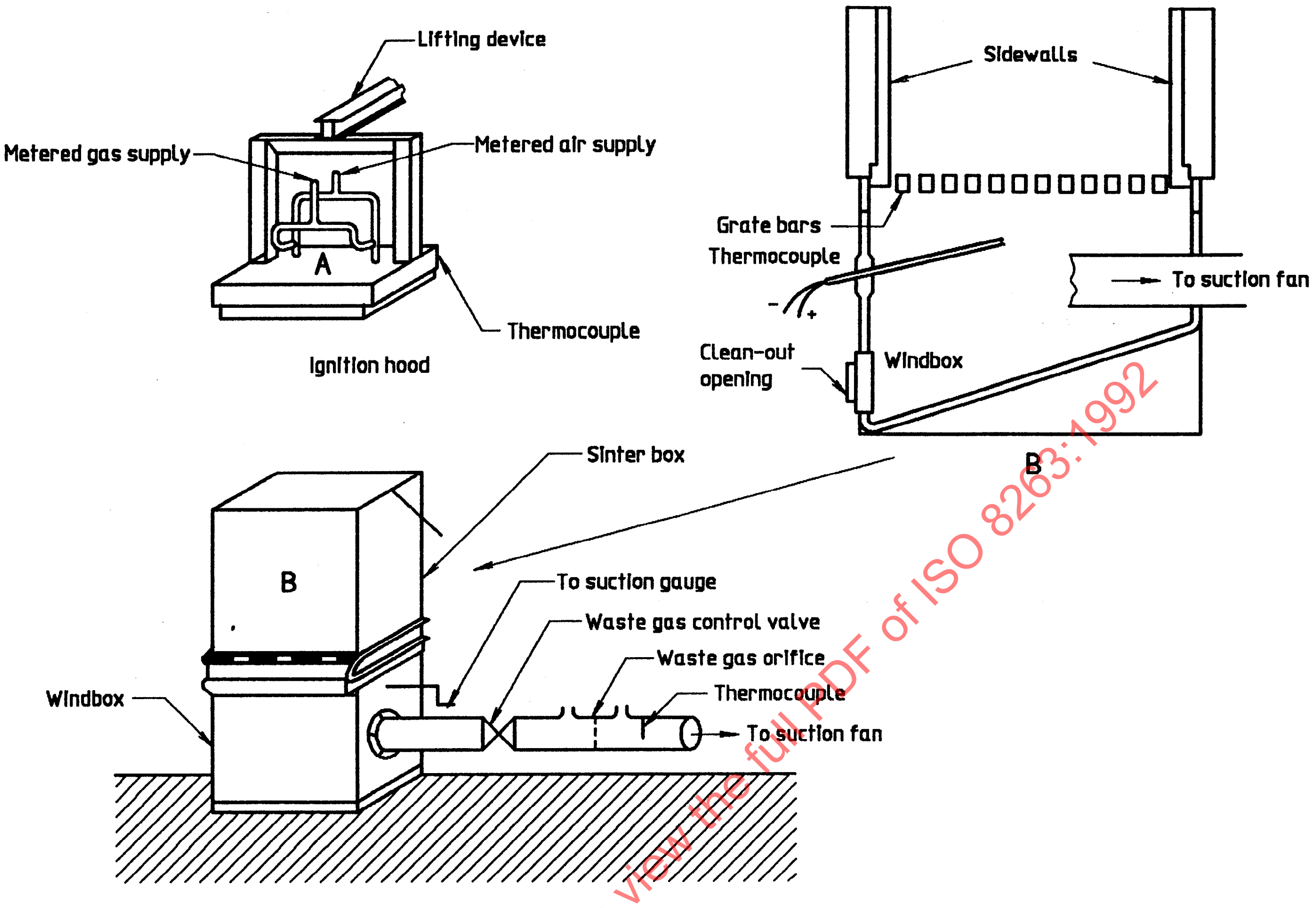

Figure 1 — Example of sintering test equipment

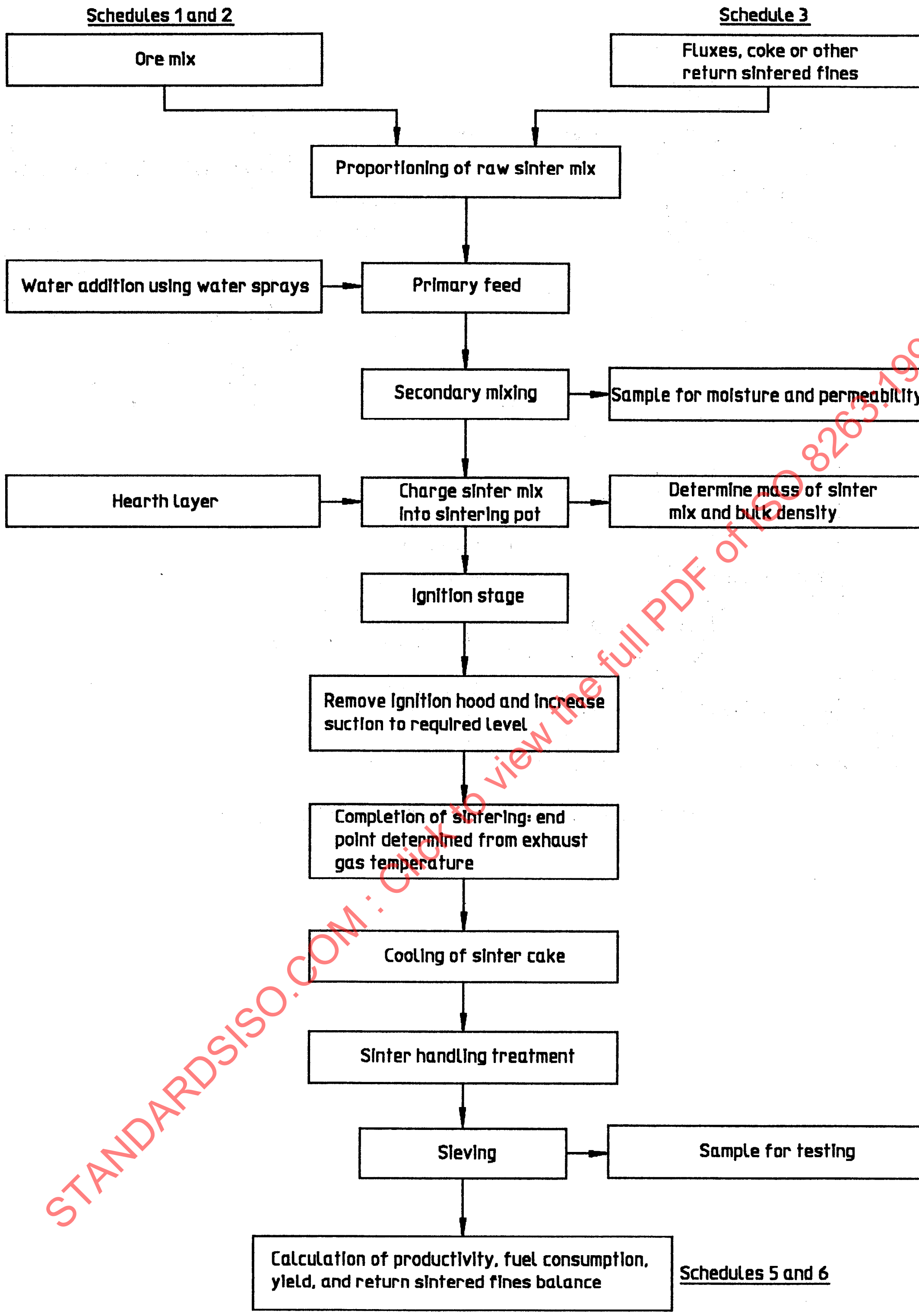

Figure 2 — Flowsheet of typical sinter test procedure