ICS 73.060.10
CCS D 31

NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

GB/T 44032-2024

Identification method for iron ore and materials containing iron

铁矿石与含铁物料的鉴别方法

Issued on: May 28, 2024 **Implemented on: December 1, 2024**

**Issued by: State Administration for Market Regulation;
Standardization Administration of the PRC**

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3 Terms and definitions

The terms defined in GB/T 20565 apply together with three terms given here. Iron-bearing dusts and sludges (3.1) are the solid waste obtained after dry dust removal, wet dust removal and waste water treatment in the raw material preparation, sintering, pelletizing, ironmaking, steelmaking and rolling processes of an iron and steel works, excluding metallurgical auxiliary dusts and sludges, fuel dusts and sludges and dusts and sludges from the processing of special ores; a note divides them by origin into raw material preparation, sintering, pelletizing, blast furnace, steelmaking and rolling dusts and sludges. The definition is taken with modification from GB/T 28292-2012, 3.2.

Mill scale (3.2) is the iron swarf produced when the surface oxide layer comes off a steel ingot or billet during forging or rolling; it is in strip form and is also called iron scale, and the definition is taken from SN/T 3102-2012, 3.2. Iron-bearing smelting slag (3.3) is the iron dominated by-product of the smelting of iron ore; a note lists blast furnace pig iron slag, foundry pig iron slag, ferromanganese ore slag and similar furnace slags, the acid liquid slag of steelmaking, the oxidizing slag of top blown, bottom blown and combined blown converters and of electric furnaces and the electric furnace reducing slag, and the pyrite cinder produced when pyrite, sulfur concentrate or ferrous sulfate is roasted in a fluidized bed furnace for desulfurization.

4 Principle

A sensory examination of the goods is carried out and a sampling and sample preparation plan is drawn up. The composition, the phases, the particle size, the acidity and alkalinity of the leachate and the content of the leached ions, the ore phases and the microscopic morphology of the sample are analysed and tested, and the results, together with the information on the origin and use of the goods supplied by the client, are compared with the main physical and chemical characteristics of typical iron ore and iron-bearing materials in order to identify the source attribute of the sample. The identification flow is shown in Figure 1.

Four footnotes accompany Figure 1. Where the goods contain parts of different character, for example different colours or blocks partly full of gas holes, these are sorted out, their masses recorded and each identified separately. Semi-quantitative analysis is carried out on the major and minor components of the sample, and other quantitative analysis, such as metallic iron or carbon content, is carried out as needed. On the basis of the sensory examination and of the composition and phase results, further techniques may be chosen where necessary, such as particle size, leachate acidity and alkalinity, leached ion content, ore phase analysis and microscopic morphology analysis. The documentary sources include the main physical and chemical characteristics of iron ore and of iron-bearing materials from different production processes, and the production process and use of the goods supplied by the client; comparing the documentary sources with the test information allows the source attribute of the goods to be inferred.

5 Instruments and equipment

The instruments and equipment listed are a wavelength dispersive X-ray fluorescence spectrometer, an X-ray diffractometer, a laser particle size analyser, a forced air drying oven, a pH meter, an inductively coupled plasma atomic emission spectrometer, an inductively coupled plasma mass spectrometer, an ore microscope and a scanning electron microscope with energy dispersive spectrometer.

6 Sensory examination

The shape, colour and lustre, surface morphology, smell and other apparent characteristics of the goods are examined by the senses in order to confirm that the appearance of the goods is consistent and uniform. Where parts of the same consignment differ clearly in their apparent characteristics, those parts are sampled and prepared separately. The result of the sensory examination is recorded in writing, in photographs or on video.

Clause 7 requires sampling according to SN/T 5571 and sample preparation according to HJ/T 20; sampling and preparation may also follow the corresponding sampling and preparation standards for the iron ore or iron-bearing material concerned.

8 Analysis and testing

8.1 The document gives the recommended standard methods for the analysis and testing, and a laboratory may also choose other standard methods that reach the same testing objective. 8.2 The major and minor components of the sample are analysed according to GB/T 16597, and where necessary particular constituents may be determined quantitatively according to the relevant iron ore standards. 8.3 The phase composition of the sample is analysed according to SN/T 3011.1.

8.4 Particle size analysis follows GB/T 10322.7 or GB/T 19077. GB/T 10322.7 applies to particle size analysis with sieves of aperture 36 micrometres or larger, and GB/T 19077 applies to particle size analysis of samples between 0.1 micrometres and 3 mm with a laser particle size analyser. 8.5 The acidity and alkalinity of the leachate are analysed with a pH meter according to GB/T 15555.12, and the ions in the leachate are determined with an inductively coupled plasma emission spectrometer or an inductively coupled plasma mass spectrometer according to JY/T 0567 or JY/T 0568. 8.6 The ore phase characteristics are identified with an ore microscope according to DZ/T 0275.4 and DZ/T 0275.5, and the microscopic morphology and composition are analysed with a scanning electron microscope and energy dispersive spectrometer according to JY/T 0582, JY/T 0584 and GB/T 17359.

9 Judgement of the attribute

9.1 Iron ore is inferred where the main components are iron, silicon and aluminium with small amounts of calcium, magnesium, manganese, potassium, sodium, phosphorus and sulfur; where the main phases are one or more of magnetite, hematite, goethite, lepidocrocite, limonite, maghemite, martite and siderite together with gangue such as quartz and silicate rock; where the leachate pH is neutral or alkaline and the main leached ions are iron, silicon, aluminium, calcium, magnesium and sodium at a mass concentration generally below 10 micrograms per millilitre; and where the microscopic morphology shows compact particles with the angular edges typical of minerals. Annex A gives the characteristic information of typical iron ore.

9.2 Direct reduced iron is inferred where the main component is iron, present mainly as metallic iron, with small amounts of silicon, aluminium, calcium, magnesium, carbon, phosphorus, sulfur, titanium, chromium and vanadium, and where the main phase is metallic iron, possibly together with ferrous oxide, triiron tetroxide, diiron trioxide, gangue and quartz; the sample can then be inferred to be a completely or incompletely reduced direct reduced iron product of the solid state reduction of iron ore. Annex B gives the characteristic information.

9.3 Iron-bearing dusts and sludges are inferred where the particle size is fine, generally of the order of tens of micrometres; where the main components are iron, calcium, magnesium, silicon, aluminium, phosphorus, titanium, manganese, zinc, carbon, sulfur, sodium and potassium, possibly with a high content of zinc, carbon or fluorine; where the main phases are magnetite, hematite, goethite, ferrous oxide, iron, graphite, periclase, calcium hydroxide and the metal oxides formed at high temperature between iron and other metals, such as magnesioferrite, zinc ferrite spinel and manganosite; where the leachate pH is neutral to alkaline with a high concentration of calcium and sodium ions, from tens to several hundred micrograms per millilitre; and where the particles are loose under the microscope and show no angular mineral edges. Annex C gives the characteristic information.

9.4 Mill scale is inferred where the sample is in strip or flake form, smooth and metallic on one face and rough on the other, where the total iron content generally reaches more than 68 % and silicon, aluminium, calcium and magnesium are also present, and where the main phases are ferrous oxide, iron oxide and triiron tetroxide. Annex D gives the characteristic information.

9.5 Iron-bearing smelting slag is inferred where the surface shows a glassy state or fused pores, the main components are iron, silicon, aluminium, calcium and magnesium with small amounts of manganese, sulfur, potassium, sodium, phosphorus, chromium and fluorine, the phases are complex and often include glassy matter with the metallic elements present mainly as silicates, aluminates and ferrites, the leachate pH is alkaline to weakly alkaline and the calcium ion content is high, from tens to several hundred micrograms per millilitre; the sample may then be inferred to be smelting slag from ironmaking or