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GB/T 4137—202X

Replace GB/T 4137-2015

Rare earth ferrosilicon alloy

稀土硅铁合金

（*English Translation*）

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Foreword

SAC/TC 229 is in charge of this English translation. In case of any doubt about the contents of English translation, the Chinese original shall be considered authoritative.

This standard is drafted in accordance with the rules given in the GB/T1.1-2020 *Directives for standardization—Part 1: Rules for the structure and drafting of standardizing documents*.

This standard replaces the GB/T 4137-2015 (*Rare earth ferrosilicon alloy*)in whole. In addition to some structural adjustments and editorial changes, the following technical deviations have been made with respect to the GB/T 4137-2015.

a) Added "Terms and definitions" (see Chapter 3);

b) Added "Classification" (see Chapter 4);

c) Deleted digital designation (see Table 1 of the 2015 edition);

d) Deleted the product designation of “RESiFe-38Ce”, “RESiFe-41Ce”, “RESiFe-13-Y”, “RESiFe-18-Y”, “RESiFe-23-YS”, “RESiFe-28-Y”, “RESiFe-33-Y”, “RESiFe-28-Y”, “RESiFe-33-Y” and “RESiFe-38Y” (see Table 1 of the 2015 edition);

e) Added product designation of “RESiFe-30LaC”, “RESiFe-30CeC”, “RESiFe-32LaC”, “RESiFe-32CeC”, “RESiFe-20CeM”, “RESiFe-23CeM” and “RESiFe-26CeM” (see Table 1);

f) Revised the product designation of light rare earth ferrosilicon alloy from "RESiFe-23Ce", "RESiFe-26Ce", "RESiFe-29Ce", "RESiFe-32Ce", and "RESiFe-35Ce" to "RESiFe-23CeS", "RESiFe-26CeS", "RESiFe-29CeS", "RESiFe-32CeS", and "RESiFe-35CeS" (see Table 1, Table 1 of the 2015 edition);

g) Revised the values of Ce/RE in light rare earth ferrosilicon alloy from "not less than 46" to "not less than 60" (See Table 1, Table 1 of the 2015 edition);

h) Added product designation "RESiFe-13-YS", "RESiFe-18-YS", "RESiFe-23-YS", "RESiFe-28-YS", "RESiFe-33-YS", "RESiFe-28-YM", and "RESiFe-33-YM" of yttrium-based heavy rare earth ferrosilicon alloy (See Table 2, Table 1 of the 2015 edition);

i) Added "If the purchaser has special requirements for the particle size range, it can be determined through negotiation by both parties." (see 5.2);

j) Added the condition requirement for "under natural scattered light" (see 6.3);

k) Added the requirement for the quantity of particle size sampling (see 7.4.2);

l) Revised product packaging description from "sealed in iron drums with anti-oxidation measures" to "woven bag packaging with plastic inner bags" (see 8.1, 6.2 of the 2015 edition).

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights. The issuing body of this document shall not be held responsible for identifying any or all such patent rights.

This standard was proposed and prepared by the National Standardization Technical Committee of Rare Earth (SAC/TC 229).

The previous editions of this standard are as follows:

——The first edition was issued in 1984 as GB/T 4137-1984;

——The first revision was issued in 1993, the second revision was issued in 2004, and the third revision was issued in 2015;

——This is the fourth revised edition.

Rare earth ferrosilicon alloy

1. Scope

This standard specifies the classification, technical requirements, test methods, inspection rules, marking, packaging, transportation, storage, and accompanying documents of rare earth ferrosilicon alloy products.

This standard is applicable to the production, inspection, and sales of light rare earth ferrosilicon alloys and yttrium-based heavy rare earth ferrosilicon alloy products prepared by carbothermic reduction method, silicothermic reduction method, and mix-melting method.

Note: The products can be used as composite nodularizing agent raw materials or as additives and alloying agents in steel production.

2. Normative references

The following normative documents through reference in this text, constitute provisions of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 15676 *Terms for rare earths*

GB/T 8170 *Rules of rounding off for numerical values & expression and judgement of limiting values*

GB/T 13247 *Methods for sampling and testing the grain size of ferroalloys products*

GB/T 15676-2015 *Terms for rare earths*

GB/T 16477(All Parts) *Chemical analysis methods of rare earth ferrosilicon alloy and rare earth ferrosilicon magnesium alloy*

GB/T 24194 *Ferrosilicon - Determination of aluminium, calcium, manganese, chromium, titanium, copper, phosphorus and nickel content - Inductively coupled plasma atomic emission spectrometric method*

GB 39176 *Rare earth products packing, marking, transport and storage*

3. Terms and definitions

Defined in GB/T 15676 and the following terms and definitions apply to this document.

3.1 Light rare earth ferrosilicon alloy

A kind of alloy which mainly contains lanthanum mischmetal or cerium mischmetal, silicon, and iron.

3.2 Yttrium-based heavy rare earth ferrosilicon alloy

A kind of alloy which mainly contains yttrium mischmetal, silicon, and iron.

3.3 Carbothermic reduction method

A method in which carbon-containing materials are used as a reductant to reduce and melt silica, rare earth oxides, rare earth enriched slag, or rare earth concentrate in the submerged arc furnace to produce rare earth ferrosilicon alloy.

[Source: Definition 8.4.5 in GB/T 15676-2015, with modifications]

3.4 Silicothermic reduction method

A method in which silicon or iron silicon is used as a reductant to reduce and melt rare earth oxides, rare earth enriched slag, or rare earth concentrate slag in the electric arc furnace to produce rare earth ferrosilicon alloy.

3.5 Mix-melting method

A method in which raw materials and flux are heated by fuel or electric energy to molten at certain temperature to prepare alloy.

4 Classification and designation

4.1 Classification

Products can be divided into light rare earth ferrosilicon alloy and yttrium-based heavy rare earth ferrosilicon alloy according to the proportion of light and heavy rare earths. Light rare earth ferrosilicon alloy products are divided into 12 grades according to production process and chemical composition; Yttrium-based heavy rare earth ferrosilicon alloy products are divided into 7 grades according to chemical composition.

4.2 Designation

The designation of rare earth ferrosilicon alloy consists of the initials of rare earth ferrosilicon alloy and arabic numerals, and the levels are separated by "-". It comprises three levels. The first level represents rare earth ferrosilicon alloy, expressed by the chemical symbol of rare earth ferrosilicon as “RESiFe”;The second level represents the mass fraction of the total amount of rare earths in the product, expressed by the numbers as "××"; The third level represents the rare earth main elements in the product and production processes. The rare earth main elements are lanthanum (La), cerium (Ce), yttrium (Y). The production processes mainly include the carbothermic reduction method, silicothermic reduction method, and mix-melting method, represented by "C", "S", and "M" respectively. The designation is expressed in following format:

Main rare earth elements and production processes

rare earth ferrosilicon alloy

the mass fraction of the total amount of rare earth，×× is the number

RESiFe- ××- ××

Example:

RESiFe-30-LaC represents a rare earth ferrosilicon alloy product produced by the carbon thermal reduction method with about 30% rare earth, and the main type of rare earth element is La.

5 Technical requirement

5.1 Chemical composition

The chemical composition of light rare earth ferrosilicon alloy products shall be as specified in Table 1. The chemical composition of yttrium-based heavy rare earth ferrosilicon alloy products shall be as specified in Table 2. By agreement between the supplier and purchaser, the product with other special requirements can also be adopted.

Table 1 Chemical composition of light rare earth ferrosilicon alloy

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Designation | Chemical composition (Mass fraction)  % | | | | | | | | |
| RE | Ce/RE | La/RE | Si | Mn | Ca | Ti | Al | Fe |
| RESiFe-30-LaC | 29.0≤RE<31.0 | / | ≥60.0 | 48.0≤Si≤53.0 | ≤2.0 | ≤4.0 | ≤1.0 | ≤1.6 | Allowance |
| RESiFe-30-CeC | 29.0≤RE<31.0 | ≥60.0 | / | 48.0≤Si≤53.0 | ≤2.0 | ≤4.0 | ≤1.0 | ≤1.6 |
| RESiFe-32-LaC | 31.0≤RE<33.0 | / | ≥60.0 | 48.0≤Si≤53.0 | ≤2.0 | ≤4.0 | ≤1.0 | ≤1.6 |
| RESiFe-32-CeC | 31.0≤RE<33.0 | ≥60.0 | / | 48.0≤Si≤53.0 | ≤2.0 | ≤4.0 | ≤1.0 | ≤1.6 |
| RESiFe-23-CeS | 21.0≤RE<24.0 | ≥60.0 | / | ≤44.0 | ≤2.5 | ≤5.0 | ≤1.5 | ≤1.0 |
| RESiFe-26-CeS | 24.0≤RE<27.0 | ≥60.0 | / | ≤43.0 | ≤2.5 | ≤5.0 | ≤1.5 | ≤1.0 |
| RESiFe-29-CeS | 27.0≤RE<30.0 | ≥60.0 | / | ≤42.0 | ≤2.0 | ≤5.0 | ≤1.5 | ≤1.0 |
| RESiFe-32-CeS | 30.0≤RE<33.0 | ≥60.0 | / | ≤40.0 | ≤2.0 | ≤4.0 | ≤1.0 | ≤1.0 |

Table 1 Chemical composition of light rare earth ferrosilicon alloy(continued)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Designation | Chemical composition (Mass fraction)  % | | | | | | | | |
| RE | Ce/RE | La/RE | Si | Mn | Ca | Ti | Al | Fe |
| RESiFe-35-CeS | 33.0≤RE<36.0 | ≥60.0 | / | ≤39.0 | ≤2.0 | ≤4.0 | ≤1.0 | ≤1.0 | Allowance |
| RESiFe-20-CeM | 18.0≤RE<21.0 | ≥60.0 | / | ≤45.0 | ≤2.5 | ≤5.0 | ≤1.5 | ≤1.5 |
| RESiFe-23-CeM | 21.0≤RE<24.0 | ≥60.0 | / | ≤44.0 | ≤2.5 | ≤5.0 | ≤1.5 | ≤1.5 |
| RESiFe-26-CeM | 24.0≤RE<27.0 | ≥60.0 | / | ≤43.0 | ≤2.5 | ≤5.0 | ≤1.5 | ≤1.5 |

Table 2 Chemical composition of yttrium-based heavy rare earth ferrosilicon alloy

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Designation | Chemical composition (Mass fraction)  % | | | | | | | |
| RE | Y/RE | Si | Mn | Ca | Ti | Al | Fe |
| RESiFe-13-YS | 10.0≤RE<15.0 | ≥50.0 | 48.0≤Si≤50.0 | ≤2.5 | ≤6.0 | ≤1.5 | ≤1.0 | Allowance |
| RESiFe-18-YS | 15.0≤RE<20.0 | ≥50.0 | 48.0≤Si≤50.0 | ≤2.5 | ≤6.0 | ≤1.5 | ≤1.0 |
| RESiFe-23-YS | 20.0≤RE<25.0 | ≥50.0 | 43.0≤Si≤48.0 | ≤2.5 | ≤6.0 | ≤1.5 | ≤1.0 |
| RESiFe-28-YS | 25.0≤RE<30.0 | ≥50.0 | 43.0≤Si≤48.0 | ≤2.0 | ≤6.0 | ≤1.0 | ≤1.0 |
| RESiFe-33-YS | 30.0≤RE<35.0 | ≥50.0 | 40.0≤Si≤45.0 | ≤2.0 | ≤6.0 | ≤1.0 | ≤1.0 |
| RESiFe-28-YM | 25.0≤RE<30.0 | ≥50.0 | 43.0≤Si≤48.0 | ≤2.0 | ≤6.0 | ≤1.0 | ≤1.0 |
| RESiFe-33-YM | 30.0≤RE<35.0 | ≥50.0 | 40.0≤Si≤45.0 | ≤2.0 | ≤6.0 | ≤1.0 | ≤1.0 |

5.2 Particle size

The product particle size ranges are divided into not greater than 5 mm, 5 mm～50 mm, and greater than 50 mm. Products with particle size less than the lower limit should not exceed 5% of the total weight, and greater than the upper limit should not exceed 5% of the total weight. By agreement between the supplier and purchaser, the particle size range with other special requirements can also be adopted.

5.3 Appearance quality

The appearance of the product is blocky, not powdered, and the section should be silver-gray. No inclusions and oxidative shedding powder on the surface and section.

6 Test methods

6.1 Chemical composition

6.1.1 The analysis method of RE, La/RE, Ce/RE, Y/RE, Si, Mn, Ca, and Ti content in the product shall be carried out according to GB/T 16477 (all parts).

6.1.2 The analysis method of Al content in the product shall be carried out according to GB/T 24194 (Al content in yttrium-based heavy rare earth ferrosilicon alloy shall be determined by standard curve method)

6.2 Particle size of product

When the particle size of the product is greater than 50 mm, a straight edge is used for measurement, and when it is less than 50 mm, a square hole sieve is used for detection, which shall be carried out according to GB/T 13247.

6.3 Appearance quality

Visual inspection under natural scattered light.

6.4 Rounding off numerical values

According to GB/T 8170

7 Inspection regulation

7.1 Factory inspection and delivery acceptance

7.1.1 The product shall be inspected by the quality inspection department of the supplier or third party inspection. The quality of the product shall be as specified in this standard and the quality certificate shall be filled in.

7.1.2 The purchaser shall inspect the received product, and in case of the product have any discrepancy with this standard; the purchaser should inform the supplier of such discrepancy with in 2 month of receiving the product for settlement negotiation by both parties. If arbitration is needed, it can be entrusted to a unit recognized by both parties and sampling shall take place at the purchaser's premises with the participation of both parties.

7.2 Batching

Products should be submitted for acceptance in batches, each batch should be made up of the same designation and particle size range. Weight of each batch is not more than 2500 kg.

7.3 Inspection items

Each batch of products shall be inspected for chemical composition, particle size, and appearance quality.

7.4 Sampling

7.4.1 Minimum weight of sample

The corresponding relations between minimum weight of sample and the specified maximum particle size of the batch of products shall be as specified in Table 3.

Table 3 Specified maximum particle size and minimum weight of sample

|  |  |
| --- | --- |
| Specified maximum particle size D  mm | minimum weight of sample  kg |
| D≥50 | 5 |
| 25≤D<50 | 3.5 |
| 10≤D<25 | 1.5 |
| D<10 | 0.5 |

7.4.2 Minimum number of sample

Minimum number of sample shall be as specified in Table 4.

Table 4 Minimum number of sample

|  |  |
| --- | --- |
| Delivered bath  t | Minimum number of sample  pcs |
| 1~2.5 | 9 |
| 0.5~1 | 7 |
| 0~0.5 | 5 |

7.4.3 Sampling method

The sampling method usually adopts a two-step sampling method, and random sampling or systematic sampling may be used in the sampling process.

When the particle size of the package is quite different, the grid method shall be used for sampling.

7.4.4 Particle size sampling

Particle size sampling shall be carried out according to GB/T 13247.

7.5 Determination of inspection result

7.5.1 If the inspection result of chemical composition has any discrepancy with this standard, then double as many samples shall be taken from the same batch for repetitive inspection on nonconforming item; If any inspection result of chemical composition of the product is still fails, then this batch is determined as nonconforming product.

7.5.2 If the inspection result of appearance quality of the product has any discrepancy with this standard, this batch is determined as nonconforming product.

8 Marking, Packaging, Transportation, Storage and Accompanying Documents

8.1 Packaging

Product shall be packaged in woven bag with plastic bag inside. By agreement between the supplier and purchaser, the packaging with other special requirements can also be adopted.

8.2 Marking, Transportation, and Storage

Marking, transportation, and storage of products shall be carried out according to GB 39176.

8.3 Accompanying documents

Each batch of product shall be accompanied by accompanying documents, which should include quality certificate. Quality certificate shall be carried out according to GB 39176. In addition, it shall also include:

a) Product certificate;

b) Inspection reports during the product quality control process and inspection report of final product;

c) Product manual;

d) This standard number.

Bibliography

[1]GB/T 15676-2015 *Terms for rare earths*