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BAOSHAN IRON & STEEL CO., LTD.

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Cold-rolled grain-oriented electrical steel strip delivered in the fully processed state

全工艺冷轧取向电工钢带

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Cold-rolled grain-oriented electrical steel strip delivered in the fully processed state

1 Scope

This document specifies the definition, classification and code, size, shape, weight, magnetic properties, inspection and testing, packaging, marking and quality certificate requirements of cold-rolled grain-oriented electrical steel strip delivered in the fully processed state, which has a nominal thickness of 0.18 mm, 0.20 mm, 0.23 mm, 0.27 mm, 0.30 mm, 0.35 mm.

This document applies to cold-rolled grain-oriented electrical steel strip delivered in the fully processed state (hereinafter referred to as product), which is delivered in the final annealing state produced by Baoshan Iron & Steel Co., Ltd.

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) is applicable to this standard.

GB/T 228.1-2021 Metallic materials - Tensile testing - Part 1: Method of test at room temperature

GB/T 247 General rule of package, mark and certification for steel plates (sheets) and strips

GB/T 2521.2 Cold-rolled electrical steel delivered in the fully-processed state - Part 2: Grain-oriented steel strip (sheet)

GB/T 2522 Methods of test for the determination of coating insulation resistance and coating adhesion of electrical strip and sheet

GB/T 2900.60 Electrotechnical terminology - Electromagnetism

GB/T 3655 Methods of measurement of the magnetic properties of electrical steel strip and sheet by means of an Epstein frame

GB/T 4340.1 Metallic materials - Vickers hardness test - Part 1: Test method

GB/T 8170 Rules of rounding off for numerical values and expression and

judgement of limiting values

GB/T 9637 Electrotechnical terminology - Magnetic materials and components

GB/T 13789 Methods of measurement of the magnetic properties of electrical steel strip and sheet by means of a single sheet tester

GB/T 17505 Steel and steel products - General technical delivery requirements

GB/T 18253 Steel and steel products - Types of inspection documents

GB/T 19289 Methods of measurement of resistivity, density and stacking factor of electrical steel strip and sheet

YB/T 4292 Methods of determination of the geometrical characteristics of electric steel sheet and strip

YB/T 4731 Reverse bend test method for electrical steel strip and sheet

Q/BQB 400 Package, mark and inspection document for cold-rolled product

IEC 60404-8-7 Specifications for individual materials - Cold-rolled grain-oriented Magnetic materials electrical steel strip and sheet delivered in the fully-processed state

IEC/TR 62581-2010 Methods of measurement of the magnetostriction characteristics by means of single sheet and Epstein test specimens

3 Terms and definitions

The terms and definitions as defined in GB/T 2521.2, GB/T 2900.60, GB/T 9637, YB/T 4292, as well as the following terms, apply to this document.

3.1 Specific total loss (iron loss)

Specific total loss refers to the total power absorbed by a unit mass of material when the magnetic polarization intensity changes sinusoidally and its peak value and frequency are specific values. The specific total loss is represented by the symbol P (J_m/f), in W/kg (or W/lb).

Example: $P_{1.7/50}$ represents the specific total loss per unit kg (or lb) of specimen, which is measured at a magnetic polarization intensity of 1.7T and a frequency of 50Hz;

$P_{1.7/60}$ represents the specific total loss per unit kg (or lb) of specimen, which is measured at a magnetic polarization intensity of 1.7T and a frequency of 60Hz.

3.2 Magnetic polarization (magnetic induction)

Magnetic polarization refers to the peak value of the specific magnetic field intensity when the specimen is magnetized by an alternating magnetic field. Its symbol is J (H) and its unit is T (Tesla).

Example: J_{800} represents the magnetic polarization corresponding to a magnetic field intensity H of 800A/m (expressed as peak value).

3.3 Specific apparent power

For the set magnetic polarization and frequency values, the total power consumed by the magnetized unit mass of the iron core is the specific apparent power, with its symbol S_S and its unit VA/kg.

Example: $S_{S1.7/50}$ represents the specific apparent power per kg of the specimen, which is measured at a magnetic polarization intensity of 1.7T and a frequency of 50Hz.

3.4 A-weighted magnetostriction velocity level, L_{VA}

When the magnetic polarization changes sinusoidally with time, its peak value is a certain calibration value, the frequency of change is a certain calibration frequency, the surface vibration sound pressure level caused by magnetostriction per unit length of electrical steel sheet (strip) along the magnetization direction is the A-weighted magnetostriction velocity level.

3.5 Surface insulation resistance

The DC resistance measured under specified conditions, that is, the resistance corresponding to the leakage current flowing through the surface of the strip (sheet) after the product is polarized for a certain period of time after the DC voltage is applied, which has a symbol C and a unit of $\Omega \cdot mm^2$/surface or $\Omega \cdot cm^2$/surface.

3.6 Inter-lamination resistance

The insulation resistance between the product laminations, that is, the upper and lower surfaces, is called inter-lamination resistance, with the symbol R_A, theoretically which is twice the surface insulation resistance, in $\Omega \cdot mm^2$/sheet or $\Omega \cdot cm^2$/sheet.

4 Classification

The designations of the materials in this document is classified according to the nominal value of the maximum specific total loss $P_{1.7/50}$ (W/kg) at a magnetic polarization of 1.7T and a frequency of 50Hz, as well as the nominal thickness of the material.

under its own weight.

6.2.5 The steel coil usually does not have a weld. If the product has a joint or weld due to the removal of defects, the joint or weld shall be marked. The front and rear parts of the joint or weld shall be of the same designation and not more than 2 places. The length of the steel strip between the welds shall not be less than 200 meters; it shall be indicated in the contract after negotiation between the supplier and the buyer.

6.2.6 Except for the uncoated series products, the products are coated with insulating coating on both sides.

6.2.7 When the user has special requirements, it shall comply with the order agreement.

6.3 Delivery status

The products are delivered in the final annealed state. The coated products are coated with insulating coating on both sides. The uncoated series products have no base layer and insulating coating on the surface. The type of insulating coating is determined by the supplier according to its own production process; it can also be determined by negotiation between the supplier and the buyer.

6.4 Surface conditions

6.4.1 The surface of the product shall be smooth and clean, free of grease, rust stains, or defects that affect use.

6.4.2 The surface of the product is allowed to have substrate defects, base layer defects, insulating coating defects that do not affect the normal use of the material, such as slight scratches, roller marks, color differences, crystal exposure, color spots, small white spots, small bubbles, cracks and other defects.

6.4.3 The insulating coating on the surface of the product shall adhere well and the coating shall be uniform, to ensure that it does not fall off during reasonable shearing operations and annealing under the stress relief annealing conditions recommended by the manufacturer.

6.4.4 When the product is delivered with welds or defects, blank paper must be inserted. If necessary, the marking form of the relevant blank paper shall be negotiated by the supplier and the buyer and indicated in the contract.

Note: If the product is used immersed in liquid as specified in the agreement, the compatibility between the liquid and the coating must be ensured.

6.5 Shear adaptability

The product shall be easy to accurately cut into a common shape, at any position with appropriate shearing tools.

7 Technical requirements

7.1 Magnetic properties

7.1.1 The properties of cold-rolled grain-oriented electrical steel provided under the conditions of 6.3 shall comply with the provisions of Tables 3, 4, 5, 6, 7, 8, 9; the aged specimens shall also meet these properties. For products with coatings, the mass of the insulating coating shall be calculated.

7.1.2 The magnetic properties of the conventional magnetostriction type, high permeability type, heatproof scribed domain-refined products in Tables 3, 4, 6 shall be tested in accordance with GB/T 3655. Before testing, the specimens shall be subjected to stress relief annealing, under the conditions provided by the manufacturer (usually the stress relief annealing temperature range is 800 °C ± 20 °C, the annealing time is 2h, it is cooled together with the furnace after annealing). However, the magnetic properties of the products produced by the non-heatproof domain-refined method (such as laser scratching) in Table 5 shall be tested in accordance with GB/T 13789; the specimens do not need to be subjected to stress relief annealing before testing. After negotiation between the supplier and the buyer, the magnetic properties of the products in Tables 3, 4, 6 can also be tested in accordance with GB/T 13789.

7.1.3 The magnetic property detection methods of each series of products in Tables 7, 8, 9 shall be carried out according to the provisions of Article 7.1.2 of this document according to the product type.

7.1.4 The magnetic polarization intensity J_{800} measured under the condition of magnetic field intensity H = 800 A/m shall comply with the provisions of Table 3, Table 4, Table 5, Table 6, Table 7, Table 8, Table 9. The magnetic polarization intensity value J_{800} of the same product, which is measured by the GB/T 13789 method, is lower than the magnetic polarization intensity value, which is measured by the GB/T 3655 method.

7.1.5 For domain-refined products with a thickness of no more than 0.20 mm, under the conditions of magnetic polarization intensity of 1.7T and frequency of 50Hz or 60Hz, the specific total loss values under 50Hz and 60Hz conditions, as measured by the GB/T 13789-2022 method, shall be converted with reference to the conversion coefficient F_C = 0.925 specified in IEC 6040-8-7 Edition 5.0 2020-09. The converted $P_{1.7/50}$ and $P_{1.7/60}$ shall comply with the provisions of Table 5, Table 7, Table 9. The conversion coefficient F_C of $P_{1.5/50}$ and $P_{1.5/60}$ under the same conditions shall be determined based on the results of actual detection and application comparison experiments.

7.1.6 For domain-refined products with a thickness of not less than 0.23 mm, the specific total loss values at 50 Hz and 60 Hz, as measured by the GB/T 13789-2022 method, shall be converted to the square circle method data, with reference to the relationship D.1 specified in Appendix D of GB/T 13789-2022. The converted $P_{1.7/50}$, $P_{1.7/60}$, $P_{1.5/50}$, $P_{1.5/60}$ shall comply with the provisions of Table 5, Table 7, Table 9.

7.2 Coating characteristics

According to the requirements of the buyer, after negotiation between the supplier and the buyer, the coating characteristics test can be carried out; the coating characteristics guarantee value shall be indicated in the contract. If the product needs to be heat treated, it shall be carried out according to the conditions specified by the manufacturer, meanwhile it shall be indicated in the contract that the coating characteristics shall be tested before or after the heat treatment.

The insulating coating shall be able to withstand the erosion of insulating paint, transformer oil, mechanical oil and other media.

7.2.1 Coating adhesion

The coating adhesion level of products with a thickness of <= 0.23 mm shall be D or above; the coating adhesion level of products with a thickness of > 0.23 mm shall be E or above.

During the shearing process and heat treatment under the heat treatment conditions specified by the supplier, the coating shall not fall off in a large area, but slight cracking of the coating is allowed on the shearing edge.

7.2.2 Coating insulation resistance

The detection of coating insulation resistance shall refer to GB/T 2522, or the two parties may negotiate and detect according to the agreed method. The relevant technical requirements shall be stated in the contract.

According to GB/T 2522, the surface insulation coating resistance measured by single-sided 5 measurements shall have an average value of not less than 30 Ω·cm²/side; the single minimum value of single-sided 5 measurements shall not be less than 5Ω·cm²/side. If the supplier can guarantee, this test may not be carried out.

7.3 Geometric properties and tolerances

7.3.1 Thickness

The nominal thickness of the product is 0.18 mm, 0.20 mm, 0.23 mm, 0.27 mm, 0.30 mm, 0.35 mm. The thickness tolerance includes the following three categories, including:

- The tolerance of the nominal thickness within the same acceptance batch, referred to as the nominal thickness tolerance;

- The deviation between the actual thickness of each point in the longitudinal direction of the product within a certain length (2000 mm ± 200 mm) parallel to the rolling direction (i.e., the length direction of the product), hereinafter referred

According to the requirements of the purchaser and indicated in the contract, the residual curvature of products with a width of not less than 150 mm can be tested. The distance between the bottom edge of the test steel sheet and the support plate shall not exceed 10 mm. If the supplier can guarantee it, this test can be omitted.

7.3.6 Burr height

The shear burr height of the trimmed product shall not exceed 0.020 mm.

7.4 Technical characteristics

7.4.1 Density

The agreed density used to calculate the magnetic properties and stacking factor is 7.65 × 10^3 kg/m^3.

7.4.2 Stacking factor

The minimum stacking factor of the product shall comply with the provisions of Table 3, Table 4, Table 5, Table 6, Table 7, Table 8, Table 9.

7.4.3 Number of bending

The minimum number of bending of the product parallel to the rolling direction shall not be less than 1. If the supplier can guarantee this, this test may not be performed.

7.4.4 Deviation of shear edge caused by internal stress

The product shall avoid internal stress as much as possible. According to the requirements of the purchaser and indicated in the contract, the shear edge deviation caused by internal stress can be tested for materials with a width of not less than 500 mm (materials after longitudinal slitting); the gap measurement value shall not exceed 1 mm. If the supplier can guarantee this, this test may not be performed.

8 Inspection and test

8.1 General requirements

8.1.1 When signing an order agreement according to this document, the user may perform specified inspections and tests or non-specified inspections and tests in accordance with GB/T 17505. However, for non-specified inspections and tests, the manufacturer shall provide the required specific total loss value and magnetic polarization intensity value of the product.

8.1.2 When placing an order for inspection and testing as specified, the user shall specify the type of inspection document in GB/T 18253.

8.1.3 Coils shall be batched by coils; generally one coil shall constitute one acceptance batch.

8.1.4 Unless otherwise agreed, the provisions of 8.1.3 apply to the inspection of shear edge deviation caused by internal stress, coating insulation resistance, geometric characteristics, tolerance.

8.1.5 When the product is supplied in the form of sub-coils, the test results on the original acceptance batch shall apply to the sub-coil.

8.2 Sampling

8.2.1 Samples shall be cut from each acceptance batch.

8.2.2 The innermost and outermost rings of the product shall be regarded as packaging materials and do not represent the quality of the entire steel coil. Specimens shall not be cut from this part. Specimens shall avoid welds and joint areas.

8.2.3 The sampling position shall be not less than 3 m from both ends of the product and not less than 15 mm from the edge of the product. For test items with special sampling requirements such as large single-sheet magnetic properties and insulation coating adhesion, sampling shall be carried out in accordance with the provisions of Appendix A.

8.2.4 By arranging the test sequence reasonably, the same set of specimens can be used to test multiple characteristics.

8.3 Surface appearance inspection

The surface appearance quality of the product is inspected by naked eyes.

8.4 Measurement of size and shape

8.4.1 Size and shape

It shall be measured with appropriate measuring tools. The measurement position shall be no less than 3 m from the head and tail ends of the product.

8.4.2 Thickness measurement

The thickness of the trimmed steel strip shall be measured at any position not less than 15 mm from the edge. The micrometer used for measurement shall have an accuracy of 0.001 mm.

8.4.3 Measurement of unevenness (wavyness)

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