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Cold-rolled non-oriented electrical steel strip (sheet) for electric vehicle driving motor

电动汽车驱动电机用冷轧无取向电工钢带(片)

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Table of Contents

Cold-rolled non-oriented electrical steel strip (sheet) for electric vehicle driving motor

1 Scope

This document specifies symbols and codes, designations, ordering contents, general requirements, technical requirements, inspection and testing, re-inspection and judgment rules, packaging, marking and quality certificates for cold-rolled non-oriented electrical steel strip (sheet) for electric vehicle driving motor.

This document is applicable to grain-non-oriented electrical steel strip (sheet) with nominal thicknesses of 0.20 mm, 0.25mm, 0.27 mm, 0.30 mm, 0.35 mm, for the manufacture of electric vehicle drive motors [hereinafter referred to as "steel strip (sheet)"].

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

GB/T 228.2-2015, *Metallic materials -- Tensile testing -- Part 2: Method of test at elevated temperature*

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

GB/T 2521.1-2016, *Cold-rolled electrical steel delivered in the fully-processed state -- Part 1: Grain non-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 9637, *Electrotechnical terminology -- Magnetic materials and components*

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

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 4731-2019, *Reverse bend test method for electrical steel strip and sheet*

3 Terms and definitions

For the purposes of this document, the terms and definitions defined in GB/T 2900.60, GB/T 9637, GB/T 2521.1-2016 apply.

4 Symbols and codes

4.1 Symbols

The following symbols apply to this document.

A_{50mm}: Elongation after break with original gauge length of 50 mm.

J_{5000}: Magnetic polarization intensity at which the peak magnetic field intensity is 5000A/m.

$P_{1.0/400}$: Specific total loss measured with the peak magnetic polarization intensity at 1.0 T and the frequency at 400 Hz.

R_{eL}: Lower yield strength.

R_m: Tensile strength.

$R_{p0.2}$: Stress that specifies the plastic elongation of 0.2%.

4.2 Codes

The following codes apply to this document.

NV: Non grain-oriented steel for electrical vehicle

NVP: Non grain-oriented high-permeability steel for electrical vehicle

NVPS: Non grain-oriented high-permeability and high-strength steel for electrical vehicle

NVS: Non grain-oriented high strength steel for electrical vehicle

5 Designations

5.1 Product type

In this document, the products are classified into four types: non-grain-oriented type, non-grain-oriented high-permeability type, non-grain-oriented high-permeability and high-strength type and non-grain-oriented high strength type.

5.2 Methods for expressing designations

5.2.1 The levels for designations of non-grain-oriented type, non-grain-oriented high-permeability type, non-grain-oriented high-permeability and high-strength type are defined based on the maximum specific total loss value $P_{1.0/400}$ of material nominal thicknesses 0.20 mm, 0.25 mm, 0.27 mm, 0.30 mm and 0.35 mm, measured with magnetic polarization peak at 1.0 T, frequency at 400 Hz. The levels for designations of non-grain-oriented high strength type are defined according to the minimum yield strength for material nominal thickness 0.35 mm.

5.2.2 The product designation consists of the following three parts in order.

- 100 times the nominal thickness of the material, in millimeters (mm).

- Product type code.

- When the product type is non-grain-oriented type, non-grain-oriented high-permeability type, or non-grain-oriented high-permeability and high-strength type, Part 3 is 100 times the maximum specific total loss $P_{1.0/400}$ (unit: W/kg) measured with the peak magnetic polarization intensity at 1.0 T and the frequency at 400 Hz. When the product type is non-grain-oriented high strength type, Part 3 is the minimum yield strength.

Example 1:

30NV1500 represents non-grain-oriented type non-oriented electrical steel strip (sheet) for electric vehicle driving motor with a nominal thickness of 0.30 mm and a maximum specific total loss $P_{1.0/400}$ of 15.0 W/kg.

Example 2:

27NVP1400 represents non-grain-oriented high-permeability type non-oriented electrical steel strip (sheet) for electric vehicle driving motor with a nominal thickness of 0.27 mm and a maximum specific total loss $P_{1.0/400}$ of 14.0 W/kg.

Example 3:

27NVPS1400 represents non-grain-oriented high-permeability and high-strength type non-oriented electrical steel strip (sheet) for electric vehicle driving motor with a

recommended inner diameter of the steel coil is 508 mm;

c) Steel coils shall be tightly rolled from steel strips of the same width. The sides of the roll shall be as straight as possible. They do not collapse under their own weights.

7.3 Delivery conditions

Steel strips (sheets) shall be delivered trimmed. Before delivery, the steel strip (sheet) shall be coated with an insulating coating on one or both sides. It can also be delivered without insulating coating. The type of insulating coating is determined by negotiation between the supplier and the purchaser.

7.4 Surface quality

The surface of the steel strip (sheet) shall be smooth and clean. There shall be no rust. Dispersed defects, such as scratches, bubbles, cracks, etc., are allowed if they are within the thickness tolerance and do not hinder the normal use of the material.

7.5 Shear adaptability

The steel strip (sheet) shall be easy to cut or punch to ensure that the steel strip (sheet) can be cut into a usual shape at any position. If the purchaser has special requirements, they can be determined through negotiation between the supplier and the purchaser.

8 Technical requirements

8.1 Magnetic properties

8.1.1 The magnetic properties of steel strips (sheets) at room temperature shall comply with the requirements in Table 1. The magnetic performance requirements after aging shall be negotiated by the supplier and the purchaser at the time of ordering and shall be specified in the contract.

8.1.2 The magnetic properties of steel strips (sheets) at 150°C are shown in Annex B, but they are not used as a basis for delivery.

not exceed 3.0 mm.

8.4.5 Residual curvature

According to the requirements of the purchaser and specified in the contract, the residual curvature of the steel strip (sheet) can be tested. The distance between the bottom edge of the test steel sheet and the support plate shall not exceed 35 mm. If the supplier can guarantee it, this test may not be performed.

8.4.6 Burr height

The height of the steel strip (sheet) shear burrs shall not exceed 0.030 mm.

8.5 Technical characteristics

8.5.1 Density

Unless otherwise agreed, the agreed density used to calculate magnetic properties and stacking coefficient shall comply with the provisions of Table 1。

8.5.2 Stacking coefficient

The minimum stacking coefficient of steel strips (sheets) shall comply with the requirements in Table 1. In case of dispute, the stacking factor applies only to the uncoated state.

8.5.3 Number of bends

The minimum number of bends perpendicular to the rolling direction of the steel strip (sheet) shall comply with the requirements in Table 2. If the supplier can guarantee it, this test may not be performed.

9 Inspection and testing

9.1 General requirements

9.1.1 Steel strips (sheets) shall be accepted in batches. Each inspection batch shall be composed of steel strips (sheets) of the same designation, specification, heat treatment status, and insulating coating not larger than 20 t. For steel strips weighing more than 20 t, each steel coil forms an inspection lot.

9.1.2 When steel strip is supplied in coils, the test results on the original acceptance batch shall apply to that coil.

9.2 Sampling

9.2.1 General requirements

9.2.1.1 Steel strip (sheet) samples shall be taken from each acceptance batch.

9.2.1.2 The innermost and outermost rings of the steel coil shall be regarded as packaging materials and do not represent the quality of the entire steel coil. The sample shall be taken from a distance of not less than 3 m from the head and tail of the steel coil and not less than 15 mm from the edge of the steel strip.

9.2.2 Magnetic properties

The magnetic property test specimens are sampled from the longitudinal and transverse directions of the steel strip (sheet). The number of specimens is half vertically and half horizontally. The recommended weight is about 0.50 kg. The sampling method, size and allowable deviation of the specimen shall comply with the provisions of GB/T 3655.

9.2.3 Geometric properties

9.2.3.1 The steel strip for testing the unevenness of the steel strip (sheet) shall have a specimen length of 1000 mm. The specimen length for testing sickle bending is 2000 mm steel strip.

9.2.3.2 The specimen length for testing the residual curvature of the steel strip (sheet) is 500 mm. The width is the width of the supplied steel strip (sheet). The axis of the specimen length shall be parallel to the rolling direction.

9.2.3.3 The sample for testing the burr height is taken from the steel strip (sheet) delivered as finished product. The recommended sample length is not less than 500 mm.

9.2.4 Technical characteristics

9.2.4.1Stacking coefficient

9.2.4.1.1 The specimens used to test the stacking coefficient of steel strips (sheets) require sufficient stacking specimens of the same size to be at least 6 mm high. In case of dispute, the test specimen shall consist of 100 pieces.

9.2.4.1.2 The specimen shall have no obvious burrs before testing. The minimum width of the sample is 20 mm and the minimum surface area is 5000 mm^2.

9.2.4.1.3 The width deviation of the specimen shall be -0.2 mm ~ 0.2 mm. The length deviation shall be -0.5 mm ~ 0.5 mm.

9.2.4.2 Number of bends

The specimen for testing the number of bends of the steel strip (sheet) shall comply with the regulations of YB/T 4731-2019.

9.2.4.3 Coating insulation resistance

The specimens used to test the insulation resistance of steel strips (sheets) coatings shall

The sickle bend of the steel strip (sheet) shall be tested according to YB/T 4292.

9.3.3.4 Unevenness

The unevenness of the steel strip (sheet) shall be tested according to YB/T 4292.

9.3.3.5 Residual curvature

The residual curvature of the steel strip (sheet) shall be tested according to YB/T 4292.

9.3.3.6 Burr height

The burr height of the steel strip (sheet) shall be tested according to YB/T 4292.

9.3.4 Technical characteristics

9.3.4.1 Stacking coefficient

The stacking coefficient of steel strips (sheets) shall be tested according to GB/T 19289.

9.3.4.2 Number of bends

The number of bends of the steel strip (sheet) shall be tested according to method B of YB/T 4731-2019.

9.3.4.3 Coating insulation resistance

The coating insulation resistance of steel strips (sheets) shall be tested according to GB/T 2522. The recommended total contact area is 645 mm^2.

9.3.4.4 Insulating coating adhesion

The adhesion of the insulating coating of the steel strip (sheet) shall be tested according to GB/T 2522.

9.3.4.5 Mechanical properties

9.3.4.5.1 The room temperature mechanical properties of the steel strip (sheet) shall be tested in accordance with GB/T 228.1-2021. It is recommended to use a test rate based on stress rate (Method B). In order to improve the reproducibility of measurement results, the beam displacement control method is recommended. The yield strength measurement rate is 5%L_c/min or 0.00083/s. The yield strength is measured at a rate of 40%L_c/min (L_c is the parallel length of the specimen) or 0.0067/s.

9.3.4.5.2 The high-temperature mechanical properties of steel strips (sheets) shall be tested in accordance with GB/T 228.2-2015. An extended strain rate range test method (Method B) is recommended. In order to improve the reproducibility of measurement results, it is recommended to adopt the beam displacement control method. The yield section speed is 0.000067 s^{-1}. The rate after yielding is 0.00083 s^{-1}.

Annex D

(normative)

Measurement of magnetic properties at 35℃ ~200℃ by Epstein square coil method

D.1 Test equipment

D.1 .1 Epstein square coil

In addition to complying with the technical requirements of GB/T3655, Epstein square coil shall also meet the requirements for continuous operation at high temperatures (usually 150°C). Relevant components and production materials shall have good high temperature resistance (≥200℃).

D.1.2 Technical requirements for heating devices

The heating device shall be able to heat the entire Epstein square coil containing the specimen to the specified temperature.

The effective space of the heating zone of the heating device shall be no less than 400 mm long, 400 mm wide and 300 mm high. The maximum allowable deviation between the specified temperature of the heating device and the indicated temperature is 2°C. The temperature gradient in the uniform temperature area corresponding to the specimen along the axis of the specimen shall not be greater than 2°C.

D.1.3 Temperature measurement system

The minimum resolution of the temperature testing system is 0.5°C. The allowable error shall be within 1°C.

The temperature measurement system (including thermocouples, wires, display devices, connection points, etc.) shall meet the requirements for use within the test temperature range of 35℃ ~ 200℃ and be calibrated.

D.1.4 Specimen temperature measurement

Set at least one temperature sensor inside the middle part of the Epstein square coil winding close to the surface of the specimen, used to monitor the temperature of the specimen. If there are multiple temperature sensors, the specimen temperature is the minimum value of multiple temperature measurement values.

The fluctuation of specimen temperature during magnetic property measurement shall meet the requirements of the specified test temperature [such as (150±2)℃].

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