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**Method of test for the thermal endurance of surface insulation
coatings of electrical sheet and strip**
(English Translation)

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1 Scope

This Document describes a test method for the thermal endurance of surface insulation coatings of electrical steel strip (sheet).

This Document defines the general principles and technical details for assessing the thermal endurance of surface insulation coatings of electrical steel strip (sheet) after heat treatment at a specified temperature (850 °C at max.) for a specified duration (2500 h at max.), including the principles, specimens, test procedures, measurement results, and test reports.

The specified properties are measured at an ambient temperature of (23±5) °C before and after heat treatment. This Document applies to the following properties of the insulation coating.

- Adhesion;
- Surface insulation resistance/interlayer insulation resistance;
- Stacking factor.

This Document does not apply to other properties of the insulation coating, such as weldability, or discoloration and the like performances that may occur due to exposure to high temperatures.

Because this is a long-term test, this Document is not applicable to acceptance testing of materials for specific orders.

2 Normative References

The provisions in following documents become the essential provisions of this Document through reference in 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 Document.

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 9637 Electrotechnical terminology - Magnetic materials and components

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

3 Terms and Definitions

For the purposes of this Document, the terms and definitions given in GB/T 2900.60, GB/T 9637 and the following apply.

3.1 Temperature/time performance designation; T/t

It consists of temperature T (°C) and time t (h), where t is the duration of heat treatment that the insulating coating can withstand relative to its specific performance characteristics.

NOTE 1: This designation is used to assess the thermal endurance of the insulating coating.

NOTE 2: A coating may have more than one performance designation. For example, given performance designations 200/2500 and 800/2, which indicate that the coating can withstand heat treatment at 200°C for 2500 h and at 800°C for 2 h, respectively.

4.1 General

The thermal endurance of the insulating coating shall be assessed by the change in coating performances before and after heat treatment at a specified temperature T and a specified time t.

Coating performances shall be measured at an ambient temperature of (23±5) °C. The thermal endurance of the following coating performances shall be assessed separately.

- Adhesion;
- Surface insulation resistance/interlayer insulation resistance;
- Stacking factor.

4.2.1 Specimen stacking procedure

Specimens shall be stacked between two plates of similar or larger dimensions made of the same material as the specimen; and then two steel clamping plates are used to sandwich the stack in the middle; the size of two steel clamping plates shall be at least 10 mm larger than the specimen size.

Bolts shall be tightened; and the springs, bolt materials, and steel clamping plates shall maintain substantially constant pressure during heat treatment of the specimen.

4.2.3 Clamping and stacking at rated temperature > 500 °C

The specimen stacking shall be uniformly clamped between two steel clamping plates, with a clamping pressure of $(0.01 \pm 0.001) \text{ N/mm}^2$. The steel plates shall be larger than the dimensions of the portion of the specimen to be tested.

Pressure shall be applied by its own weight or by an external force transmitted from outside the furnace by suitable heat insulation rods.

4.3.1 Rated time $\leq 2500 \text{ h}$

The clamped and stacked specimens shall be placed in a heating furnace. The furnace shall be heated to T (°C) at a rate not exceeding 200 °C/h .

When the furnace temperature reaches T (°C) $\pm 1.5\%$, it shall be maintained at this temperature for a specified duration of t (h) $\pm 1.5\%$, where T and t constitute the temperature/time performance designation T/t .

After the duration t (h), the clamped and stacked specimens shall be removed from the furnace and cooled to ambient temperature.

The furnace shall have sufficient power and heating capacity to ensure that when the furnace reaches temperature T (°C), the temperature difference between the clamped surface and the furnace chamber shall be less than $2.5\%T$ (°C). The heating capacity of the furnace shall be verified, for example, by using thermocouples on the clamped specimens.

A furnace with forced atmospheric convection is recommended.

For temperatures $\leq 500^\circ\text{C}$, heat treatment shall be performed in air. For temperatures $> 500^\circ\text{C}$, other atmospheres, such as an inert atmosphere, can be used.

4.3.2 Heating method for specimens during continuous test

Where continuous operating time for heating of the specimen can be guaranteed, the procedure in 4.3.1 shall be followed; where continuous heating cannot be guaranteed, the specimen shall be heated at $(T + 30) \text{ °C} \pm 1.5\%$ for $2500 \text{ h} \pm 1\%$.

Temperature T can typically reach 250°C.

NOTE: Continuous operation test at high temperatures is impractical and uneconomical; the above empirical method has become common practice in the industry. When continuous heating of the specimen cannot be guaranteed, the supplier and the purchaser shall agree on the criteria for assessing temperature/time performance designation.

5 Temperature/Time Performance Designation

The standard temperature/time performance designation values for rated time tests are typically.

150/168; 180/168; 200/168; 250/168; 150/2500; 180/2500; 200/2500; 250/2500; 400/6; 500/5;

750/2; 800/2.

The standard temperature/time performance designation values for continuous operation tests are typically. 150/continuous; 180/continuous; 200/continuous; 250/continuous.

NOTE: Refer to Appendix C for the selection of temperature/time performance designations for different types of coatings.

6.1 General

Adhesion measurements in the thermal endurance assessment test shall be conducted using a copper tower with a diameter of (30 ± 0.1) mm at an ambient temperature of (23 ± 5) °C. The testing equipment shall refer to the relevant requirements of GB/T 2522.

NOTE: The supplier and the purchaser may agree to use copper towers of different diameters, such as 32 mm, 20 mm, and 10 mm. Smaller diameters shall increase the severity of the test.

6.2 Specimens

Four test specimens shall be cut parallel to the rolling direction at least 40 mm from the edge of the steel sheet or strip. The specimens shall be at least 30 mm wide, at least 280 mm ~ 320 mm long, and of nominal thickness, without damaging the coating.

NOTE: Test results of the adhesion of the insulation coating on an electrical steel plate of one nominal thickness are considered applicable to steel plates of other thicknesses using the same coating.

6.3 Test procedure

Take two specimens and test them without heat treatment. Test one specimen with one side facing the copper tower, and test the other specimen with the other side facing the copper tower.