SIST

SLOVENSKI STANDARD
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Magnetni materiali - Metode merjenja magnetnih lastnosti magnetnih pločevin in trakov pri srednjih frekvencah

Magnetic materials - Methods of measurement of magnetic properties of magnetic steel sheet and strip at medium frequencies

Magnetische Werkstoffe - Verfahren zur Messung der magnetischen Eigenschaften von Elektroblech und -band bei mittleren Frequenzen

Matériaux magnétiques - Méthodes de mesure des propriétés magnétiques a fréquences moyennes des tôles et feuillards magnétiques en acier

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ICS:

29.030	Magnetni materiali	Magnetic materials
77.140.50	Ploščati jekleni izdelki in polizdelki	Flat steel products and semi-products

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English version

Magnetic materials - Methods of measurement of magnetic properties of magnetic steel sheet and strip at medium frequencies

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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CEN

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Foreword

This European Standard has been prepared by Technical Committee ECISS/TC 24 "Electrical steel and strip qualitiees - Qualities, dimensions, tolerances and specific tests", the secretariat of which is held by AFNOR.

This European Standard is technically in accordance with IEC 404-10, with some editorial amendments.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 1997, and conflicting national standards shall be withdrawn at the latest by July 1997.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard is applicable to electrical steel sheet and strip for the construction of magnetic circuits for use in the frequency range 400 Hz to 10 000 Hz.

This European Standard specifies the following methods for the measurement of magnetic properties of electrical steel sheet and strip:

- a.c. measurements made with the 25 cm Epstein frame;

- determination of specific total losses by the wattmeter method;

- determination of magnetic field strength excitation and current and specific apparent power.

NOTE. The informative annex A gives the calculation method for the supplementary loss arising from the use of the Epstein frame at medium frequencies.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

IEC 50 (221) International Electrotechnical Vocabulary (IEV), Chapter 221: Magnetism

3 Accuracy and reproducibility

The final accuracy of the test apparatus is a complex function dependent on the measuring instruments and other features of the measuring environment and equipment components; therefore, it is not always possible to state the absolute accuracy which can be attained.

Moreover, experience in the use of a given method indicates the reproducibility which can be expected. Whenever the drafting Technical Committee has agreed upon reproducibility values, these have been given in this standard.

4 General conditions for a.c. measurements made with the 25 cm Epstein frame

4.1 Scope

This clause specifies the general conditions for the determination of a.c. magnetic properties of electrical steel sheet and strip by means of the 25 cm Epstein frame.

The use of the 25 cm Epstein frame is applicable to flat strip specimens obtained from electrical sheets and strips of any quality. The magnetic properties are determined for a sinusoidal induced voltage.

The measurements are made at an ambient temperature of 23 °C ± 5 °C on test specimens which have first been demagnetized.

4.2 Principle of the 25 cm Epstein frame method

The 25 cm Epstein frame, which comprises a primary winding, a secondary winding and the specimen to be tested as a core, forms an unloaded transformer whose properties are measured by the methods described in the following clauses.

At the higher end of the frequency range a specially constructed Epstein frame (see annex A) may be required in which the interwinding capacitances are low and the material of the winding formers supporting the solenoids has a low dielectric loss.

A separate measuring system (for example a commercially available universal bridge capable of measuring resistance, capacitance and inductance) is required to determine the interwinding capacitance of the Epstein frame

4.3 Test specimens

The magnetic circuit shall be made up of a core constructed with the strips to be tested, assembled in a square having double-lapped joints (see figure 1) to form four branches of equal length and equal cross-sectional area.

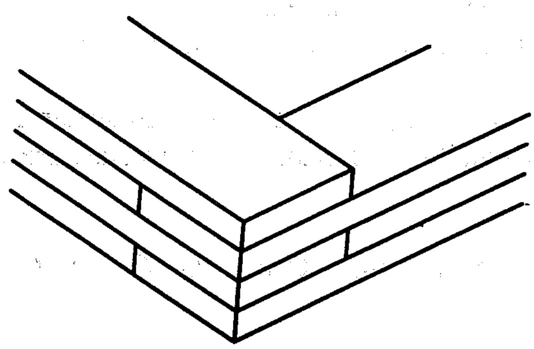

Figure 1. Double-lapped joints

The strips shall be sampled in accordance with the product standard. They shall be cut by a method which will produce clean burr-free edges. They shall have the following dimensions:

- width b = 30 mm ± 0,2 mm;

- length l such that 280 mm ≤ l ≤ 500 mm, the strips being of the same length within a tolerance of ± 0,5 mm.

For specimens of length greater than 305 mm, care shall be taken to avoid bending the strips during the test.

When the strips are cut parallel or normal to the direction of rolling, the edge of the parent sheet shall be taken as the reference direction.

The following tolerances shall be allowed for the angle between the direction of rolling and that of cutting:

± 1° for grain-oriented steel sheet;

± 5° for non-oriented steel sheet;

Only flat strips shall be used. Measurements shall be made without additional insulation.

The number of strips forming a test specimen shall be not less than twelve and shall be a multiple of four. A force of 1 N ± 0,1 N shall be applied to each corner, normal to the plane of the overlapping strips.

4.4 25 cm Epstein frame

The 25 cm Epstein frame (hereafter referred to as the "Epstein frame") shall consist of four solenoids which are practically identical into which the test specimen strips are introduced in such a manner that a closed magnetic circuit is formed (see figure 2).

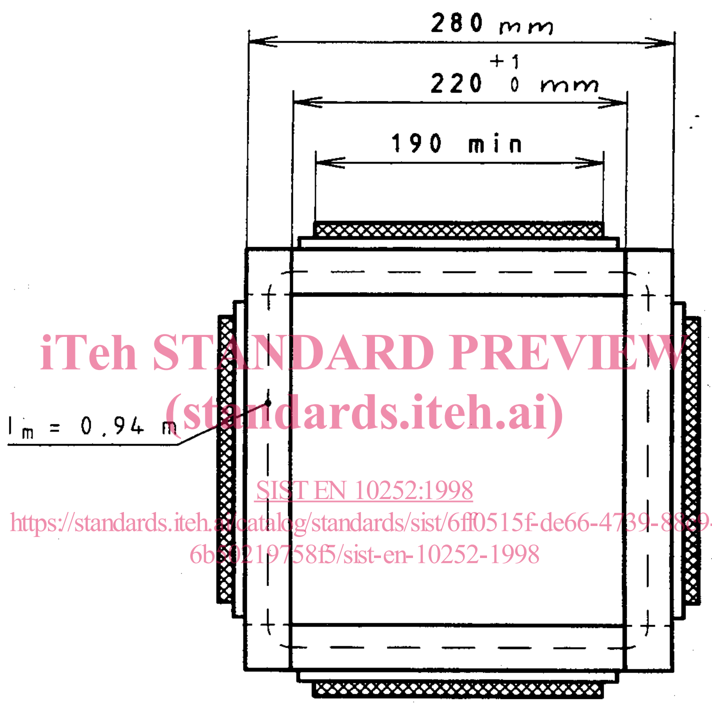

Figure 2: 25 cm Epstein frame

If measurements are to be made under the conditions specified in 4.5, a mutual inductor shall be provided for air flux compensation.

The winding formers supporting the solenoids shall be made of hard insulating material of low dielectric loss, such as polystyrene, and have a rectangular cross-section and an inner width of 32 mm. A height of about 5 mm will be sufficient and is recommended.

The solenoids shall be mounted on a non-conducting and non-magnetic base plate in a square arrangement. Each side of the inner square formed by the test specimen strips shall have a length of $220\ ^{+1}_{0}$ mm (figure 2).

In order to avoid undue wear of the winding formers and especially of their inner surfaces, winding formers of larger cross-section can be used into which replaceable liners of appropriate dimensions may be inserted.

Each solenoid comprises two windings:

- a primary winding (magnetizing winding):

- a secondary winding (voltage winding).

The windings on each solenoid shall be evenly distributed over a length of at least 190 mm, with each solenoid carrying one-fourth of the total number of turns. The individual primary windings of the four solenoids shall be connected in series, and the secondary individual windings shall be connected in a similar fashion.

At high frequencies, the loss due to the capacitance between the primary and secondary windings and also the self-capacitance of the secondary winding could be significant. The windings shall be spaced to minimize this loss.

The capacitance between the windings and the self-capacitance of the secondary winding shall be measured. If necessary, a correction shall be applied for the loss introduced.

The number of turns of the primary and secondary windings shall be chosen to suit the particular conditions of the power supply, instrumentation and measuring frequency.

A total of 200 turns for each of the primary and secondary windings is recommended and is commonly used for tests in the frequency range 400 Hz to 10 000 Hz.

The impedance of the windings shall be sufficiently small to avoid waveform distortion and minimize internal voltage drops.

The effective length l_m of the magnetic path in this test equipment is conventionally taken as 0,94 m. This value shall be used.

Consequently, the effective mass, i.e. the magnetically active mass of the test specimen, is given by the equation:

$$m_a = \frac{l_m}{4l} \cdot m \qquad (1)$$

where:

m_a	=	effective mass of test specimen, in kilogrammes
m	=	mass of test specimen, in kilogrammes
l_m	=	conventional effective magnetic path length, in metres
l	=	length of a test specimen strip, in metres

4.5 Air flux compensation

A correction for air flux shall be made for field strengths greater than or equal to 1000 A/m. For low frequencies (less than or equal to 1000 Hz) a mutual inductor may be used to compensate for the air flux.

The mutual inductance of the compensator shall be adjusted to be the same as that of the windings of the empty Epstein frame. Thus when the windings are properly connected, the voltage induced in the secondary winding of the mutual inductor by the primary current compensates for the voltage induced in the secondary winding of the empty Epstein frame by the flux attributed to the primary current.

4.6 Power supply

The source shall be of low internal impedance and shall be highly stable in terms of voltage and frequency. During the measurement, the variation of voltage and the variation of frequency shall not exceed ± 0,2 % of the specified value. The form factor of the secondary induced voltage shall be maintained within ± 1 % of 1.111 (this can be achieved by various means, e.g. electronic feedback amplifiers).

The form factor of the secondary voltage is the quotient of the r.m.s. value and the average rectified value. The former is measured by an r.m.s. volmeter, such as a moving iron instrument and the latter by an average type voltmeter, such as a rectifier-type instrument.

NOTE. When a negative feedback amplifier is used for the supply it may be necessary to observe the waveform of the secondary induced voltage on an oscilloscope to ensure that the waveform of the fundamental frequency is being produced.