IEC/TR 62581

Edition 1.0 2010-08

TECHNICAL REPORT

Electrical steel – Methods of measurement of the magnetostriction characteristics by means of single sheet and Epstein test specimens

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE X

ICS 29.030

ISBN 978-2-88912-101-4

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICAL STEEL –
METHODS OF MEASUREMENT OF THE MAGNETOSTRICTION CHARACTERISTICS BY MEANS OF SINGLE SHEET AND EPSTEIN TEST SPECIMENS

FOREWORD

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC 62581, which is a technical report, has been prepared by IEC technical committee 68: Magnetic alloys and steels.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
68/411/DTR	68/414/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

Magnetostriction is one of the magnetic properties that accompany ferromagnetism. It causes reversible deformations of a material body due to magnetization arising from an applied magnetic field.

Nowadays, the environmental problem of acoustic noise pollution caused by transformers and other applications of electrical steels (e.g. ballast, motors, etc.) is a concern of industry [31][1]. Magnetostriction of electrical steels is recognized as one of the causes of the problem and a standardization of methods of measurement of the magnetostriction is required to advance developments in materials to address this problem.

Historically, several methods have been used to measure magnetostriction including strain gauge, capacitance, differential transformer, piezoelectric pick-up and piezoelectric accelerometer methods. However, these methods require skill to set up the sensor accurately and to avoid vibrational noise that accompanies these contact methods. To solve these problems, optical methods that adopt optical vibrometers and optical displacement meters have been developed [1]-[8].

The optical method satisfies the following requirements for the measurement: non-contact, high resolution, high reproducibility and ease of operation without any special skill on the part of the operator. Several optical sensors can be used: laser Doppler vibrometers, heterodyne displacement meters and laser displacement meters with high resolution.

Magnetostriction is a magneto-mechanical phenomenon which accompanies the change of the volume fraction of magnetic domains which have a certain magnetic orientation with respect to the direction of the applied magnetic field, and which is intrinsically sensitive to stress [14],[15]. The stress sensitivity is dependent on material conditions such as grain orientation, residual stress and coating tension. The magnetostriction of electrical steel is increased by compressive stresses in the magnetizing direction rather than tensile stresses [9],[16]-[23]. Magnetic cores of electrical machines such as transformers often contain areas of increased stress. Therefore the stress sensitivity should be evaluated under a specified stress.

The acoustic noise emission from transformers and other machines is usually evaluated in terms of the A-weighted sound pressure level specified in IEC 61672-1. Vibration velocities caused by magnetostriction are transformed into sound pressure on the surface of the materials. Therefore, A-weighted characteristics of magnetostriction, such as A-weighted magnetostriction velocity level or A-weighted magnetostriction acceleration level, are necessary for the assessment of electrical steel sheets with respect to the acoustic noise [24]-[26].

This technical report is comprised of articles which review the optical and accelerometer methods of measurement of magnetostriction with the aim of producing a standard method of measurement of magnetostriction.

Two methods, by a single sheet tester and by a single strip tester, are described. The former should be applied to single sheet specimens with width of not less than 100 mm which have not been stress relief annealed. The latter method should be applied to Epstein test specimens, which may have been stress relief annealed to remove stresses imparted to the specimens during preparation.

---

1 The figures in square brackets refer to the Bibliography.

ELECTRICAL STEEL – METHODS OF MEASUREMENT OF THE MAGNETOSTRICTION CHARACTERISTICS BY MEANS OF SINGLE SHEET AND EPSTEIN TEST SPECIMENS

1 Scope

This technical report describes the general principles and technical details of the measurement of the magnetostriction of single sheet specimens preferably 500 mm long and 100 mm wide and Epstein strip specimens, specified in IEC 60404-2, of electrical steel by means of optical sensors and accelerometers.

These methods are applicable to test specimens obtained from electrical steel sheets and strips of any grade. The characteristics of magnetostriction are determined for a sinusoidal induced voltage, for specified peak values of magnetic polarization and for a specified frequency.

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

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.

IEC 60050-121, *International Electrotechnical Vocabulary – Part 121: Electromagnetism*

IEC 60050-221, *International Electrotechnical Vocabulary – Chapter 221: Magnetic materials and components*

IEC 60404-2, *Magnetic materials – Part 2: Methods of measurement of the magnetic properties of electrical steel sheet and strip by means of an Epstein frame*

IEC 60404-3:1992, *Magnetic materials – Part 3: Methods of measurement of the magnetic properties of electrical steel strip and sheet by means of a single sheet tester*
Amendment 1 (2002)
Amendment 2 (2009)

IEC 61672-1, *Electroacoustics – Sound level meters – Part 1: Specifications*