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# TECHNICAL REPORT

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**Rare earth sintered magnets – Stability of the magnetic properties at elevated temperatures**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

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## CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references.....	7
3 Terms and definitions.....	7
4 Classification of magnetic flux loss due to temperature.....	9
4.1 Reversible flux loss.....	9
4.2 Irreversible flux loss.....	9
4.3 Permanent flux loss.....	9
5 Long term ageing of rare earth magnets.....	10
6 Experimental.....	11
7 Temperature stability.....	13
7.1 Flux change due to temperature.....	13
7.2 Effect of temperature on $B_r$ and $H_{CJ}$ (demagnetization curves at different temperatures).....	14
7.3 The time effects at constant temperature (influence of temperature exposure and $L/D$ ).....	16
7.4 The influence of $H_{CJ}$ on the irreversible flux loss for $Sm_2Co_{17}$ magnets.....	18
7.5 The influence of $H_{CJ}$ on the irreversible flux loss for Nd-Fe-B magnets.....	20
7.6 Irreversible flux loss per decade.....	22
7.7 Permanent flux loss.....	22
8 Summary.....	24
Annex A (informative) Summary of temperature stability graphs.....	25
Annex B (informative) Non-linearity of temperature dependence of $B_r$ and $H_{CJ}$ .....	26
Bibliography.....	27
Figure 1 – Change of magnetic flux density operating on a load line during elevated temperature ageing after R. Tenzer (schematic) [7, 8].....	10
Figure 2 – Long term ageing of rare earth magnets (schematic) [9].....	11
Figure 3 – Measuring system of open circuit flux utilizing a fluxgate type digital integrating fluxmeter [13].....	12
Figure 4 – Temperature dependence of flux for $SmCo_5$ magnet ( $L/D = 0,7$ ) [16] (See Table 1).....	14
Figure 5 – Temperature dependence of flux for $Sm_2Co_{17}$ magnet ( $L/D = 0,7$ ) [16] (See Table 1).....	14
Figure 6 – Temperature dependence of flux for Nd-Fe-B magnet ( $L/D = 0,7$ ) [17] (See Table 1).....	14
Figure 7 – $J$ - $H$ demagnetization curves of Nd-Fe-B magnet measured at different temperatures [18].....	14
Figure 8 – $J$ - $H$ demagnetization curves of Nd-Fe-B magnet measured at different temperatures [19].....	15
Figure 9 – Temperature dependence of normalized $B_r$ and $H_{CJ}$ for $SmCo_5$ , $Sm_2Co_{17}$ and Nd-Fe-B magnets [19].....	15
Figure 10 – Time dependence of irreversible flux loss for $SmCo_5$ magnet exposed at different temperatures [22].....	16
Figure 11 – Time dependence of irreversible flux loss for $SmCo_5$ magnets with various $L/D$ s [24].....	16

Figure 12 – Time dependence of irreversible flux loss for Sm <sub>2</sub> Co <sub>17</sub> magnet exposed at different temperatures (Material 1) [22] .....	17
Figure 13 – Time dependence of irreversible flux loss for Sm <sub>2</sub> Co <sub>17</sub> magnets with various <i>L/D</i> s (Material 2) [24] .....	17
Figure 14 – Time dependence of irreversible flux loss for Nd-Fe-B magnet exposed at different temperatures [23] .....	17
Figure 15 – Temperature dependence of irreversible flux loss after exposure for 100 h for Nd-Fe-B magnets with various <i>L/D</i> s [25] .....	17
Figure 16 – Time dependence of irreversible flux loss for a Sm <sub>2</sub> Co <sub>17</sub> magnet with <i>H</i> <sub>CJ</sub> = 0,48 MA/m and <i>L/D</i> = 0,7 [26] .....	19
Figure 17 – Time dependence of irreversible flux loss for a Sm <sub>2</sub> Co <sub>17</sub> magnet with <i>H</i> <sub>CJ</sub> = 1,19 MA/m and <i>L/D</i> = 0,7 [27] .....	19
Figure 18 – Time dependence of irreversible flux loss for a Sm <sub>2</sub> Co <sub>17</sub> magnet with <i>H</i> <sub>CJ</sub> = 1,97 MA/m and <i>L/D</i> = 0,7 [28] .....	19
Figure 19 – Time dependence of irreversible flux loss for a Nd-Fe-B magnet with <i>H</i> <sub>CJ</sub> = 1,16 MA/m and <i>L/D</i> = 0,7 [30] .....	20
Figure 20 – Time dependence of irreversible flux loss for a Nd-Fe-B magnet with <i>H</i> <sub>CJ</sub> = 1,66 MA/m and <i>L/D</i> = 0,7 [31] .....	20
Figure 21 – Time dependence of irreversible flux loss for a Nd-Fe-B magnet with <i>H</i> <sub>CJ</sub> = 2,17 MA/m and <i>L/D</i> = 0,7 [32] .....	21
Figure 22 – Time dependence of irreversible flux loss for a Nd-Fe-B magnet with <i>H</i> <sub>CJ</sub> = 2,45 MA/m and <i>L/D</i> = 0,7 [33] .....	21
Figure 23 – Comparison of irreversible flux loss for Sm <sub>2</sub> Co <sub>17</sub> magnets with different <i>H</i> <sub>CJ</sub> 21	
Figure 24 – Comparison of irreversible flux loss for Nd-Fe-B magnets with different <i>H</i> <sub>CJ</sub> .....	21
Figure 25 – Relationship between irreversible flux loss per decade and initial flux loss .....	23
Figure B.1 – Temperature dependence of normalized <i>B<sub>r</sub></i> and <i>H</i> <sub>CJ</sub> to show the non-linearity (see data for Nd-Fe-B magnets in Figure 9) .....	26
Table 1 – Magnetic properties of the rare earth magnets employed for the open circuit flux measurements to determine the reversible temperature coefficient of the magnetic flux .....	13
Table 2 – Reversible temperature coefficient of the magnetic flux determined by temperature cycling .....	13
Table 3 – Temperature coefficients of <i>B<sub>r</sub></i> and <i>H</i> <sub>CJ</sub> for SmCo <sub>5</sub> , Sm <sub>2</sub> Co <sub>17</sub> and Nd-Fe-B magnets (temperature range for the coefficient: 25 °C to 150 °C) .....	16
Table 4 – Magnetic properties of the specimens for the experiments to evaluate the effects of temperature and <i>L/D</i> on irreversible flux loss .....	18
Table 5 – Magnetic properties of the Sm <sub>2</sub> Co <sub>17</sub> magnets for the experiment to evaluate the influence of <i>H</i> <sub>CJ</sub> on the irreversible flux loss .....	20
Table 6 – The magnetic properties of Nd-Fe-B magnets for the evaluation of the influence of <i>H</i> <sub>CJ</sub> on irreversible flux loss measured by a pulse recording fluxmeter .....	22
Table 7 – The permanent flux loss of Sm <sub>2</sub> Co <sub>17</sub> magnets after exposure for 1 000 h at different temperatures .....	23
Table 8 – The permanent flux loss of Nd-Fe-B magnets after exposure for 1 000 h at different temperatures .....	23
Table 9 – Basic magnetic properties of the three intermetallic compounds .....	24
Table A.1 – Summary of temperature stability graphs .....	25

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

### **RARE EARTH SINTERED MAGNETS – STABILITY OF THE MAGNETIC PROPERTIES AT ELEVATED TEMPERATURES**

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IEC 62518, 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
68/376/DTR	68/383/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 maintenance result 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

$\text{SmCo}_5$  was the first sintered rare earth magnet to be developed (1967) [1]<sup>1</sup>, followed by  $\text{Sm}_2\text{Co}_{17}$  [2, 3, 4] and Nd-Fe-B [5]. These magnets are used in a wide variety of applications. Recently, these magnets have been used in higher temperature applications such as in heavy duty permanent magnet motors. For these high temperature applications, the temperature stability of the permanent magnet has to be considered along with the design of the magnetic circuit. This is particularly relevant for the relatively inexpensive Nd-Fe-B magnetic material which has a comparatively low Curie temperature. The temperature stability of the rare earth sintered magnets has a critical influence on the reliability of high temperature motors and this will, in turn, contribute to energy savings in the future.

Therefore, the subject of this technical report will be of considerable interest to the manufacturers of this type of motor and to the developers of permanent magnet materials.

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<sup>1</sup> The figures in square brackets refer to the Bibliography.

## **RARE EARTH SINTERED MAGNETS – STABILITY OF THE MAGNETIC PROPERTIES AT ELEVATED TEMPERATURES**

### **1 Scope**

The scope of this technical report is to describe the temperature behaviour of rare earth sintered magnets in detail for use in designing magnetic circuits exposed to elevated temperatures. The temperature behaviour of SmCo<sub>5</sub>, Sm<sub>2</sub>Co<sub>17</sub> and Nd-Fe-B sintered magnets is described.

The various changes of open circuit flux which can occur due to temperature are discussed in Clause 4. The long term stability of the magnets is discussed in Clause 5. The experimental procedures are described in Clause 6. Results of the measurements of the flux loss occurring at the ambient temperature after heating isothermally at 50 °C, 75 °C, 100 °C, 125 °C, 150 °C and 200 °C for up to 1000 h are given in Clause 7. The effect of length to diameter ratio ( $L/D$ ) of the magnet samples and the influence of  $H_{cJ}$  on the flux loss were also studied. The results are discussed in Clause 8.

The data in this technical report was provided by the Institute of Electrical Engineers of Japan (IEEJ) and its subcommittees. This data has been gathered from the members of these subcommittees.

The temperature stability correlated with the complex corrosion behaviour and the spin re-orientation phenomena at cryogenic temperatures will not be given in this technical report.

### **2 Normative references**

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

IEC 60050-151, *International Electrotechnical Vocabulary – Part 151: Electrical and magnetic devices*

IEC 60050-221:1990, *International Electrotechnical Vocabulary – Chapter 221: Magnetic materials and components*  
Amendment 1 (1993)

IEC 60404-8-1, *Magnetic materials – Part 8-1: Specifications for individual materials – Magnetically hard materials*