
British Standard
Magnetic materials

Part 8. Individual materials

Section 8.1 Specification for magnetically hard materials

Matériaux magnétiques

Partie 8. Matériaux particuliers

Section 8.1 Matériaux magnétiquement durs — Spécifications

Magnetische Werkstoffe

Teil 8. Einzelne Werkstoffe

Abschnitt 8.1 Hartmagnetische Werkstoffe

National foreword

This Section of BS 6404 : Part 8 has been prepared under the direction of the Iron and Steel and Non-ferrous Metals Standards Committees. It is identical with IEC 404-8-1 : 1986 'Magnetic materials, Part 8 : Specifications for individual materials. Section One – Standard specifications for magnetically hard materials', published by the International Electrotechnical Commission (IEC).

The following Parts of BS 6404 have been published:

Part 1. Classification

Part 2. Methods of measurement of magnetic, electrical and physical properties of magnetic sheet and strip

Part 3. Methods of measurement of specific total losses of magnetic sheet and strip by means of a single sheet tester

Part 4. Methods of measurement of the d.c. magnetic properties of solid steels

Part 5. Methods of measurement of the magnetic properties of magnetically hard (permanent magnet) materials

Part 6. Methods of measurement of the magnetic properties of isotropic nickel-iron soft magnetic alloys, types E1, E3 and E4

Part 7. Method of measurement of the coercivity of magnetic materials in an open magnetic circuit

Part 8. Individual materials

Section 8.2 Specification for cold-rolled, magnetic, non-oriented, alloyed steel strip delivered in the semi-processed state

Section 8.3 Specification for cold-rolled, magnetic, non-oriented, non-alloyed steel strip delivered in the semi-processed state

Section 8.4 Specification for cold-rolled, non-oriented magnetic steel sheet and strip delivered in the finally annealed state

Section 8.6 Specification for soft magnetic metallic materials

Section 8.7 Specification for grain-oriented magnetic steel sheet and strip

Part 9. Methods for determination of the geometrical characteristics of magnetic steel sheet and strip

Additional Parts of IEC 404 will be published and are expected to provide the basis for additional Parts of BS 6404.

Terminology and conventions. The text of the international standard has been approved as suitable for publication as a British Standard without deviation. Some terminology and certain conventions are not identical with those used in British Standards.

Cross-references

International standard	Corresponding British Standard
IEC 50 (121) : 1978	BS 4727 Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms Part 1 Terms common to power telecommunications and electronics Group 01 : 1983 Fundamental terminology (Technically equivalent)
IEC 404-1 : 1979	BS 6404 Magnetic materials Part 1 : 1984 Classification (Technically equivalent)
IEC 404-5 : 1982	Part 5 : 1986 Methods of measurement of the magnetic properties of magnetically hard (permanent magnet) materials (Identical)
IEC 404-7 : 1982	Part 7 : 1986 Method of measurement of the coercivity of magnetic materials in an open magnetic circuit (Identical)

The Technical Committee has reviewed the provisions of IEC 50 (901), to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard.

A related British Standard to IEC 50 (901) is BS 4727 : Part 1 : Group 07 : 1973 'Magnetism terminology'.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

NOTE. This amendment implements Amendment 1 to
IEC 404-8-1 : 1986. A consequent change to the national
foreword has also been made.

Revised text

AMD 7328
February 1993

National foreword

In paragraph 1, line 3, after 'hard materials' , ' insert 'including Amendment 1,'.

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February 1993

CONTENTS

Add, between 10.2 and TABLES, the title of new Clause 11 as follows:

11. Irreversible demagnetization behaviour

Add, below TABLES, the following:

Figure

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3. Classification

3.1 Principal magnetic properties

Replace, in the table of this sub-clause: 901-02-026 by: 901-02-26.

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8. Testing

8.2 Testing methods

Delete, in the second paragraph, the term: minimum.

10.1.5.1 Chemical composition

Replace, in the fifth and sixth lines of this sub-clause, the phrase:

. . . iron, copper, manganese and other elements . . . by the following:

. . . other transition metal (TM) elements such as Cr, Mn, Fe, Ni, Cu, Zr or Hf. This substitution is mainly found in the alloys of the type $\text{RE}_2\text{Co}_{17}$, which are therefore often designated alloys of the type $\text{RE}_2\text{TM}_{17}$.

10.1.5.2 Manufacturing method

Add, after the second paragraph of this sub-clause:

Note for the magnetization procedure:

$\text{RE}_2\text{TM}_{17}$ -type high-coercivity magnets require special magnetization considerations, because magnetizing fields in the range of five times the intrinsic coercivity H_{cJ} are required. See Clause 5 and Sub-clause 14.1 of IEC 404-5.

10.1.5.3 Sub-classification

Replace, the text of this sub-clause by the following:

Anisotropic alloys of the type RECo_5	(R5-1-x)
with $x = 1, 2, \dots 10$	
Anisotropic alloys of the type $\text{RE}_2\text{Co}_{17}$ ($\text{RE}_2\text{TM}_{17}$)	(R5-1-x)
with $x = 11, 12, \dots$	
Anisotropic alloys of the type RECo_5 with binder	(R5-3-x)
with $x = 1, 2, \dots$	

10.1.5.4 Magnetic properties and density

Replace, in this sub-clause: . . . Tables VIII and IX by the following: . . . Tables VIIIA, VIIIB and IX.

Delete the note.

10.1.6.4 *Magnetic properties and density*

Replace, in this sub-clause: . . . an isotropic and an anisotropic alloy . . . by: . . . two isotropic and three anisotropic alloys.

Delete the note.

Add, between Sub-clause 10.2.5 and Table I, the following Clause 11:

11. Irreversible demagnetization behaviour

A permanent magnet, being originally in a remanent state, will lose a certain amount of flux when exposed to a demagnetizing (counteracting) magnetic field. After removing the demagnetizing magnetic field the original magnetic flux of the remanent state may be totally or partly restored. In the former case, the magnetic change is completely reversible, while in the latter one it is partly reversible and partly irreversible. The reversible change of magnetic flux corresponding to the change of magnetic field is quantitatively described by the relative recoil permeability μ_{rec} as given in the relevant tables of the material standards. Therefore, this reversible change can be taken into consideration for the layout of the permanent magnet system.

For the layout it is of prime importance to know the range of demagnetizing fields showing reversible changes only. More strictly speaking one must know the demagnetizing field strength causing a tolerable amount of irreversible flux change (flux loss). This is explained in detail in Figure 1.

Figure 1 shows the demagnetization and recoil curves for a magnetically hard material, which has a remanence $B_r = J_r$ after having been fully magnetized. Application of a certain demagnetizing field strength H_D and reduction of that field again to zero (transient action of the field), leads to a remanent flux density $B_p = J_p$ in the material which is called remanent recoil flux density (permanence). For $B_p < B_r$, a relative irreversible loss of magnetic flux $(B_r - B_p)/B_r$ has occurred. The loss increases with increasing H_D . Therefore the value of H_D which leads to a pre-determined, still tolerable maximum loss, is a quantitative measure of the stability of the magnetically hard material against a demagnetizing field. If, for instance, the tolerable maximum loss is 5 %, the related field is called H_{D5} . H_D may be determined experimentally as given in Clause 11 of IEC 404-5.

TABLES II, III, IV, V, VI, VII, VIII, IX and XII

Extend, in the existing tables, the heading: Magnetic properties over the column Relative recoil permeability.

Table VII

Amend in this table, under the heading: Material, the code number of the brief designation FeCoVCr 4/0.4 from R3-1-1 to R3-0-1.

Table VIII

Replace the number and title of this table by the following:

TABLE VIIIA

*Magnetic properties and density of anisotropic alloys
of the type $RECo_5$*

Delete footnote 6).

New TableVIIIB

Add the new table between Table VIIIA and Table IX.

Table X

Replace this table by new Table X.

Table XI

Replace this table by new Table XI.

New Figure 1

Add this figure after Table XVI.

TABLE VIII B

Magnetic properties and density of anisotropic alloys of the type RE_2Co_{17}

Material		Magnetic properties 1) 2)					Density g/cm³
Brief designation	Code number	Maximum BH product $(BH)_{max}$ kJ/m³	Remanence B_r mT	Coercivity H_{CB} kA/m	Coercivity H_{CJ} kA/m	Relative recoil permeability μ_{rec}	
		Specified minimum values				Typical values	
RECo 165/50	R5-1-11	165	950	440	500	1,1	8,2
RECo 170/70	R5-1-12	170	970	630	700	1,1	8,2
RECo 180/90	R5-1-13	180	1 000	680	900	1,1	8,2

- 1) See Sub-clause 3.1.
- 2) Typical values for additional magnetic properties mentioned in Sub-clause 3.2.
- T_c = approximately 1 100 K
 $\alpha(B_r)$ = -0,03%/K
 $\alpha(H_{CJ})$ = approximately -0,2 %/K

}

for temperatures from 273 K to 373 K.

TABLE X

Chemical composition, magnetic properties and density of isotropic and anisotropic CrFeCo alloys

Material		Chemical composition (wt. %)			Magnetic properties ^{1) 2)}					Density g/cm³
Brief designation	Code number	Cr	Co	Fe	Maximum BH product (BH) _{max} kJ/m³	Remanence B _r mT	Coercivity H _{cB} kA/m	Coercivity H _{cJ} kA/m	Relative recoil permeability μ _{rec}	
		Typical values			Specified minimum values				Typical values	
Isotropic										
CrFeCo 12/4	R6-0-1	25 to 35	10 to 25	balance	12	800	40	42	5,5 to 6,5	7,6
CrFeCo 10/3	R6-0-2	25 to 35	10 to 17	balance	10	850	27	29	5,5 to 6,5	7,6
Anisotropic										
CrFeCo 28/5	R6-1-1	25 to 35	10 to 25	balance	28	1 000	45	46	3 to 4	7,6
CrFeCo 30/4	R6-1-2	25 to 35	10 to 17	balance	30	1 150	40	41	3 to 4	7,6
CrFeCo 35/5	R6-1-3	25 to 35	18 to 25	balance	35	1 050	50	51	3 to 4	7,6

1) See Sub-clause 3.1.

2) Typical values for additional magnetic properties mentioned in Sub-clause 3.2.

T_c

= approximately 1 125 K (extrapolated value of alloys in the optimum magnetic state; phase decomposition takes place at a lower temperature).

= approximately 910 K for the decomposed structure.

$\alpha(B_r)$

= -0,03%/K (anisotropic alloys)

= -0,05%/K (isotropic alloys)

$\alpha(H_{cJ})$

= -0,04 %/K

}

for temperatures from 273 K to 373 K.

TABLE XI

Magnetic properties and density of isotropic and anisotropic hard ferrites

Material		Magnetic properties ^{1) 2)}					Density g/cm ³
Brief designation	Code number	Maximum BH product (BH) _{max} kJ/m ³	Remanence B _r mT	Coercivity H _{oB} kA/m	Coercivity H _{cJ} kA/m	Relative recoil permeability μ _{rec}	
		Specified minimum values				Typical values	
Isotropic Hard ferrite 7/21	S1-0-1	6,5	190	125	210	1,2	4,9
Anisotropic							
Hard ferrite 20/19	S1-1-1	20,0	320	170	190	1,1	4,8
Hard ferrite 20/28	S1-1-2	20,0	310	220	280	1,1	4,6
Hard ferrite 22/30*	S1-1-7	22,0	350	255	295	1,05	4,6
Hard ferrite 24/23*	S1-1-3	24,0	350	215	230	1,1	4,8
Hard ferrite 25/14*	S1-1-4	25,0	380	130	135	1,1	5,0
Hard ferrite 25/22	S1-1-5	25,0	370	205	220	1,1	4,8
Hard ferrite 26/18	S1-1-6	26,0	370	175	180	1,1	5,0
Hard ferrite 26/26*	S1-1-8	26,0	370	230	260	1,05	4,7
Hard ferrite 29/22*	S1-1-9	29,0	390	210	220	1,05	4,8

1) See Sub-clause 3.1.

2) Typical values for additional magnetic properties mentioned in Sub-clause 3.2.

$$\left. \begin{aligned}
 T_c &= \text{approximately } 723 \text{ K} \\
 \alpha(B_r) &= -0,2\%/K \\
 \alpha(H_{cJ}) &= +0,2 \text{ to } 0,5\%/K
 \end{aligned} \right\} \text{ for temperatures from } 273 \text{ K to } 373 \text{ K.}$$

* These are preferred grades and should normally be used by designers.

