BRITISH STANDARD

BS EN
12438:1998

Magnesium and magnesium alloys — Magnesium alloys for cast anodes

The European Standard EN 12438:1998 has the status of a British Standard

ICS 77.120.20

National foreword

This British Standard is the English language version of EN 12438:1998.

The UK participation in its preparation was entrusted by Technical Committee NFE/35, Light metals and their alloys, to Subcommittee NFE/35/4, Magnesium and magnesium alloys, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 9 and a back cover.

This British Standard, having been prepared under the direction of the Engineering Sector Board, was published under the authority of the Standards Board and comes into effect on 15 November 1998

ISBN 0 580 29993 7

Amendments issued since publication

Amd. No.	Date	Text affected

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 12438

April 1998

ICS 77.120.20; 77.150.10

Descriptors: Magnesium, magnesium alloys, anodes, castings, ingots, designation, quality, chemical composition, specifications, tests, electrochemical methods

English version

Magnesium and magnesium alloys — Magnesium alloys for cast anodes

Magnésium et alliages de magnésium — Alliages de magnésium pour anodes coulées

Magnesium und Magnesiumlegierungen — Magnesiumlegierungen für Gußanoden

This European Standard was approved by CEN on 25 March 1998.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. 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.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 12438:1998 E

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 190, Foundry technology, the secretariat of which is held by DIN.

Within its programme of work, Technical Committee CEN/TC 190 requested CEN/TC 190/WG 3.10, Cast magnesium, to prepare the following standard:

EN 12438, *Magnesium and magnesium alloys — Magnesium alloys for cast anodes*.

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 October 1998, and conflicting national standards shall be withdrawn at the latest by October 1998.

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

Contents

		Page
Foreword		2
Introduction		3
1	Scope	3
2	Normative references	3
3	Designations	3
3.1	Material	3
3.2	Casting process	3
4	Requirements	3
4.1	General	3
4.2	Chemical composition	3
5	Testing	3
5.1	Analysis of chemical composition	3
5.2	Electrochemical testing	3
6	Rounding of numbers	3
Annex A (normative) Test method for the determination of the electrode potential of galvanic anodes		6
Annex B (normative) Test method for the determination of the rate of mass loss of galvanic anodes		7
Annex C (informative) List of corresponding international designations and former national designations		9
Annex D (informative) Bibliography		9

Introduction

This European Standard classifies the commercially available magnesium anode alloys into a number of grades suitable for the applications to which they might be put. The annexes A and B describe methods for electrochemical tests with corresponding recommended values. Annex C gives a list of corresponding international designations and former national designations.

1 Scope

This European Standard specifies the chemical composition of magnesium alloy ingots for anodes and chemical composition of magnesium alloy anode castings.

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.

EN 1559-1, *Founding — Technical conditions of delivery — Part 1: General.*

EN 1559-5, *Founding — Technical conditions of delivery — Part 5: Additional requirements for magnesium alloy castings.*

ISO 31-0:1992, *Quantities and units — Part 0: General principles.*

NOTE Informative references to documents used in the preparation of this standard, and cited at the appropriate places in the text, are listed in a bibliography, see annex D.

3 Designations

3.1 Material

The material shall be designated either by symbol or by number (see Tables 1 and 2).

3.2 Casting process

The following symbols shall be used for the different casting processes:

— S, sand casting;

— K, permanent mould casting (gravity);

— C, continuous casting.

4 Requirements

4.1 General

The requirements for technical delivery conditions given in EN 1559-1 and EN 1559-5 shall apply.

4.2 Chemical composition

The chemical composition of magnesium based alloy ingots for anodes shall conform to the requirements for the appropriate material given in Table 1. The chemical composition of magnesium based alloy anode castings shall conform to the requirements for the appropriate material given in Table 2.

5 Testing

5.1 Analysis of chemical composition

Sufficient samples shall be taken by the manufacturer to assure conformance to the chemical composition requirements of the alloys in Tables 1 and 2. Samples shall be taken from the molten metal at the time of casting. Samples shall be representative of the material delivered.

5.2 Electrochemical testing

If applicable, electrochemical testing shall be carried out in accordance with annexes A and B.

6 Rounding of numbers

In recording chemical analysis, the number representing the result for any value specified in this standard shall be expressed to the same number of decimal places as the corresponding number in this standard. The rounding of numbers shall meet the requirements of ISO 31-0:1992, annex B, clause **B.3**, rule A or B. The choice shall be left to the discretion of the manufacturer, unless the use of one of the rules is agreed by the time of acceptance of the order.

Table 1 — Chemical composition of magnesium alloy ingots for anode castings

Alloy group	Material designation		Composition in per cent (mass fraction)									
	Symbol	Number	Element	Mg	Al	Zn	Mn	Si	Fe	Cu	Ni	Others each
MgAlZn	EN–MBMgAl3Zn1	EN–MB21130	min.	Rem.	2,6	0,7	0,20	—	—	—	—	—
			max.	—	3,5	1,4	1,0	0,30	0,01	0,05	0,001	0,05
	EN–MBMgAl6Zn1	EN–MB21140	min.	Rem.	5,6	0,7	0,20	—	—	—	—	—
			max.	—	6,5	1,4	1,0	0,30	0,01	0,05	0,001	0,05
	EN–MBMgAl6Zn3	EN–MB21150	min.	Rem.	5,1	2,1	0,20	—	—	—	—	—
			max.	—	7,0	4,0	1,0	0,30	0,01	0,05	0,001	0,05
MgMn	EN–MBMgMn1	EN–MB40010	min.	Rem.	—	—	0,50	—	—	—	—	—
			max.	—	0,01	0,05	1,3	0,05	0,02	0,02	0,001	0,05
	EN–MBMgMn2	EN–MB40020	min.	Rem.	—	—	1,20	—	—	—	—	—
			max.	—	0,01	0,05	2,5	0,05	0,02	0,02	0,001	0,05

NOTE The material designation is in accordance with EN 1754.

Table 2 — Chemical composition of magnesium alloy anode castings

Alloy group	Material designation		Casting process[1]	Composition in per cent (mass fraction)											
	Symbol	Number		Element	Mg	Al	Zn	Mn	Si	Fe	Cu	Ni	Others each	As + Sb + Pb + Cr + Ni[2]	Cd + Hg + Se[2]
MgAlZn	EN–MAMgAl3Zn1	EN–MA21130	S, K, C	min.	Rem.	2,5	0,6	0,2	—	—	—	—	—	—	—
				max.	—	3,5	1,4	1,0	0,3	0,02	0,05	0,002	0,05	0,1	0,01
	EN–MAMgAl6Zn1	EN–MA21140	S, K, C	min.	Rem.	5,5	0,6	0,2	—	—	—	—	—	—	—
				max.	—	6,5	1,4	1,0	0,3	0,02	0,05	0,002	0,05	0,1	0,01
	EN–MAMgAl6Zn3	EN–MA21150	S, K, C	min.	Rem.	5,0	2,0	0,2	—	—	—	—	—	—	—
				max.	—	7,0	4,0	1,0	0,3	0,02	0,05	0,002	0,05	0,1	0,01
MgMn	EN–MAMgMn1	EN–MA40010	S, K, C	min.	Rem.	—	—	0,5	—	—	—	—	—	—	—
				max.	—	0,01	0,05	1,3	0,05	0,03	0,02	0,002	0,05	0,1	0,01
	EN–MAMgMn2	EN–MA40020	S, K, C	min.	Rem.	—	—	1,2	—	—	—	—	—	—	—
				max.	—	0,01	0,05	2,5	0,05	0,03	0,02	0,002	0,05	0,1	0,01

[1] S = sand casting; K = permanent mould casting (gravity); C = continuous casting.
[2] Only for anodes used in potable water (tap water).

NOTE The material designation is in accordance with EN 1754.

Annex A (normative)

Test method for the determination of the electrode potential of galvanic anodes

A.1 Test pieces

Test pieces shall be sections of the anodes where the core is removed.

Before starting the test, the test pieces shall be degreased with a solvent (e.g. xylol), then be cleaned in running tap water with a plastic brush, then be washed with ethanol and then be dried in air at room temperature.

A.2 Test apparatus

The test shall be carried out with the apparatus shown schematically in Figure A.1.

A.3 Test solution

The test solution shall be a sodium chloride solution of concentration 0,0010 mol NaCl/l de-ionized water.

A.4 Electrical connection

A galvanostatical polarization connection shall be used.

A.5 Test procedure

Four single measurements shall be made on four different test pieces.

After putting the test piece into a measuring cell filled with sodium chloride solution, the temperature of the electrolyte solution shall be adjusted to (60 ± 3) °C.

The reference electrode (e.g. a saturated calomel electrode) shall be connected to the measuring cell by means of an electrolyte bridge and a Haber-Luggin capillary tube.

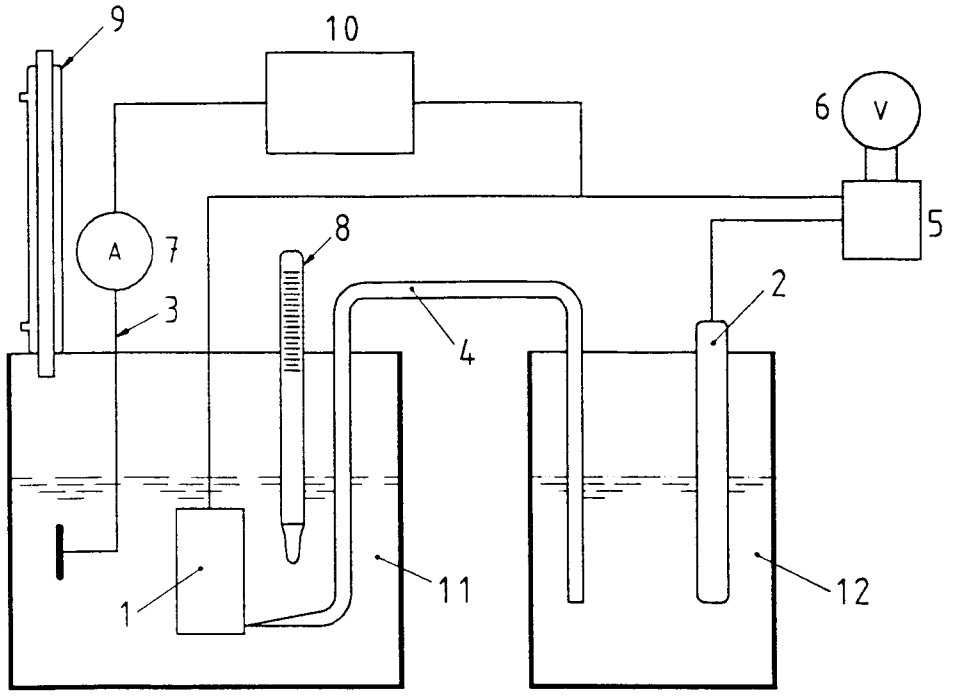
The capillary tube shall be moved towards, and located as near as possible to the test piece surface and this distance should not be more than twice the outside diameter of the capillary tube.

Application of the current is galvanostatically effected by using a galvanostat or a 12 V battery.

After 24 h test the potential of electrodes shall be read from the voltmeter.

The four single values and the mean value, each related to the standard hydrogen electrode, shall be given in the test report.

NOTE With a current density of (50 ± 1) $\mu A/cm^2$ in a sodium chloride solution of concentration 0,0010 mol NaCl/l water at (60 ± 3) °C an average of the electrode potential of the anodes more negative than UH = −0,9 V is recommended. This is to make sure that there is no passivation of the anode in low conductivity electrolytes.



1	measuring electrode (test piece)	7	amperemeter
2	reference electrode	8	thermometer
3	counter electrode	9	return condenser
4	Haber-Luggin capillary tube	10	current *I*, constant
5	measuring amplifier	11	Measuring cell
6	voltmeter	12	Reference cell

Figure A.1 — Apparatus for testing the electrode potential of galvanic anodes

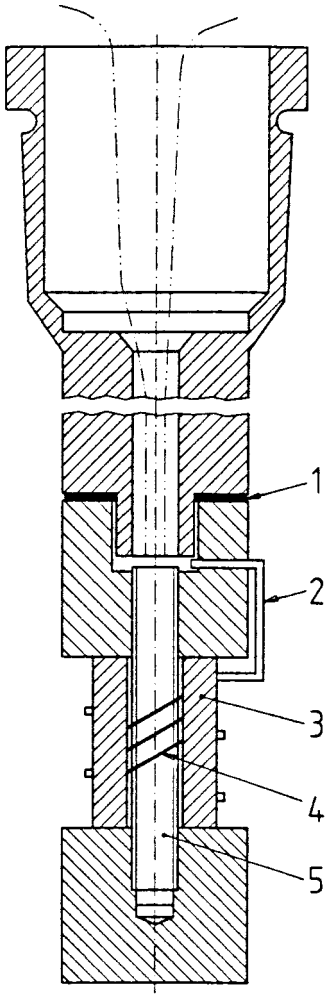
Annex B (normative)

Test method for the determination of the rate of mass loss of galvanic anodes

B.1 Test pieces

Test pieces shall be sections of the anodes where the steel core is removed. The test piece surface area exposed to the test solution should be about 30 cm^2. Both end surfaces shall be covered by a suitable test piece support (see Figure B.1).

Before starting the test, the test pieces shall be degreased with a solvent, then be cleaned in running tap water with a plastic brush, then be washed with ethanol and then be dried in air at room temperature.



1 Sealing gasket
2 Platinum counter electrode
3 Magnesium anode
4 Metallic contact by helical spring
5 Threaded steel rod

Figure B.1 — Test piece support for the measurement of the mass loss rate

B.2 Test apparatus

The test shall be carried out with the apparatus shown schematically in Figure B.2. A suitable test piece support is shown in Figure B.1.

B.3 Test solution

The test solution shall be a sodium chloride solution of concentration 0,01 mol NaCl/l de-ionized water.

B.4 Electrical connection

A galvanostatical polarization connection shall be used.

B.5 Test procedure

Four single measurements shall be made on four different test pieces.

After putting the test piece into a measuring cell filled with sodium chloride solution, the temperature of the electrolyte solution shall be adjusted to (60 ± 3) °C. Apply galvanostatically a current of 50 μA per square centimetre of the anode test piece surface. The determination of the mass loss is based on the volume of the formed hydrogen. At the beginning of the test the level of sealing liquid in the gas burette shall be adjusted to the upper mark and the tap shall be closed. After 24 h the tap shall be opened again. The level shall be once more adjusted to the upper mark and the tap shall be closed. Atmospheric pressure and test temperature shall be noted. After 24 h the volume of the formed hydrogen, atmospheric pressure and room temperature at the end of the test shall be noted.

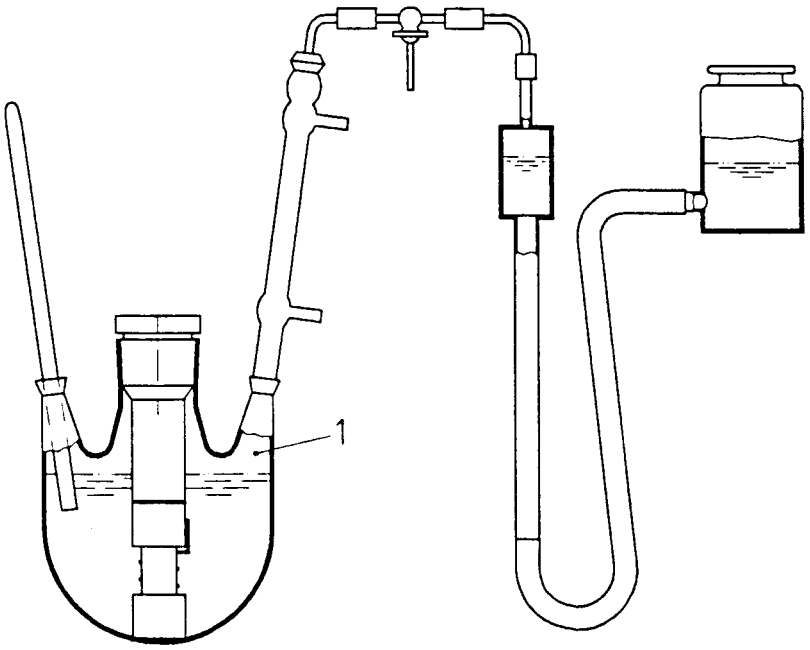
B.6 Evaluation

The volume of the formed hydrogen shall be reduced according to equation (1) to normal conditions.

$$V_0 = \frac{T_0}{p_0}\left[\frac{(V_{t0} + \Delta V)p_2}{T_2} - \frac{V_{t0}\,p_1}{T_1}\right] \quad (1)$$

where:

- V_0 is the volume of the formed hydrogen under normal conditions, given in litres;
- V_{t0} is the dead volume as shown in Figure B.2, given in millilitres;
- ΔV is the volume of the formed hydrogen, given in millilitres;
- p_0 is 1013 hPa;
- p_1 is the atmospheric pressure at the beginning of the test, given in hectopascals;
- p_2 is the atmospheric pressure at the end of the test, given in hectopascals;
- T_1 is the temperature at the beginning of the test, given in kelvins;
- T_2 is the temperature at the end of the test, given in kelvins;
- T_0 is 273 K.



1 V_{t0} dead volume

Figure B.2 — Apparatus for the determination of the mass loss of galvanic anodes by measuring the formation of hydrogen

The mass loss rate v related to the surface is a result of equation (2).

$$v = \frac{V_0 M_{Mg} \times 21{,}4}{A\, t\, Z_{Mg}} \qquad (2)$$

where:

v is the mass loss rate related to surface, given in grams per square metre per day;

V_0 is the volume of hydrogen under normal conditions, given in litres;

M_{Mg} is the mol mass of magnesium = 24,312 g/mol;

21,4 is a calculation factor;

A is the test surface area of the anodes, given in square centimetres;

t is the duration of the test, given in hours;

Z_{Mg} is the magnesium valence = 2.

NOTE The mass loss rate gives an indication of the anode quality and life time. To be sure to have a sufficient anode alloy in sodium chloride solution of concentration 0,01 mol NaCl/l water at (60 ± 3) °C, a mass loss rate not greater than 30g/m^2 per day is recommended.

Annex C (informative)

List of corresponding international designations and former national designations

Table C.1 is a list of corresponding international designations and former national designations.

Annex D (informative)

Bibliography

In the preparation of this European Standard, use was made of a document for reference purposes. This informative reference is cited at the appropriate place in the text and the publication is listed hereafter.

EN 1754, *Magnesium and magnesium alloys — Magnesium and magnesium alloy anodes, ingots and castings — Designation system.*

Table C.1

Material designation		List of corresponding designations		
Symbol	Number	USA	Germany	
		ASTM	non-standardized common designation	previous common designation
EN–MAMgAl3Zn1	EN–MA21130	AZ 31	MgAl3Zn1	AZ 31
EN–MAMgAl6Zn1	EN–MA21140	AZ 61	MgAl6Zn1	AZ 61
EN–MAMgAl6Zn3	EN–MA21150	AZ 63	MgAl6Zn3	AZ 63
EN–MAMgMn1	EN–MA40010	M 1	MgMn1	M 1
EN–MAMgMn2	EN–MA40020	M 2	MgMn2	M 2

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL