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Magnesium and magnesium alloys — Magnesium alloys for cast anodes

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

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 26202 was prepared by the European Committee for Standardization (CEN) (as EN 12438) and was adopted, under a special "fast-track procedure", by Technical Committee ISO/TC 79, *Light metals and their alloys*, Subcommittee SC 5, *Magnesium and alloys of cast or wrought magnesium*, in parallel with its approval by the ISO member bodies.

Contents

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of an identical text or by endorsement, at the latest by October 1998, and conflicting national standards shall be withdrawn at the latest by October 1998.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.

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.

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

Alloy group	Material designation: Symbol	Number	Composition in percent (mass fraction): 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: Symbol	Number	Casting process[1])	Composition in percent (mass fraction): 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.

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.

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.

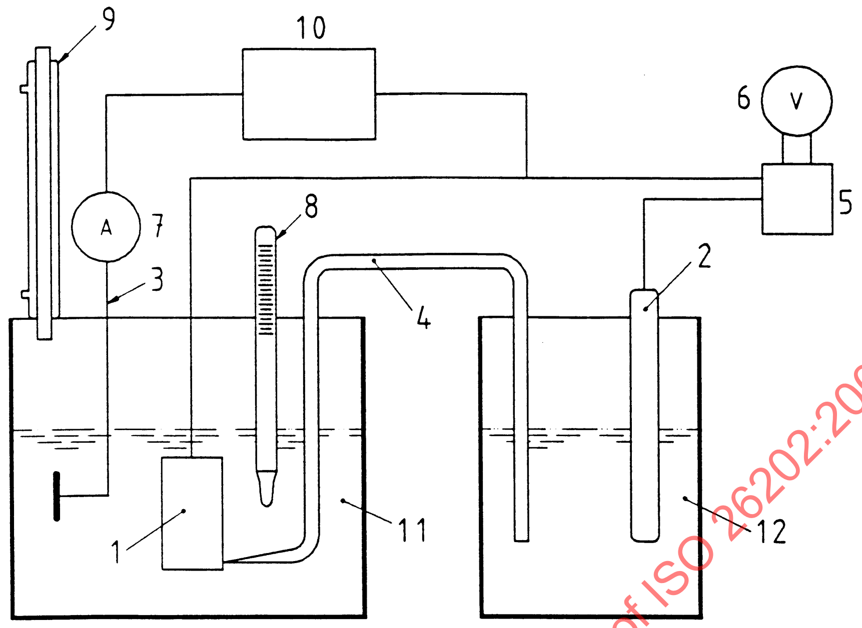
The capillary tube shall be moved towards, and located as near as possible to the test piece surface and this distance should not be more than twice the outside diameter of the capillary tube.

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 U_H = -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.

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.

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

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;