INTERNATIONAL STANDARD

ISO 16220

Second edition
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Magnesium and magnesium alloys — Magnesium alloy ingots and castings

Magnésium et alliages de magnésium — Lingots et pièces moulées en alliage de magnésium

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 16220 was prepared by Technical Committee ISO/TC 79, *Light metals and their alloys*, Subcommittee SC 5, *Magnesium and alloys of cast or wrought magnesium*.

This second edition cancels and replaces the first edition (ISO 16220:2000), which has been technically revised.

Introduction

This International Standard classifies the commercially available magnesium alloys into a number of grades suitable for the applications to which they might be put.

Some of the alloys referenced in this International Standard can be the subject of a patent or of patent applications and their listing herein is not to be construed in any way as the granting of a license under such patent rights.

This International Standard is technically identical with European Standard EN 1753, except for some minor deviation in Ni content, Mn content and Fe/Mn ratio. Grade designation also differs slightly; the correlation is given in Annex A.

Magnesium and magnesium alloys — Magnesium alloy ingots and castings

1 Scope

This International Standard specifies the chemical composition of magnesium alloy ingots. It also specifies the chemical composition of magnesium alloy castings and the mechanical properties of separately cast samples of these alloys (see Clause 6). By agreement, this International Standard also specifies the mechanical properties of magnesium alloy castings determined from samples cut from a casting.

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.

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

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

ISO 6892, *Metallic materials — Tensile testing at ambient temperature*

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

3 Designation

3.1 Material

The material shall be designated by symbols as given in Tables 1 to 5.

NOTE 1 The material symbol designations are in accordance with ISO 2092:1981[1)]. The material number designations are identical to those used in EN 1753.

NOTE 2 A list of European designations, national and former national European designations corresponding to those specified in this International Standard is given in Annex A.

3.2 Temper designation

The following symbols for temper designation shall be used:

— F: as-cast; applies to products that acquire some temper from casting processes not having special control over the amount of thermal treatment;

1) Withdrawn in 2002.

— T4: solution heat-treated and naturally aged; applies to products that have no further treatment after solution heat treatment;

— T5: as-cast and artificially aged; applies to products that are cooled from the casting process, and then artificially aged to improve mechanical properties or dimensions;

— T6: solution heat-treated and artificially aged; applies to products that are solution heat treated followed by artificially ageing.

3.3 Casting process designation

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

— S: sand casting;

— K: permanent-mould casting;

— D: pressure-die casting;

— L: investment casting.

3.4 Designation for ordering

The designation used for ordering shall include, in the following order, the number of castings, a mention of this International Standard, the ISO alloy designation, the designation for the heat treatment process (temper), and the designation for the casting process.

EXAMPLE An order for 20 castings conforming to this International Standard, of magnesium alloy ISO-MC21120, delivered in as-cast (F temper) and made by sand casting (S), is as follows:

20 castings – ISO 16220 – ISO-MgAl9Zn1(A) (or ISO-MC21120)-F-S

4 Requirements

4.1 Chemical composition

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

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

Conformance shall be determined by the manufacturer by analysing samples taken at the time the ingots or castings are produced.

NOTE For additional information regarding the manganese and iron contents, see Annex B.

4.2 Mechanical properties of castings

The mechanical properties obtained from test pieces prepared from separately cast samples for sand castings and permanent-mould castings shall meet the requirements given in Tables 3 and 4. As appropriate, the tests shall be carried out in accordance with Clause 7.

NOTE 1 Mechanical properties obtained from test pieces prepared from separately cast samples for investment castings are not specified, as experience is limited. As a general rule they are similar to those for permanent mould castings.

NOTE 2 The values obtained from test pieces cut from castings can differ from the minimum values specified in the tables because of variation in structure arising from differences in section thickness and soundness.

NOTE 3 The mechanical properties obtained from test pieces prepared from separately cast samples, especially for pressure-die castings, are very dependent upon injection and process parameters; therefore, the properties given in Table 5 are for guidance only.

The Brinell hardness test shall be carried out on sound areas of castings or on a test piece which has not been stressed.

4.3 Frequency of testing

The frequency of testing shall be in accordance with EN 1559-5.

4.4 General condition of the product

The product shall have a clean surface according to agreement between the manufacturer and the purchaser, and shall be commercially free from visible and internal defects to a standard also agreed between the manufacturer and the purchaser.

5 Sampling

Conditions for sampling, formation of batches and frequency of verification shall be as specified in EN 1559-5.

6 Test pieces for mechanical properties

6.1 Design

The design of test pieces shall be subject to agreement between the manufacturer and the purchaser.

6.2 Test pieces obtained from separately cast samples

6.2.1 Sand-cast samples

Test pieces may be in the machined or unmachined condition.

The following conditions shall apply:

— samples shall be cast in sand moulds and without artificial chilling;

— the minimum diameter of the test piece shall be 12 mm;

— the gauge length and the parallel length shall conform to ISO 6892.

6.2.2 Permanent-mould cast samples

Test pieces may be in the machined or unmachined condition.

The following conditions shall apply:

— the minimum diameter of the test piece shall be 12 mm;

— the gauge length and parallel length shall conform to ISO 6892.

6.2.3 Pressure-die cast samples

The following condition shall apply:

— the surface of the test pieces shall be as cast.

6.2.4 Investment cast samples

Test pieces may be in the machined or unmachined condition.

The following conditions shall apply:

— the minimum diameter of the test piece shall be 5 mm;

— the gauge length and parallel length shall conform to ISO 6892.

6.3 Test pieces cut from castings

The geometry and location of test pieces cut from castings shall be specified by agreement between the manufacturer and the purchaser.

If it is agreed between the manufacturer and the purchaser to use test pieces of circular cross-section, the minimum diameter shall be 4 mm.

7 Test methods

7.1 Tensile test

Tensile tests shall be carried out in accordance with ISO 6892.

7.2 Brinell hardness test

Brinell hardness tests shall be carried out in accordance with ISO 6506-1.

A test ball of 5 mm diameter is recommended. By agreement between the manufacturer and the purchaser, a smaller ball diameter may be used for thin-wall castings.

8 Retests

Retests shall be carried out in accordance with EN 1559-5.

9 Rounding of numbers

The number representing the result for any value specified in this International Standard shall be expressed to the same number of decimal places as the corresponding number in this International Standard. The rounding of numbers shall meet the requirements of ISO 31-0:1992, 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

Alloy group	Material designation			Composition % mass fraction													
	In accordance with ISO 2092:1981 [a]	In accordance with EN 1753	Min. or max.	Mg	Al	Zn	Mn [b]	RE [c]	Zr	Ag	Y	Li	Si	Fe	Cu	Ni	Others each
MgAlZn	ISO-MgAl9Zn1 (A)	ISO-MB21120	min. max.	Rem.	8,5 9,5	0,45 0,9	0,17 0,40	— —	— —	— —	— —	— —	— 0,08	— 0,004	— 0,025	— 0,001	— 0,01
	ISO-MgAl9Zn1 (B)	ISO-MB21121	min. max.	Rem.	8,0 10,0	0,3 1,0	0,1 0,50	— —	— —	— —	— —	— —	— 0,3	— 0,03	— 0,20	— 0,01	— 0,05
MgAlMn	ISO-MgAl2Mn	ISO-MB21210	min. max.	Rem.	1,7 2,5	— 0,20	0,35 0,60	— —	— —	— —	— —	— —	— 0,05	— 0,004	— 0,008	— 0,001	— 0,01
	ISO-MgAl5Mn	ISO-MB21220	min. max.	Rem.	4,5 5,3	— 0,30	0,28 0,50	— —	— —	— —	— —	— —	— 0,08	— 0,004	— 0,008	— 0,001	— 0,01
	ISO-MgAl6Mn	ISO-MB21230	min. max.	Rem.	5,6 6,4	— 0,30	0,26 0,50	— —	— —	— —	— —	— —	— 0,08	— 0,004	— 0,008	— 0,001	— 0,01
MgAlSi	ISO-MgAl2Si	ISO-MB21310	min. max.	Rem.	1,9 2,5	— 0,20	0,2 0,6	— —	— —	— —	— —	— —	0,7 1,2	— 0,004	— 0,008	— 0,001	— 0,01
	ISO-MgAl4Si	ISO-MB21320	min. max.	Rem.	3,7 4,8	— 0,20	0,2 0,6	— —	— —	— —	— —	— —	0,7 1,2	— 0,004	— 0,008	— 0,001	— 0,01
MgZnCu	ISO-MgZn6Cu3Mn	ISO-MB32110	min. max.	Rem.	— 0,2	5,5 6,5	0,25 0,75	— —	— —	— —	— —	— —	— 0,20	— 0,05	2,4 3,0	— 0,01	— 0,01
MgZnREZr [d]	ISO-MgZn4RE1Zr	ISO-MB35110	min. max.	Rem.	— —	3,5 5,0	— 0,15	1,0 1,75	0,1 1,0	— —	— —	— —	— 0,01	— 0,01	— 0,03	— 0,005	— 0,01
	ISO-MgRE3Zn2Zr	ISO-MB65120	min. max.	Rem.	— —	2,0 3,0	— 0,15	2,4 4,0	0,1 1,0	— —	— —	— —	— 0,01	— 0,01	— 0,03	— 0,005	— 0,01
MgREAgZr [e]	ISO-MgAg2RE2Zr	ISO-MB65210	min. max.	Rem.	— —	— 0,2	— 0,15	2,0 3,0	0,1 1,0	2,0 3,0	— —	— —	— 0,01	— 0,01	— 0,03	— 0,005	— 0,01
	ISO-MgRE2Ag1Zr	ISO-MB65220	min. max.	Rem.	— —	— 0,2	— 0,15	1,5 3,0	0,1 1,0	1,3 1,7	— —	— —	— 0,01	— 0,01	0,05 0,10	— 0,005	— 0,01
MgYREZr [f, g]	ISO-MgY5RE4Zr	ISO-MB95310	min. max.	Rem.	— —	— 0,20	— 0,15	2,0 4,0	0,1 1,0	— —	4,75 5,5	— 0,20	— 0,01	— 0,01	— 0,03	— 0,005	— 0,01
	ISO-MgY4RE3Zr	ISO-MB95320	min. max.	Rem.	— —	— 0,20	— 0,15	2,4 4,4	0,1 1,0	— —	3,7 4,3	— 0,20	— 0,01	— 0,01	— 0,03	— 0,005	— 0,01

a Withdrawn in 2002.

b For maximum manganese content, see Annex B.

c RE = rare earth metals.

d Cerium-rich.

e Neodymium-rich.

f Neodymium- and heavy RE-rich.

g Improved corrosion resistance can be obtained by reducing the maximum manganese content to 0,03 %, the maximum iron content to 0,01 %, the maximum copper content to 0,02 % and the maximum zinc + silver content to 0,2 %.