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Founding - Ausferritic spheroidal graphite cast iron

Gießereiwesen - Ausferritisches Gusseisen mit Kugelgraphit

Fonderie - Fontes ausferritiques à graphite sphéroïdal

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Founding - Ausferritic spheroidal graphite cast irons

Fonderie - Fontes ausferritiques à graphite sphéroïdal

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Foreword

This document (EN 1564:2011) has been prepared by Technical Committee CEN/TC 190 “Foundry technology”, the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by May 2012, and conflicting national standards shall be withdrawn at the latest by May 2012.

This document supersedes EN 1564:1997.

Within its programme of work, Technical Committee CEN/TC 190 requested CEN/TC 190/WG 7 "Spheroidal graphite, silicon molybdenum and austempered ductile iron" to revise EN 1564:1997.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive 97/23/EC, see informative Annex ZA, which is an integral part of this document.

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

Annex K provides details of significant technical changes between this European Standard and the previous edition.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

Ausferritic spheroidal graphite cast iron is a cast alloy, iron, carbon and silicon based, the carbon being present mainly in the form of spheroidal graphite particles.

NOTE 1 Ausferritic spheroidal graphite cast iron is also known as austempered ductile iron (ADI).

Compared with the spheroidal graphite cast irons as specified in EN 1563 [1], this material combines higher strength and toughness properties as a result of the ausferritic matrix structure.

This European Standard classifies ausferritic spheroidal graphite cast irons in accordance with the mechanical properties of the material.

The mechanical properties of these ausferritic spheroidal graphite cast irons depend on the graphite and the matrix structure.

The required structure is obtained by selecting the appropriate composition and subsequent processing.

The mechanical properties of the material can be evaluated on machined test pieces prepared from cast samples or samples cut from a casting.

Five grades of ausferritic spheroidal graphite cast iron are defined by the mechanical properties measured on machined test pieces prepared from cast samples. When, for these grades, hardness is a requirement of the purchaser as being important for the application, Annex C provides guidance values for hardness.

Two grades of ausferritic spheroidal graphite cast iron are defined in Annex A in accordance with their hardness. These cast irons are used in applications (e.g. mining, earth moving) where high abrasion resistance is required.

In this standard a new designation system by number, as established in EN 1560 [2], is given.

NOTE 2 This designation system by number is based on the principles and the structure as set out in EN 10027-2 [3] and so corresponds with the European numbering system for steel and other materials.

Some ausferritic spheroidal graphite cast iron grades can be used for pressure equipment.

The permitted material grades of ausferritic spheroidal graphite cast iron for pressure applications and the conditions for their use are given in specific product or application standards.

For the design of pressure equipment, specific design rules apply.

Annex ZA gives information relating to the conformance of permitted ausferritic spheroidal graphite cast iron grades to the Pressure Equipment Directive 97/23/EC.

1 Scope

This European Standard defines the grades and the corresponding requirements for ausferritic spheroidal graphite cast irons.

This European Standard specifies five grades of ausferritic spheroidal graphite cast iron by a classification based on mechanical properties measured on machined test pieces prepared from cast samples.

This European Standard also specifies two grades by a classification as a function of hardness.

This European Standard does not cover technical delivery conditions for iron castings, see EN 1559-1 [4] and EN 1559-3 [5].

NOTE Grades given in Annex A are not intended for pressure equipment applications.

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.

EN 764-5:2002, *Pressure Equipment — Part 5: Compliance and Inspection — Documentation of Materials*

EN 10204:2004, *Metallic products — Types of inspection documents*

EN ISO 148-1:2010, *Metallic materials — Charpy impact test — Part 1: Test method (ISO 148-1:2009)*

EN ISO 945-1:2008, *Microstructure of cast irons — Part 1: Graphite classification by visual analysis (ISO 945-1:2008)*

EN ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method (ISO 6506-1:2005)*

EN ISO 6892-1:2009, *Metallic materials — Tensile testing — Part 1: Method of test at ambient temperature (ISO 6892-1:2009)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
ausferritic spheroidal graphite cast iron
iron based cast material with the carbon being present mainly in the form of spheroidal graphite particles, with an ausferritic matrix structure

NOTE Usually this ausferritic matrix structure is obtained by an austempering heat treatment.

3.2
graphite spheroidising treatment
operation that brings the liquid iron into contact with a substance to produce graphite in the predominantly spheroidal (nodular) form during solidification

NOTE This operation is often followed by a second one called inoculation.

3.3
austemper heat treatment of spheroidal graphite cast iron
process, consisting of heating the castings above the A_{C1} temperature and holding a sufficient time to increase the carbon content of the austenite, followed by cooling at a rate sufficient to avoid the formation of pearlite and transforming the matrix structure for a time and a temperature (above the martensite start temperature) sufficient to produce the desired properties

NOTE This process produces a microstructure that consists predominantly of ferrite and austenite. This microstructure is called ausferrite.

3.4
cast sample
quantity of material cast to represent the cast material, including separately cast sample, side by side cast sample and cast-on sample

3.5
separately cast sample
sample cast in a separate sand mould under representative manufacturing conditions and material grade

3.6
side-by-side cast sample
sample cast in the mould alongside the casting, with a joint running system

3.7
cast-on sample
sample attached directly to the casting

3.8
relevant wall thickness
wall thickness representative of the casting, defined for the determination of the size of the cast samples to which the mechanical properties apply

4 Designation

The material shall be designated either by symbol or by number as given in Tables 1, 2 or A.1.

In the case of samples cut from the casting the letter C is added at the end of the designation by symbol, see EN 1560.

NOTE The comparison of EN 1564 grade designations with the grades from the ISO standard for ausferritic spheroidal graphite cast irons, ISO 17804:2005 [6], is given in Annex B.

5 Order information

The following information shall be supplied by the purchaser:

a) the number of this European Standard;

b) the designation of the material;

c) the relevant wall thickness of the casting;

d) any special requirements.

All requirements shall be agreed between the manufacturer and the purchaser by the time of acceptance of the order e.g. technical delivery conditions according to EN 1559-1 and EN 1559-3.

6 Manufacture

Unless otherwise specified by the purchaser, the method of manufacture of ausferritic spheroidal graphite cast irons and heat treatment required to obtain the specified mechanical properties and microstructure shall be left to the discretion of the manufacturer.

The manufacturer shall ensure that the requirements defined in this standard are met for the material grade specified in the order.

All agreements between the manufacturer and the purchaser shall be made by the time of acceptance of the order.

7 Requirements

7.1 General

The property values apply to ausferritic spheroidal graphite cast irons cast in sand moulds or moulds of comparable thermal behaviour. Subject to amendments to be agreed upon in the order, they can apply to castings obtained by alternative methods.

The material designation is based on the minimum mechanical properties obtained in cast samples with a thickness or diameter of 25 mm. The designation is irrespective of the type of cast sample.

Mechanical properties are wall thickness dependant as shown in Table 1.

NOTE Tensile testing requires sound test pieces in order to guarantee pure uni-axial stress during the test.

7.2 Test pieces machined from cast samples

7.2.1 General

The mechanical properties of ausferritic spheroidal graphite cast iron test pieces shall be as specified in Table 1, and, if applicable, in accordance with the requirements given in 7.2.2.

7.2.2 Impact energy

The impact energy values given in Table 2 at room temperature, if applicable, shall only be determined if specified by the purchaser by the time of acceptance of the order.

7.3 Test pieces machined from samples cut from a casting

If applicable, the manufacturer and the purchaser shall agree on:

— the location(s) on a casting where the sample(s) shall be taken;

— the mechanical properties that shall be measured;

— the minimum values, or allowable range of values, for these mechanical properties (for information, see Annex C).

NOTE 1 The properties of castings are not uniform, depending on the complexity of the castings and variation in their section thickness.

NOTE 2 Mechanical properties for test pieces cut from a casting are affected not only by material properties (subject of this standard) but also by the local casting soundness (not subject of this standard).

Table 1 — Mechanical properties measured on test pieces machined from cast samples

Material designation		Relevant wall thickness [a]	0,2 % proof strength	Tensile strength	Elongation
		t	$R_{p0,2}$	R_m	A
			MPa	MPa	%
Symbol	Number	mm	min.	min.	min.
EN-GJS-800-10 EN-GJS-800-10-RT	5.3400 5.3401	$t \leq 30$	500	800	10
		$30 < t \leq 60$		750	6
		$60 < t \leq 100$		720	5
EN-GJS-900-8	5.3402	$t \leq 30$	600	900	8
		$30 < t \leq 60$		850	5
		$60 < t \leq 100$		820	4
EN-GJS-1050-6	5.3403	$t \leq 30$	700	1 050	6
		$30 < t \leq 60$		1 000	4
		$60 < t \leq 100$		970	3
EN-GJS-1200-3	5.3404	$t \leq 30$	850	1 200	3
		$30 < t \leq 60$		1 170	2
		$60 < t \leq 100$		1 140	1
EN-GJS-1400-1	5.3405	$t \leq 30$	1 100	1 400	1
		$30 < t \leq 60$		To be agreed between the manufacturer and the purchaser.	
		$60 < t \leq 100$			

NOTE 1 The relevant wall thickness does not affect the minimum 0,2 % proof strength provided the heat treatment parameters and alloying are adjusted as a function of the relevant wall thickness.

NOTE 2 Guidance values for Brinell hardness for these grades are given in Annex D.

[a] For relevant wall thicknesses more than 100 mm, the manufacturer and the purchaser shall agree on the type and size of the cast sample and the minimum values to be obtained.

Table 2 — Minimum impact energy values measured on V-notched test pieces machined from cast samples

Material designation		Relevant wall thickness [a]	Impact energy value at room temperature 23 °C ± 5 °C	
		t	Mean value of 3 tests	Individual value
Symbol	Number	mm	J	J
			min.	min.
EN-GJS-800-10-RT	5.3401	$t \leq 30$	10	9
		$30 < t \leq 60$	9	8
		$60 < t \leq 100$	8	7

[a] For relevant wall thicknesses more than 100 mm, the manufacturer and the purchaser shall agree on the type and size of the cast sample and the minimum values to be obtained.

7.4 Hardness

Brinell hardness and its range values for the grades listed in Table 1 shall only be specified when agreed between the manufacturer and the purchaser by the time of acceptance of the order.

For the five grades listed in Table 1, information regarding hardness is given in Annex D and Annex E.

For the two grades defined by hardness properties, Annex A applies.

7.5 Graphite structure

The graphite structure shall be mainly of form V and VI in accordance with EN ISO 945-1. A more precise definition may be agreed upon by the time of acceptance of the order.

NOTE Annex F gives more information regarding nodularity.

7.6 Matrix structure

The matrix structure of the various grades of ausferritic spheroidal graphite cast iron consists predominantly of ferrite and austenite – otherwise known as ausferrite. Other matrix constituents, (e.g. martensite, bainite, carbides) shall be minimised and may be present at a level that will not affect the required mechanical properties of the grades given in Table 1 and Table 2, but can be beneficial in the abrasion resistant grades as given in Annex A.

The cooling rate within some sections may not be sufficient to avoid the formation of pearlite or other high temperature transformation products. In such cases, the maximum acceptable quantities of these micro constituents, the locations within the casting, and the mechanical properties in these locations may be agreed upon between the manufacturer and the purchaser.

8 Sampling

8.1 General

Samples shall be made from the same material as that used to produce the casting(s) which they represent.

Several types of samples (separately cast samples, cast-on samples, side-by-side cast samples, samples cut from a casting) can be used, depending on the mass and wall thickness of the casting.

When relevant the type of sample should be agreed between the manufacturer and the purchaser. Unless otherwise agreed the choice of the option is left to the discretion of the manufacturer.

When the mass of the casting exceeds 2 000 kg and its relevant wall thickness exceeds 60 mm, cast-on samples or side-by-side samples should preferably be used; the dimensions and the location of the sample shall be agreed between the manufacturer and the purchaser by the time of acceptance of the order.

If the spheroidizing treatment is carried out in the mould (in-mould process), the separately cast sample should be avoided.

All samples shall be adequately marked to guarantee full traceability to the castings which they represent.

The samples shall be subject to the same heat treatment, as that of the castings they represent, if any.

Tensile and impact test pieces shall be finally machined from the samples after the heat treatment.