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Abrasion resisting alloy cast iron

DIN 1695

Verschleißbeständiges legiertes Gußeisen

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

1 Field of application

This standard specifies the material properties and composition of abrasion resisting alloy cast iron and of castings produced from this material.

This standard is supplemented by the general technical delivery conditions specified in DIN 1690 Part 1 for castings made from metallic materials.

2 Concepts

2.1 Abrasion

See DIN 50 320 for definition.

For the purposes of this standard, the concept "abrasion" is understood to refer to the abrasive wear of cast iron as a base material by minerals or other solids as the abrading material in gases, liquids or in other solids as the carrying medium.

2.2 Abrasion resisting cast iron materials

For the purposes of this standard, abrasion resisting cast iron materials are understood to refer to grades of material which show a high degree of resistance to abrasive wear.

3 Material

The classification into grades is based on the main alloying constituents, see table 1.

The choice of the material is determined by the abrasion resistance desired (see table 1), the impact stress to be anticipated and also by the degree of machinability, if appropriate (see clause 7).

The selection of the grade is a matter for the purchaser. Its suitability, from the point of view of casting, for the casting proposed shall be verified by the casting producer.

4 Designation

The symbols or material numbers given in table 1 shall be used to designate the material grade at the time of ordering.

Example:

An abrasion resisting alloy cast iron identified by the symbol G-X 300 CrNiSi 9 5 2 or the material number 0.9630 shall be designated:

Cast iron DIN 1695 – G-X 300 CrNiSi 9 5 2

or

Cast iron DIN 1695 – 0.9630

5 Manufacturing process

The manufacturing process is left to the casting producer's discretion, unless otherwise agreed.

6 Heat treatment

Castings made from abrasion resisting cast iron are predominantly used in the heat treated condition.

If required, in order to achieve the desired condition, a specific heat treatment is to be agreed upon. Table 1 of Supplement 1 to DIN 1695 provides guideline data for the various heat treatments.

The use of the castings in the as-cast condition is only possible for some grades under specified conditions (see note in table 2).

7 Machinability

Castings of abrasion resistant cast iron materials are predominantly used in the unmachined condition.

Bainitic cast iron G-X 300 NiMo 3 Mg is quite suitable for machining.

The carbidic chromium cast iron grades G-X 300 CrMo 15 3 to G-X 260 Cr 27 can be machined quite well after softening.

Limited machining is possible on the self-hardening carbidic cast iron grades G-X 260 NiCr 4 2, G-X 330 NiCr 4 2 and G-X 300 CrNiSi 9 5 2.

8 Requirements

8.1 Chemical composition

Table 1 summarizes the chemical composition.

8.2 Hardness

The Vickers hardness values are listed in table 2.

Other methods of hardness testing, e.g. Rockwell hardness testing, may be applied by agreement instead of the Vickers methods. However, in this case, the hardness values shall be agreed between purchaser and producer in addition to the scope of supply within the range of the guide values given in table 2 of Supplement 1 to DIN 1695.

8.3 Strength properties

Tensile strength and other strength properties are only relevant to some degree to the properties in use of abrasion resisting alloy cast iron. For this reason, the

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guide values for the mechanical properties given in table 2 of Supplement 1 to DIN 1695, as a rule, are not to be verified.

The abrasion resisting bainitic cast iron grade G-X 300 NiMo 3 Mg is an exception to this. Tests may, by special agreement, be made on test pieces of this material taken from separately cast samples as described in DIN 1693 Part 1.

8.4 Physical properties

Table 2 of Supplement 1 to DIN 1695 gives guide values on physical properties.

8.5 Structure

The structure of grade G-X 300 NiMo 3 Mg contains free carbon in the form of spheroidal graphite.

The structures of the other abrasion resisting material grades are generally free from graphite and contain carbides in a predominantly martensitic, austenitic and perlitic matrix.

Table 3 of Supplement 1 to DIN 1695 gives guide values relating to the various structures of abrasion resisting cast iron materials.

8.6 General condition of the castings

The specifications of DIN 1690 Part 1 shall apply.

8.7 Shape and dimensions

The specifications of DIN 1690 Part 1 shall apply.

Table 2 of Supplement 1 to DIN 1695 gives guide values relating to shrinkage.

8.8 Machining allowances

The specifications of DIN 1690 Part 1 shall apply.

8.9 Masses

See table 2 of Supplement 1 to DIN 1695 for guide values relating to the density of the individual materials for the purposes of calculating the masses.

Table 1. Grades, chemical composition and properties

Grade		Composition, % by mass						Properties
Symbol	Material number	C	Si	Mn	Cr	Ni	Mo	
G-X 300 NiMo 3 Mg	0.9610	2,8 to 3,5	2,0 to 2,6	0,2 to 0,5		1,5 to 4,5	0,5 to 0,8	High strength material with tensile strength of 700 to 1300 N/mm² at 1 to 8 % elongation. Has the highest impact strength of the abrasion resisting cast iron grades complying with this standard.
G-X 260 NiCr 4 2	0.9620	2,6 to 2,9	0,2 to 0,8	0,3 to 0,7	1,4 to 2,4	3,3 to 5,0	up to 0,5	High abrasion resistance, may be used under moderate impact stress conditions.
G-X 330 NiCr 4 2	0.9625	3,0 to 3,6	0,2 to 0,8	0,3 to 0,7	1,4 to 2,4	3,3 to 5,0	up to 0,5	Very high abrasion resistance, may be used under low impact stress conditions.
G-X 300 CrNiSi 9 5 2	0.9630	2,5 to 3,5	1,5 to 2,2	0,3 to 0,7	8 to 10	4,5 to 6,5	up to 0,5	Very high abrasion resistance, may be used under high impact stress conditions. Abrasion resistance increases whilst impact resistance decreases with increasing carbon content. The degree to which grades G-X 300 CrMo 15 3, G-X 300 CrMoNi 15 2 1, G-X 260 CrMoNi 20 2 1 and G-X 260 Cr 27 in the softened condition can be machined depends on the carbon content. G-X 300 CrMoNi 15 2 1 has high through hardenability, and G-X 260 CrMoNi 20 2 1 the highest through hardenability.
G-X 300 CrMo 15 3	0.9635	2,3 to 3,6	0,2 to 0,8	0,5 to 1,0	14 to 17	up to 0,7 *)	1,0 to 3,0	
G-X 300 CrMoNi 15 2 1	0.9640	2,3 to 3,6	0,2 to 0,8	0,5 to 1,0	14 to 17	0,8 to 1,2 *)	1,8 to 2,2	
G-X 260 CrMoNi 20 2 1	0.9645	2,3 to 2,9	0,2 to 0,8	0,5 to 1,0	18 to 22	0,8 to 1,2 *)	1,4 to 2,0	
G-X 260 Cr 27	0.9650	2,3 to 2,9	0,5 to 1,5	0,5 to 1,5	24 to 28	up to 1,2	up to 1,0	
G-X 300 CrMo 27 1	0.9655	3,0 to 3,5	0,2 to 1,0	0,5 to 1,0	23 to 28	up to 1,2	1 to 2	

*) Can also be manufactured as a grade containing Cu.

Table 2. **Hardness values**

Grade		Vickers hardness HV 30		
		After special heat treatment or in the as-cast condition	Hardened or quenched and tempered	Softened
Symbol	Material number	Minimum	Minimum	Maximum
G-X 300 NiMo 3 Mg	0.9610	400	550	300
G-X 260 NiCr 4 2	0.9620	450 [1]	520	–
G-X 330 NiCr 4 2	0.9625	450 [1]	550	–
G-X 300 CrNiSi 9 5 2	0.9630	450 [1]	600	–
G-X 300 CrMo 15 3	0.9635	450 [1]	600	400 [2]
G-X 300 CrMoNi 15 2 1	0.9640	450 [1]	600	400 [2]
G-X 260 CrMoNi 20 2 1	0.9645	450 [1]	600	420
G-X 260 Cr 27	0.9650	450 [1]	550	400
G-X 300 CrMo 27 1	0.9655	450 [1]	600	400

[1] These grades shall only be used in the as-cast condition if no requirements are made on the impact strength.
[2] Up to a maximum carbon content of 3,1 %.

Standards referred to

DIN 1690 Part 1 General technical delivery conditions for castings made from metallic materials
DIN 1693 Part 1 Cast iron with spheroidal graphite; carbon and low alloy material grades
Supplement 1 to
DIN 1695 Abrasion resisting alloy cast iron; guidance on heat treatment, properties, structures
DIN 50 320 Wear; concepts; systematic analysis of wear processes, classification of wear phenomena

Explanatory notes

This standard covers only alloy grades of cast iron. It is however intended to standardize unalloyed abrasion resisting carbidic grades of cast iron.

This standard takes into account, to a great extent, American Standard ASTM A 532-75a which has already been published, as well as British Standard BS 4844 Part 2 and Part 3, and thus constitutes a step towards an ISO Standard. A comparison of the grades specified in DIN 1695 with those standardized in the USA and the UK can only be drawn to a limited extent as the standards are drafted on a different basis and the ranges for the chemical composition frequently overlap. Table 3 below can thus only be considered as a guide.

Table 3 compares the grades specified in DIN 1695 with the corresponding grade designations in the American and British Standards; the commonly used commercial names are attached.

Table 3. **Comparison between the grades specified in DIN 1695, ASTM A 532 and British Standard 4844**

Grade as specified in DIN 1695		Grade as specified in ASTM A 532-75a	Grade as specified in BS 4844 Parts 2 and 3 (1974 editions)	Commercial name
Symbol	Material number			
G-X 300 NiMo 3 Mg	0.9610	–	–	–
G-X 260 NiCr 4 2	0.9620	Class I Type B Ni-Cr-LC	Part 2 Grade 2A	Ni-Hard 2
G-X 330 NiCr 4 2	0.9625	Class I Type A Ni-Cr-HC	Part 2 Grade 2B	Ni-Hard 1
G-X 300 CrNiSi 9 5 2	0.9630	Class I Type D Ni-Hi-Cr	Part 2 Grade 2C + 2D+ 2E	Ni-Hard 4
G-X 300 CrMo 15 3	0.9635	Class II Type C 15 % Cr-Mo-HC	Part 3 Grade 3A + 3B	Alloy 15-3
G-X 300 CrMoNi 15 2 1	0.9640	–	Part 3 Grade 3A + 3B	Alloy 15-2-1
G-X 260 CrMoNi 20 2 1	0.9645	Class II Type D + E 20 % Cr-Mo-LC + 20 % Cr-Mo-LC	Part 3 Grade 3C	Alloy 20-2-1
G-X 260 Cr 27	0.9650	Class III Type A 25 % Cr	Part 3 Grade 3D	–
G-X 300 CrMo 27 1	0.9655	Class III Type A 25 % Cr	Part 3 Grade 3E	–

Grade G-X 300 NiMo 3 Mg is also known as a fabrication material under the designation "bainitic cast iron with spheroidal graphite". The martensitic structure is, however, preferred for applications as an abrasion resisting material.