CLAASGUSS®

Technical Information No. 10

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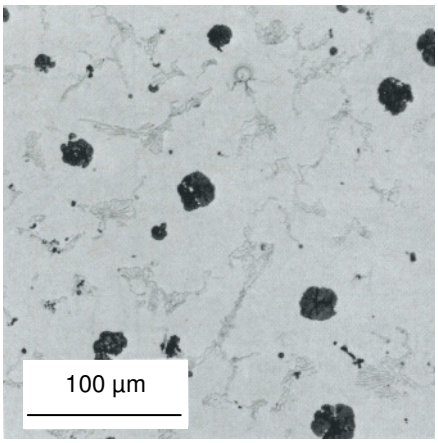
Austenitic cast iron materials

Microstructure and properties

The principal characteristic of austenitic grades of cast iron is that they have a stable austenitic basic structure at ambient temperature. Most varieties are also referred to by the trade name "Ni-Resist" because they contain at least 20% nickel, which is the main reason for their austenitic microstructure.



Austenitic microstructure of EN-GJS-AXNiCr 20-2

Compared to unalloyed and low alloyed grades of cast iron, austenitic grades offer a range of "exceptional" properties. These include the following:

- Good scaling resistance
- High resistance to heat
- Impressive thermal expansion characteristics, which are adjustable within certain limits
- Resistance to corrosion from sea water and alkaline media
- Good running properties
- High elongation at fracture
- Cold toughness
- Resistance to erosion
- Non-magnetizable

With this profile of properties, austenitic grades of cast iron offer an alternative to non-corrosive, heat-resistant steels and even, in some cases, to Ni base alloys. In comparison to these, they offer numerous economic advantages because the process control involved in production is simpler. For example, the lower melting and pouring temperatures reduce the risk of reactions between the molten mass and the mold material, which in turn means lower costs for cleaning and re-working. In general, the surface quality is superior to that achieved with cast steel. With better flow and mold filling characteristics it is not only possible to achieve greater dimensional accuracy with the cast parts, but thinner walls as well. In addition, austenitic cast parts are also better for mechanical machining than cast steel.

In comparison to unalloyed or low alloyed cast iron materials, however, the higher feeding requirement and the high level of shrinkage of the austenitic basic structure mean that a more complex gate and feeding system is required, one which is more similar to the type used for cast steel. The melting process and the handling of the molten mass also require greater care in order to prevent the absorption of gas and the degeneration of graphite during solidification.

Grades of material and the influence of alloying elements

This class of materials is standardized in DIN EN 13835. In a similar way to white, wear-resistant grades, this standard specifies not only minimum values for properties but specifies chemical compositions as well. These have a particularly important influence on the properties of the materials in this class.

These days, grades with spheroidal graphite are of greater importance than grey cast iron grades because they provide greater strength and toughness and because they are less susceptible to growth at higher temperatures.

The diverse alloying elements have different functions when it comes to the production of the desired profile of properties. The main purpose of the primary alloying element, nickel, is to stabilize the austenitic microstructure. In addition, nickel also increases the material's tensile strength and elongation at fracture, with little effect on hardness and yield strength. Furthermore, nickel also has a major influence on the coefficient of thermal expansion, which can be adjusted to a certain degree by adjusting the nickel content. This value can vary between 5 and 18.7 µm/(mK) depending on the nickel content.
Although chromium improves resistance to corrosion, strength and elevated temperature properties, the amount that can be added is limited because it would otherwise lead to excessive formation of carbide and, as a result, embrittlement and excessive hardness. This would cause major problems for machining the material and it would also have a negative impact on its pouring properties.
Copper has a positive impact in terms of resistance to corrosion from acids, whereas manganese is added specifically to cold-tough varieties. Manganese keeps the austenite stable long term at temperatures of as low as –196 °C.
For high temperature applications, silicium and molybdenum alloys are used. Silicium increases the resistance to scaling by forming a protective layer of SiO_2. However, excessive amounts make the material brittle if it is exposed to high temperatures over longer periods. Molybdenum, in contrast, makes the material more resistant to heat.

Corrosion resistance

Unlike corrosion-resistant steels, austenitic cast iron does not develop a passive film because the chromium content is too low. Instead, the high resistance to corrosion is provided by the inherent resistance of the nickel-holding matrix and/or the formation of a protective layer made of corrosion products, on which all the other alloying elements are involved. Uniform attack is somewhat stronger on austenitic cast iron than on corrosion-resistant steels. Unlike these kinds of steel, however, there is no risk of hole or crevice corrosion which can be caused by damage to the passive film.

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Classification of grades of austenitic cast iron according to DIN EN 13835

Graphite type	Material designation		Tensile strength R_m N/ mm² min.	0.2% Tensile yield strength $R_{p0,2}$ N/ mm² min.	Elong-ation to fracture A % min.	Impact resistance values Charpy V-notch test according to EN 10045-1 J min.
	Abbreviation	Number				
Normal grades						
Lamellar	EN-GJL-A-XNiCuCr15-6-2	EN-JL3011	170	-	-	-
Spheroidal	EN-GJS-A-XNiCr20-2	EN-JS3011	370	210	7	13[1)]
	EN-GJS-A-XNiMn23-4	EN-JS3021	440	210	25	24
	EN-GJS-A-XNiCrNb20-2	EN-JS3031	370	210	7	13[1)]
	EN-GJS-A-XNi22	EN-JS3041	370	170	20	20
	EN-GJS-A-XNi35	EN-JS3051	370	210	20	-
	EN-GJS-A-XNiSiCr35-5-2	EN- JS3061	370	200	10	-
Special grades						
Lamellar	EN-GJL-A-XNiMn13-7	EN-JL3021	140	-	-	-
Spheroidal	EN-GJS-A-XNiMn13-7	EN-JS3071	390	210	15	16
	EN-GJS-A-XNiCr30-3	EN-JS3081	370	210	7	-
	EN-GJS-A-XNiCr30-5-5	EN-JS3091	390	240	-	-
	EN-GJS-A-XNiCr35-3	EN-JS3101	370	210	7	-

[1)] Optional requirement subject to agreement between the manufacturer and customer