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British Stainless Steel Association

Introduction to Stainless Steel

What is Stainless Steel?

Stainless steel is a generic term for a group of corrosion resistant steels containing a minimum of 10.5 per cent of chromium. Varying additions of nickel, molybdenum, titanium, niobium and other elements may be present. The mechanical properties and behaviour in service of the various types of steel depend upon their composition, and careful selection of the most appropriate steel grade is vital to success in any application.

Types of Stainless Steel

There are several types of stainless steel – FERRITIC, MARTENSITIC, AUSTENITIC and DUPLEX. The ferritic steels are magnetic, have a low carbon content and contain chromium as the main alloying element, typically at the 13% and 17% levels. The martensitic steels are magnetic, containing typically 12% chromium and a moderate carbon content. They are hardenable by quenching and tempering like plain carbon steels and find their main application in cutlery manufacture, aerospace and general engineering. The austenitic steels are non-magnetic and, in addition to chromium typically at the 18% level, contain nickel, which increases their corrosion resistance. They are the most widely used group of stainless steels. Duplex steels are used where combinations of higher strength and corrosion resistance are needed. Super austenitic grades and precipitation hardened grades of steel are also available.

Corrosion Resistance

All stainless steels have a high resistance to corrosion due to their chromium content. This remarkable resistance to attack is due to the naturally occurring chromium-rich film, which is always present on the surface of the steel. Although extremely thin, this invisible, inert film is tightly adherent to the metal and extremely protective in a wide range of corrosive media. The film is rapidly self-repairing in the presence of oxygen and damage by abrasion, cutting or machining is instantaneously repaired. In general the corrosion resistance of these steels improves as the chromium content increases and in particular the addition of nickel to create the austenitic grades strengthens the oxide film and raises their performance in more aggressive conditions. The additions of molybdenum to either the ferritic or austenitic steels improves their pitting corrosion resistance and produces the most resistant steels in the two categories. The ferritic steels are used in the more mildly corrosive environments, being often used in trim work and somewhat less demanding applications.

In the home, stainless steel does not suffer from the unsightly rusting common to ordinary steels and is normally unaffected by the variety of tap waters, food, drink, soaps and detergents which are encountered. With the correct care and attention a clean, bright, attractive finish can be maintained and so either ferritic or austenitic steels can be used, as appropriate. As a result of their superior corrosion resistance and ease of cleaning, austenitic stainless steels are used widely in food processing, brewing, soft drink processing equipment, and in catering equipment generally.

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The austenitic steels are also highly resistant to the wide range of rural and industrial atmospheres encountered in the United Kingdom, resulting in extensive use in architectural, structural, and street furniture applications. Their resistance to attack by acids, alkalis and other chemicals, has led to a wide use in the chemical and process plant industries.

The selection of the correct grade and finish of steel for a given application is very important to obtain the corrosion resistance required. The presence of aggressive impurities in corrosive media can necessitate the use of one of the higher alloyed stainless steel grades.

Welding

The ferritic stainless steels can be welded in thinner sections, but it is recommended that advice be sought on welding practices. The austenitic stainless steels are readily welded by the full variety of welding techniques. Incorrect welding practice, particularly on thicker sections, can impede corrosion resistance if the correct steel grade has not been chosen. This can be overcome by the use of stabilised steels or by the use of extra low carbon steels (ELC). Brazing and soldering can be carried out successfully on lighter sections. However, the corrosion resistance of silver bearing brazed joints may not match the parent material.

Other properties of Stainless Steels

There is a wide range of stainless steels with other attractive properties to complement their corrosion resistance.

The appropriate austenitic steels, in particular, can give excellent formability and impact strength. Their high temperature strength and scaling resistance up to 1100^{o}C are extremely useful for many applications, before much more highly alloyed materials have to be considered. Other grades are resistant to slow elongation under stress at high temperatures; these are the creep resistant grades. Austenitic steels also perform well at low temperatures, down to –200^{o}C and colder, where they do not embrittle and lose ductility or impact resistance. When deformed the strength of the austenitic steels is raised significantly by work hardening, which can be a useful design property. There are specially alloyed steels containing nitrogen, which also have built in higher strength, for such as pressure vessel applications. Again it is important that the correct grade of steel is selected to give the best combination of properties for the application.

Forms Available

Stainless steels are available in a wide range of product forms, including:

Plate, sheet, strip, precision strip, billet, engineering rounds, bar, rod, wire, pipe, tube, forgings, rings, castings, sections – hot rolled, extruded, drawn, cold formed, sintered products. The flat product forms can be obtained in a variety of surface finishes, and advice should be sought on the suitability of the different finishes for particular applications.

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Table1 – Examples of Stainless Steel Grades

European Steel Number EN 10088	Redundant BS 1449-2 Grade	Type	Tensile Strength (min) N/mm2	0.2% Proof Stress (min) N/mm	Elongation % (min)
FERRITIC					
1.4512	409S19	11% Cr + Ti	380	220	25
1.4016	430S17	17% Cr	430	260	20
1.4000	403S17	13% Cr + Al	400	230	19
MARTENSITIC					
1.4006	410S21	13% Cr 0.1% C	Normally supplied softened	-	-
1.4028	420S45	13% Cr 0.3% C	Normally supplied softened	-	-
DUPLEX					
1.4362	-	23% Cr 4.5% Ni	600	420	420
1.4462	-	22% Cr 5.5% Ni 3% Mo	660	480	20
AUSTENITIC					
1.4301	304S31} 304S16} 304S15]	18% Cr 8.5% Ni	540	230	45
1.4307	304S11	18% Cr 9% Ni Low C	520	220	45
1.4404	316S11	17% Cr 11% Ni 2% Mo	530	240	40
1.4541	321S31	17% Cr 9% N + Ti	520	220	40
SUPER AUSTENITIC					
1.4539		20% Cr 25% Ni 4.5% Mo + Cu	530	270	35
1.4547		20%Cr 18% Ni 6% Mo + Cu	650	320	35

Further information on stainless steel grades and standards is shown on the BSSA web site, www.bssa.org.uk.

Before commencing any task ensure that you have received the appropriate health and safety literature from the supplier and fully understand it. If in doubt seek advice.

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