STAINLESS STEEL

In metallurgy, stainless steel, also known as inox steel or inox from French "inoxydable", is defined as a steel alloy with a minimum of 10.5% to 11% chromium.

Stainless steel is the universal name for a number of different steels used primarily for their anti-corrosive element. Stainless steel has been developed to resist a number of corrosive environments. It ensures that our workplaces are safe, that buildings last longer and that our food preparation surfaces are hygienic. It is also an earth friendly material; it can be melted down, recycled and made into something else.

The minimum Stainless steel is always made using chromium. The minimum amount of chromium used to make stainless steel is 10.5%; it is chromium that makes the steel stainless. Chromium also improves the corrosion resistance by forming a chromium oxide film on the steel. This very thin layer, when placed under the right conditions, can also be self-repairing.

There are other elements used to make stainless steel as well, including nickel, nitrogen and molybdenum. Bringing these elements together forms different crystal structures that enable a variety of properties in machining, welding and forming.

There are four major types of stainless steel:

A*ustenitic* is the most widely used type. It has a nickel content of at least 7%, which makes it very flexible. It is used in a range of houseware products, industrial piping and vessels, constructional structures and architectural facades. This is not hardenable by heat treating.

Ferritic stainless steel has similar properties to mild steel, but better corrosion resistance. This type of steel is commonly used in washing machines, boilers and indoor architecture.

Martensitic stainless steel is a very hard, strong steel. It contains around 13% chromium and is used to make knives and turbine blades. Duplex is both a austenitic and ferritic and primarily used in chemical plants and piping applications. They usually contain approx. 22-25% chrome and 5% nickel with moly and nitrogen. They have higher yield strength and greater stress corrosion cracking resistance to chloride than austenitic.

Precipitation Hardening stainless steels are chrome-nickel stainlesses which contain alloying additions such as aluminum, copper or titanium that allow them to be hardened by a solution and aging heat treatment. They can be either austenitic or martensitic in the ages condition.

303 – 303 stainless is the most machinable of the austenitic grades of ss. With the addition of sulfur to this grade, the sulfur enhances the alloys machinability which is ordinarily difficult to machine. Applications for 303 is shafts, valve bodies, valve trim and food industry applications where 304 is normally used. 303 stainless is resistant to atmospheric corrosion, food products, sterilization solutions and many organic chemicals as well as a variety of inorganic chemicals.

304 – 304 and 304L (low carbon version) is a low carbon austenitic alloy. By keeping the carbon at .03% max, it minimizes carbide precipitation during welding.
Applications are the same as 303

310 – Grade 310, combining excellent high temperature properties with good ductility and weldability, is designed for high temperature service. It resists oxidation in continuous service at temperatures up to 1150°C provided reducing sulphur gases are not present. It is also used for intermittent service at temperatures up to 1040°C. Applications for molten salt, sulfur bearing gas and heat exchanger and recuperator tubing.

316 – 316 is the 2nd most common stainless after 304 and is commonly used in food and surgical applications. The addition of moly prevents specific forms for corrosion. By keeping the carbon at .03% max, it has been shown to minimize carbide precipitation during welding. Decreasing the sulfur will enhance its ability for electro-polishing. It is also known as a marine grade due to the increased resistance to chloride corrosion in comparison to 304. It is generally used in marine applications and watches, pharmaceutical equipment, valve bodies, bleaching and dying equipment or the textile and food industry.

317 – 317 is a molybdenum-bearing austenitic chrome nickel similar to 316 except the alloy content is higher. It was developed primarily to more effectively resist the attack of sulfurous acid compounds.

321 – this is titanium bearing stainless and it is stabilized against carbide precipitation. In higher temperatures the carbon combines with the titanium to form a harmless titanium carbide leaving the chrome to maintain full corrosion resistance. 321 is basically 304 modified by adding titanium in an amount at least 5 times the carbon plus nitrogen contents.

347 – 347 is a columbium/tantalum stabilized austenitic ss. Similar to 321, it has good intergranular-corrosion compared to typical 18-8 type alloys. It is widely used in aircraft exhausts, expansion joints and in high temperature chemical processing. It is resistant to atmospheric conditions and should be considered for applications requiring intermittent heating between 800F and 1650f.

410 – 410 is a hardenable martensitic alloy that is designed for high stress parts that require high ductility as well as good corrosion resistance. Working temps up to 1200F are acceptable. 410 is widely used in blades and buckets, steam turbines, turbine wheels, valves, aircraft parts and pumps and pump shafts.

416 – Grade 416 has the highest machinability of any stainless steel, at about 85% of that of a free-machining carbon steel. As for most other free-machining stainless steels the improvement in machinability is achieved by addition of sulphur which forms manganese sulphide inclusions; this sulphur addition also lowers the corrosion resistance, weldability and formability to below that of its non-free machining equivalent Grade 410. Grade 416 is sometimes used in the unhardened or hardened and highly tempered condition because of its low cost and ready machinability.

630 – 17-4 Precipitation Hardening also known as Type 630 is a chromium-copper precipitation hardening stainless steel used for applications requiring high strength and a moderate level of corrosion resistance. High strength is maintained to approximately 600 degrees Fahrenheit (316 degrees Celsius).

17-4 PH – A precipitation hardening martensitic stainless steel with Cu and Nb/Cb additions. The grade combines high strength, hardness (up to 572°F / 300°C), and corrosion resistance. The grade should not be used at temperatures above 572°F (300°C) or at very low temperatures. It has adequate resistance to atmospheric corrosion or in diluted acids or salts where its corrosion resistance is equivalent to Alloy 304 or 430.

15-5 PH – A martensitic precipitation hardened steel – it offers high strength combined with excellent corrosion resistance. It is similar to 17-4ph in properties, it is more chemically balanced to reduce ferrite which enhances its transverse properties. It is used when high transverse strength is required – valve parts, paper mills, aircraft, power generation chemical processing , nuclear and space craft.

904L – 904L is a non-stabilized low carbon high alloy austenitic stainless steel. The addition of copper to this grade gives it greatly improved resistance to strong reducing acids, particularly sulphuric acid. It is also highly resistant to chloride attack - both pitting / crevice corrosion and stress corrosion cracking. This grade is non-magnetic in all conditions and has excellent weldability and formability. The austenitic structure also gives this grade excellent toughness, even down to cryogenic temperatures. 904L does have very substantial contents of the high cost ingredients nickel and molybdenum. Many of the applications in which this grade has previously performed well can now be fulfilled at lower cost by duplex stainless steel 2205 (S31803 or S32205), so it is used less commonly than in the past.

2205 Duplex – 2205 duplex has a microstructure that contains both austenitic and ferritic phases and excellent combination of strength and corrosion resistance. In the annealed condition, it has twice the strength of a typical austenitic stainless. Used in oil and pas, pumps and pump parts, valves and chemical and paper manufacturing.

2507 – Commonly known as Super Duplex 2507®, is very similar to UNS S31803 Duplex. The difference between the two is the contents of chromium and nitrogen are higher in the Super Duplex Grade which in turn creates higher corrosion resistance as well as a longer lifespan. Super Duplex is composed of between 24% to 26% chromium, 6% to 8% nickel, 3% molybdenum, and 1.2% manganese, with the balance being iron. Also found in Super Duplex are trace amounts of carbon, phosphorus, sulfur, silicon, nitrogen, and copper. Benefits include: good weldability and workability, a high level of thermal conductivity and low coefficient of thermal expansion, high resistance to corrosion, fatigue, high resistance to pitting and crevice corrosion, high resistance to stress corrosion cracking (especially chloride stress corrosion cracking), high energy absorption, high strength, and erosion. Essentially, the Duplex alloys are a compromise; possessing some of the ferritic stress corrosion cracking resistance and much of the superior formability of the common austenitic stainless alloys, more cost effectively than the high nickel alloys.

Alloy 20 – Alloy 20 stainless steel is a super-austenitic stainless alloy developed for maximum corrosion resistance to sulfuric acid and other aggressive environments not suitable for typical austenitic grades. Alloy 20 seems to fall in-between both the stainless and nickel categories, as it does contain characteristics of both; however, the unified numbering system (UNS) does ultimately recognize it as a nickel based alloy, hence the UNS N08020 number. Alloy 20 is an austenitic nickel-iron-chromium based alloy with additions of copper and molybdenum. Its nickel content aids in its chloride ion stress and corrosion resistance. The addition of copper and molybdenum provides resistance to hostile environments, pitting and crevice corrosion. Chromium adds to its resistance of oxidizing environments, such as nitric acid, and columbium (or niobium) reduces the effects of carbide precipitation.

Nickel 200 – Nickel 200 alloy is a commercially pure nickel that exhibits good corrosion resistance. It is ferromagnetic and has relatively low electrical resistivity. This combination of properties has allowed its use in a wide variety of applications. Because the alloy displays good corrosion resistance, it has been used in food handling equipment, caustic solution, and general corrosion-magnetic and mechanical properties have enabled it to be used in devices requiring magnetic actuated parts.

Nickel 201 – Nickel 201 alloy is a low carbon modification of Nickel 200 alloy that has found applications in the electronic industry at temperatures up to 1200°F(649°C). It is preferred to nickel 200 above 600°F(315°C), because of ts better resistance to "creep."

Alloy 400 – (Monel) alloy 400 is a nickel/copper alloy that is easily machined and fabricated. It is used for its excellent combination of strength, corrosion resistance, ductility and weldability. Very good in salt water and brackish water and not susceptible to stress corrosion cracking.

Alloy 600 – (Inconel) – alloy 600 is a nickel/chrome/iron alloy good in applications that require resistance to corrosion and heat. Good for a combination of high strength and good workability under a wide variety of temperatures. It is acid resistant. Used in jet engines, super heaters, food processing, steam generators.

Alloy 625 – Alloy 625 (UNS N06625) is a nickel-chromium-molybdenum alloy with excellent strength from room temperature up to about 1500°F. It maintains good oxidation resistance up to 1800°F and provides good resistance to corrosion. Some of the applications of this alloy are in chemical processing, aerospace and marine engineering, pollution-control equipment, and nuclear reactors.

Alloy 800 – (Incoloy) – alloy 800 is a nickel-iron/chrome alloy with additions of copper and moly. Has excellent resistance to general corrosion, pitting and crevice corrosion in chemicals containing chlorides and sulfuric, nitric and phosphoric acids. Used for tanks, piping, heat exchangers, pumps, valves and other process equipment. 800, valves, and other process equipment. Standard product forms are round, flats, pipe, tube, plate, sheet, strip, and wire.

Alloy 825 – Alloy 825 is a titanium stabilized austenitic nickel/iron/chrome alloy with additions of copper and moly. It has good resistance to oxidizing and non-oxidizing hot acids. The moly aids in resistance to pitting and crevice corrosion. Applications include salt water cooled heat exchangers, offshore piping system tubes, heat exchangers, evaporators and scrubbers.

Alloy C-276 – (Hastalloy) C-276 is a nickel-molly-chrome alloy with the addition of tungsten. It has excellent corrosion resistance. It is suitable for most chemical process applications. It resists stress corrosion cracking is resistant to oxidation at temps up to 1900 F. A nickel-iron-chromium alloy with additions of copper and molybdenum. It also contains niobium for stabilization against sensitization and resultant intergranular corrosion. The alloy has excellent resistance to general corrosion, pitting, and crevice corrosion in chemicals containing chlorides and sulfuric, phosphoric, and nitric acids. Used for tanks, piping, heat exchangers, pumps, valves, and other process equipment. Standard product forms are round, flats, pipe, tube, plate, sheet, strip, and wire.