Stainless Steel Material

Stainless steels are alloys of iron that has a minimum of about 12% chromium. The chromium is the alloying element that imparts its corrosion resistant qualities. It combines with oxygen to form a thin, invisible, non-reactive chromium oxide film on the surface. This self-forming, self-healing passive film always forms in the presents of oxygen. When exposed to weather, a 12% chromium stainless steel (passive) will not corrode (red rust). If greater corrosion protection is required, a stainless grade is used that has mores chromium.

300 Series stainless steels are chromium-nickel compositions and are known as austenitic. They offer excellent corrosion resistance, for the most part are non-magnetic, and have excellent ductility. 300 series stainless steel can be cold work hardened and show slight magnetism, but it cannot be heat-treated. Type 304 is one of the most popular for fasteners used in construction applications. This type, sometimes referred as 18-8 (18% chromium, 8% nickel), provides better thread strength than 302, helping eliminate thread rollover. Most fasteners that are made in 304 stainless are self-tapping type due to the fact that they cannot be heat-treated. Self-drilling fasteners are available, but for steel applications must have a carbon steel drill tip affixed to the body so drilling can occur like our SD300 brand.

400 Series stainless steels are straight-chromium compositions and are known as martensitic. They resist corrosion in mild environments, and can be heat-treated for additional strength. They are magnetic, and when heat-treated, provide exceptional strength. The most popular grade used for fasteners is 410 stainless. Because of its heat-treating capabilities, self-drilling fasteners are widely produced in this grade. Corrosion can occur rather quickly if not properly process. It is recommended that fasteners that are used in exterior construction applications have some sort of plating on the surface. This will not only aid improve corrosion resistance, but can provide lubricity for improving drilling and tapping.

Material Selection

Many variables characterize a corrosive environment, i.e., chemicals and their concentration, atmospheric conditions, temperature, time, so it is difficult to select which alloy to use without knowing the exact nature of the environment. However, there are guidelines:

Type 304 serves a wide range of applications. It withstands ordinary rusting in architecture, it is resistant to food-processing environments (except possibly for high-temperature conditions involving high acid and chloride contents), it resists organic chemicals, dyestuffs, and a wide variety of inorganic chemicals. Type 304 L (low carbon) resists nitric acid well and sulfuric acids at moderate temperature and concentrations. It is used extensively for storage of liquefied gases, equipment for use at cryogenic temperatures (304N), appliances and other consumer products, kitchen equipment, hospital equipment, transportation, and wastewater treatment.

Type 316 contains slightly more nickel than Type 304, and 2-3% molybdenum giving it better resistance to corrosion than Type 304, especially in chloride environments that tend to cause pitting. Type 316 was developed for use in sulfite pulp mills because it resists sulfuric acid compounds. Its use has been broadened, however; to handling many chemicals in the process industries.

Type 430 has lower alloy content than Type 304 and is used for highly polished trim applications in mild atmospheres. It is also used in nitric acid and food processing.

Type 410 has the lowest alloy content of the three general-purpose stainless steels and is selected for highly stressed parts needing the combination of strength and corrosion resistance, such as fasteners. Type 410 resists corrosion in mild atmospheres, steam, and many mild chemical environments.

Service tests are most reliable in determining optimum material, and ASTM G-4 is a recommended practice for carrying out such tests. Tests should cover conditions both during operation and shut-down. For instance, sulfuric, sulfurous and polythionic acid condensates formed in some processes during shutdowns may be more corrosive than the process stream itself. Tests should be conducted under the worst operating conditions anticipated.

Specifications and recommended practices relating to stainless steels are also issued by ASTM. Stainless steels resist corrosion in a broad range of conditions, but they are not immune to every environment. For example, stainless steels perform poorly in reducing environments, such as 50% sulfuric and hydrochloric acids at elevated temperatures. The corrosive attack experienced is a breakdown of the protective film over the entire metal surface.

Such misapplications of stainless steels are rare and are usually avoided. The types of attack which are more likely to be of concern are pitting, crevice attack, stress corrosion cracking, and intergranular corrosion.

Source: Design Guidelines for the selection and use of stainless steel. Specialty Steel Industry of the United States.

Relative Corrosion Resistance of AISI Stainless Steels

TYPE Number	UNS Number	Mild Atmospheric and Fresh Water	Atmospheric		Chemical		
			Industrial	Marine	Mild	Oxidizing	Reducing
302	(S30200)	X	X	X	X	X	
304	(S30400)	X	X	X	X	X	
305	(530500)	X	X	X	X	X	
316	(531600)	X	X	X	X	X	X
410	(S41000)	X			X		
430	(543000)	X	X		X	X	

* The"X" notations indicate that a specific stainless steel type may be considered as resistant to the corrosive environment categories.

This list is suggested as a guideline only and does not suggest or imply a warranty on the pan of the Specialty Steel Industry of the United States or any of the member companies. When selecting a stainless steel for any corrosive environment, it is always best to consult with a corrosion engineer and, if possible, conduct tests in the environment involved under actual operating conditions.