SUGGESTIONS FOR WELDING STAINLESS STEEL

STAINLESS WELDING ELECTRODES
WELDING STAINLESS STEEL (cont.)
SS FILLER METAL SELECTOR GUIDE

Stainless steels were primarily developed to render corrosion resistance. There are certain other requirements that must be met in every stainless application. They may include corrosion resistance in a particular medium, avoidance of contamination of product, resistance to oxidation and carburization at elevated temperatures as well as the ability to provide requisite mechanical strength. There are several grades of stainless steels which can be broadly grouped into 300 Series, 400 Series, and others, 300 Series stainless steels contain iron, chromium, nickel, and carbon as principal ingredients. 400 Series stainless steels contain iron, chromium, and carbon as principal ingredients. Not all 400 series are weldable.

Weldable 400 Series stainless steels are also called straight chromium steels, since their major alloying element is chromium. The 400 Series can be divided into ferritic grades and martensitic grades. Each grade calls for different preheat and interpass welding temper-atures. The martensitic grades contain chromium from 11 –14% and are air hardenable unless modified with an addition of aluminum, titanium, columbium, or carbon levels below 0.1%. These modified grades and the higher chromium grades up to 30% have markedly decreased hardenability and are called ferritic stainless steels.

The second group of stainless steels are 300 Series. These grades are very popular in the fabrication industry, as they can withstand a variety of corrosion media. The chromium content of these steels range from 16% to 30%, and the nickel content from 5% to 35%. These are called austenitic steels, as the micro- structure of these grades is predominantly austenite. Nonetheless, there is some ferrite in several grades. The other grades which do not contain any ferrite are called fully austenitic grades. A small amount of ferrite is necessary to stop cracking during solidification of welds. However, in certain media, ferrite causes corrosion, and the only choice for such media is to opt for fully austenitic grades. Fully austenitic grades give rise to micro-fissuring during welding, which could be eliminated by choosing low heat input processes along with restricted low melting constituents in the weld metal.

In addition to the 300 and 400 Series, stainless steels are also classified as 200 Series, 505, 505 modified, 630, 2209, 2553, etc. These products are used for specific purposes which will be discussed under their respective item description. However, duplex and super duplex stainless steels call for special mention.

Welding Requirements

To weld stainless steels, three factors are to be considered:
• The type of stainless steel material that is to be welded.

• The process of welding.

• The distortion due to welding.

Welding of 300 Series Stainless Steels

The 300 Series is composed of two types of material: those which contain ferrite and austenite; and those which contain only austenite.

None of the above require any preheat or interpass temperature or post weld heat treatment. However, heating up to 150°F before welding is advisable to evaporate any condensed moisture in the joint. The stainless steels which do not contain any ferrite are called fully austenitic steels. These materials are prone to develop micro-fissures during welding. Formation of micro-fissures could be avoided by selecting the low heat input process of welding such as TIG or shielded metal arc with up to 1/8" diameter electrodes. The consumables selected for welding of these materials should be able to deposit weld metal with low levels of impurities and low melting constituents. Welding of austenific stainless steels with more than 10% ferrite should be done with low interpass temperature in order to avoid temper embrittlement, which could occur between 800' F and 1100° F Some grades, such as 309L, 309LSI, and 312, which contain higher ferrite are used for welding of dissimilar metals, in which case the resulting ferrite in the weld deposit, after dilution from the base materials, should be taken into consideration. If the ferrite after dilution is too low--say, less than 2FN or less--there could be a problem of microfissuring in the welds. If the resulting ferrite is too high, such welds undergo faster embrittlement and it is advisable to limit such welds to one or two layers.

Welding of 400 Series Stainless Steels

Welding of most of the 400 Series stainless steels call for maintaining preheat and interpass temperatures, and in some cases post-weld heating to avoid formation of brittle structure called martensite.

Alloy 405, 409Cb, and 430 grades which are ferritic do not require preheat, but it is advisable to heat to 200°F to avoid condensation in the joint. Alloy 410 calls for a preheat and interpass temperature of 400°F to avoid possible formation of martensite. Alloy 420 is a martensitic grade, and is extremely sensitive to air hardening, and should be preheated and welded above 600°F and subjected to post-weld heating at 500°F for one hour.

Welding of Duplex and Super Duplex Stainless Steels

Duplex and super duplex stainless steels were developed to combine the best properties of austenitic and ferritic steels. They have higher yield strength, 65 Ksi (450 N / mm^2), and higher tensile strength, 100 Ksi (69 N / mm^2), compared to 300 Series stainless steels. These steels are resistant to corrosion as well as to stress corrosion cracking and pitting from hydro carbon compounds.

Filler metals to weld duplex and super duplex stainless steels will have similar chemical composition to that of parent metal except that the nickel is higher by 3% to 4%. Higher nickel is required to reduce ferrite in order to obtain optimum mechanical properties.

Duplex and super duplex stainless steels are sensitive to embrittlement around 900° F and could rapidly form brittle inter-metallic phases (such as 'CHI" and "SIGMA") between 1300° F and 1500°F. Control of heal input during welding is essential to avoid formation of intermetallic phases. Heat input in the range of 15-60 KJ / inch is recommended for welding.

Duplex stainless steels typically have a pitting Index between 35 and 38, and super duplexes typically have a pitting Index above 40. Pitting index is calculated with the following formula:

PITTING INDEX =
% Cr + 3.3 (% Mo) + 16 (% N)

Processes Of Welding

Influence of welding processes and parameters also are to be considered for welding of stainless steels. The major welding processes are:
• Shielded metal arc welding (SMAW)

• TIG welding

• MIG welding

SMAW Welding

In shielded metal arc welding, the consumable used for welding is a coated electrode. The coating flux contains various minerals in order to impart different characteristics to welding. Some principal functions of the flux are:

• To ionize the arc atmosphere and improve metal transfer.

• To generate shielding gases, and thus protect the molten weld metal from atmospheric oxidation.

• To provide slag coverage to the molten weld metal.

• To provide deoxidants to react with dissolved oxygen in the weld metal and protect alloying elements.

• To provide alloying elements to the weld.

• To make a clean slag-metal separation on solidification.

The electrodes should be transferred to a holding oven when the package is opened to stop them from absorbing moisture from the atmosphere.