

## Stainless Steel Brazing

Stainless steel is a general term covering a group of materials, which have different corrosion and heat resistant properties dependent upon their composition and heat treatment. Most users appreciate this difference but there are still instances where drawings will merely state 'stainless steel'. All stainless steels can usually be classified into groups that are collectively known as Ferritic, Martensitic, and Austenitic steels

### *Ferritic Stainless Steels*

The ferritic steels contain 12-18% chromium with up to 0.5% nickel, and are magnetic. Their properties cannot be improved by heat treatment and they rely on mechanical working for their strength.

These steels, often referred to as stainless irons, can be fabricated and present few problems in welding although they can give difficulties in brazing. Common applications are turbine blades and household cutlery British Standard alloys of type 403 and 430 are included in this group of steels.

### *Martensitic Stainless steels*

These steels are heat-treated and consequently the effects of temperature can influence the mechanical and corrosion resistant properties. It is sometimes necessary to localise the heat affected zone or heat treat the assembly after joining. Martensitic steels are magnetic.

High chromium stainless steels are more affected by temperature and consequently care must be taken to ensure that the correct heat treatment is employed, either before or after joining. Common applications are valve holders and seatings, and surgical instruments where sharp edges are required.

### *Austenitic Stainless Steels*

The Austenitic steels are based on the 18% chromium 8% nickel composition although the chromium addition can vary from 15-22% and the nickel from 6-11%. These steels cannot be hardened by heat treatment and must rely for their mechanical properties on mechanical working. This means that any thermal joining treatment will reduce the mechanical properties in the 'heat affected zone'.

Austenitic steels if heated between 550 °C and 750 °C will precipitate complex chromium carbide. This will render the material susceptible to a rapid corrosion process known as weld decay. The degree of this precipitation will be a function of the carbon content but it is obvious that most thermal joining processes will be a potential hazard. The steels can be stabilised by the addition of either niobium or titanium and all Austenitic steels that are to be brazed or welded should either be in this condition or have a low carbon content.

Alloys include types 302, 303, 304, 310, 316, 321, 325 and 347.

ALLOY	Resistance to Crevice Corrosion	
	Ferritic/Austenetic	Martensitic
SiIBRAZE 56IN	YES	YES
SiIBRAZE 55	NO	NO
SiIBRAZE 40	NO	NO
SiIBRAZE 60	In some cases	In some cases

## *Stainless Steel Brazing - Continued*

Stainless steel is used for many applications where it is subjected to stress and it is also frequently subjected to a corrosive environment.

Strong ductile joints can be easily made on stainless steel but care must be taken in the choice of brazing alloy and grade of stainless steel to ensure that the joint will be satisfactory in service. Brazing will involve heating the steel to a temperature where carbide precipitation (weld decay) would take place. It is therefore essential that the steel must be stabilised, or low carbon content steel is used.

Particular care must be taken in the selection of brazing alloys for stainless steel when the resultant joints are to be exposed to water or humidity in service. In these conditions failure of the joint can result from corrosion, often referred to as "interfacial or crevice corrosion", at the brazing alloy/stainless steel interface.

The mechanism of this failure is complex but the basic mechanism is that a galvanic will be set up between the brazing alloy and stainless steel that causes attack along the interface between the two materials. Joint failure is such that the brazing alloy can be detached from the stainless steel. Where the brazing alloy has been removed the surface of the stainless steel is usually dull grey suggesting that the brazing alloy has failed to wet and bond successfully. Failure due to crevice corrosion is rare in joints made in austenitic stainless steel but is more common in the low nickel or nickel-free chromium steels of the Ferritic or Martensitic type.

Special brazing alloys have been developed to overcome this problem. The most suitable silver brazing alloy for service with any stainless steel where crevice corrosion is a problem is a silver-copper- indium-nickel alloy known as SilBRAZE 56IN. Being free of zinc, it is immune to dezincification.

Other alloys that are less resistant to crevice corrosion are also available.

### *Fluxes*

The use of a flux is essential when brazing stainless steel in air. With components where the joint area can be easily heated up to brazing temperature, Easyflo flux can be used. However, should prolonged heating be necessary, a flux metal reaction will take place when this flux is used. This reaction will form a film on the surface of the stainless steel so that it cannot be 'wetted' by the brazing alloy, and the addition of fresh flux will not remove this film. In these instances it is necessary to use Tenacity Flux No 5 flux. This has improved high temperature properties and does not react with stainless steel. The only problem is that the residues are not water-soluble and have to be removed with caustic soda, or mechanical methods, such as grit blasting.

Fluxes containing boron, such as Tenacity 5A and Tenacity 6 should not be used where crevice corrosion is a known service hazard.

### **Heating Methods for Silver Brazing of Stainless Steel**

For silver brazing operations in air, hand torch or fixed burners and induction heating are the most commonly used heating methods.