Welding and Fabrication

Welding and Fabrication Overview

The HAYNES® and HASTELLOY® alloys fall into two main categories:

Corrosion-resistant Alloys (CRA), which are generally used at temperatures below 1000°F, and are able to withstand corrosive liquids.
High-temperature Alloys (HTA), which are generally used above 1000°F, at which temperatures they possess considerable strength and resistance to hot air and/or other hot gases.

The high-temperature alloys can also be sub-categorized according to the mechanism used to provide their strength. Many of the alloys contain significant quantities of atomically-large elements; these provide strength through a mechanism known as solid-solution strengthening. Other HTA materials use a mechanism known as age-hardening (also known as precipitation-hardening) to attain the required strength levels. There is also one age-hardenable, corrosion-resistant alloy.

The heat treatments required to strengthen the age-hardenable materials are normally performed after welding and hot/cold-working, and prior to these heat treatments, there is much in common with the fabrication techniques/parameters employed with the solid-solution strengthened alloys, as long as they are supplied in the annealed condition.

As with the stainless steels and other alloy systems, it is advantageous to have a rudimentary understanding of the metallurgical changes that might occur in the HAYNES® and HASTELLOY® alloys, if exposed to the heat of welding, the high temperatures involved with hot-working, or the effects of annealing after cold-working. If brazing is to be attempted, it is very important to understand how the temperatures involved with brazing might affect the HAYNES® and HASTELLOY® materials, or conversely how subsequent age-hardening (in the case of the age-hardenable alloys) or annealing treatments (in the case of any of the alloys) might affect the brazed joint.

In addition to the general purpose alloys manufactured by Haynes International, there are several special purpose alloys, requiring different fabrication approaches. One is a titanium alloy made only in the form of tubulars, and for which fabrication references are given. One is a high-temperature, nickel-based alloy that requires a nitrogen diffusion treatment to impart strength to the material, and for which there are some specific fabrication issues. The other two are cobalt-based, wear-resistant alloys, one of which is not normally welded or formed; the other is easily welded, but somewhat resistant to cold-working due to a high work-hardening rate.

Haynes International Alloys

Base	Corrosion-resistant Alloys (CRA)	
	Solid-Solution	Age-Hardenable
Nickel	B-3® C-4, C-22®, C-276, C-2000® G-30®, G-35® HYBRID-BC1®	C-22HS®

Base	High-temperature Alloys (HTA)	
	Solid-Solution	Age-Hardenable

Nickel	N, S, W, X 75 214®, 230® 617®, 625, 625SQ® HR-120®, HR-160®, HR-224®, HR-235®	242®, 244®, 263, 282® 718 R-41 Waspaloy X-750
Cobalt	25, 188	-
Iron	556®, MULTIMET®	-

Base	**Lightweight Alloy (LA)**
	Age-Hardenable
Titanium	Ti-3Al-2.5V

Base	**High-temperature Alloy (HTA-NS)**
	Nitrogen-Strengthenable
Cobalt	NS-163®

Base	**Wear-resistant Alloy (WRA)**
Cobalt	6B

Base	**Wear & Corrosion-resistant Alloy (WCRA)**
Cobalt	ULTIMET®