Nickel Base Alloy

Materials General Review

The categorization of Nickel and Nickel base alloy depends on the alloy's main elemental contents of Ni, Cu, Cr, Fe and Mo. The most common ones are Ni, Ni-Cu, Ni-Mo, Ni-Cr-Fe, Ni-Cr-Mo, Ni-Cr-Mo-Cu, Ni-Fe-Cr, and other alloys. Pure Nickel contains very low amount of other alloys, which is categorized using 200 numeric series; Ni-Cu is Monel alloy which is categorized as 400 numeric series; among Ni-Cr-Fe alloy series, if Ni element is higher, then it is under 600 series' Inconel alloy; if Fe is dominant, then it is of 800 series' Incoloy alloy; as for Ni-Mo (Fe) and Ni-Cu-Mo (W, Cu), they belong to Hastelloy' s alloy category.

Note: Our company's main product is Nickel Base Alloy based; so except for the above material characteristic introduction, other instructions only use the phrase "Nickel base."

There are three main differences when comparing Nickel Base Alloy welding with the common carbon steel welding as listed below :

a. Welding area cleaning requirements :

The surface of High Nickel alloy when exposed to atmosphere will easily produce Nickel oxide film. Commercial grade pure Nickel's melting point is at 1446˚C, but Nickel Oxide's melting point reaches 2090°C; and thus during welding it will not melt with the original non-oxidized metal, unlike carbon steel with Fe oxide. When welding high Nickel alloy, while the base metal has melted, this oxide is still in solid state, which results in subtle residue of slag inclusion in the weld metal internally. This condition causes severe impact to weld metal mechanical and corrosion resistance properties. Thus whether it is before welding or after welding, it is imperative to verify that base metal contains no existence of foreign impurities. In addition, the joint area must be cleaned of surface oxide, while heavier oxide film must be removed using grinding, machining, or other methods.

b.Sticky and high surface tension force of metal drops

Because of the sticky and high surface extension force of metal drops of Nickel Base Alloy melting metal is inferior to carbon steel's metal drops which have higher wetting effect; welder might have false impression that by raising welding current the metal pool's wetting effect will be enhanced. Actually, using strong welding current will not improve the wetting effect, but instead will create more defects because the high heat will cause the melting pool's deoxidizer to evaporate ; which will allow welding groove to form blow holes more easily.

c. Weld metal shallow penetration

Nickel Base Alloy welding has poorer arc penetration force reaching sometimes only half of welding of carbon steel, the groove of root face should be thinner.

Welding Consumables Selection (Nickel base and dissimilar base metal)

Base metal A / Base metal B		Carbon steel & low alloy steel	Nickel base alloy	
			(Inconel) Ni-Cr- Mo alloy (600 series)	(Incoloy) Ni-Cr- Fe alloy (800 series)
Stainless steel	Austenite series	G309, G309L G309MoL, GNC132, GTN82, GMN82	GNC132, GNC112 GTN625, GMN625	GNC132, GNC182 GTN82, GMN82
Stainless steel	Martensite series	G309, G309L GNC132 GTN82, GMN82	GNC132, GNC112 GTN625, GMN625	GNC132, GNC182 GTN82, GMN82
Stainless steel	Ferrite series	G309, G309L GNC132 GTN82, GMN82	GNC132, GNC112 GTN625, GMN625	GNC132, GNC182 GTN82, GMN82
Nickel base alloy	pure nickel	GNC132 GTN82, GMN82	GNC132, GNC112 GTN625, GMN625	GNC132, GNC182 GTN82, GMN82
Nickel base alloy	Monel Ni-Cu alloy	GNC132 GTN82, GMN82	GNC132 GTN625, GMN625	GNC132 GTN82, GMN82
Nickel base alloy	Incoloy Ni-Cr-Fe alloy	GNC132, GNC112 GNC182, GTN82, GMN82	GNC132, GNC112 GTN625, GMN625 GTN82, GMN82	
Nickel base alloy	Inconel Ni- Cr-Mo alloy	GNC132, GNC112 GTN625, GMN625 GTN82, GMN82		

Base metal A / Base metal B		Nickel base alloy		Stainless Steel	
		(Monel) Ni- Cu alloy	Pure Nickel	Ferrite series	Martensite series
Stainless steel	Austenite series	GNC132	GNC132	G309, G309L GNC132	G309, G309L GNC132
Stainless steel	Martensite series	GNC132	GNC132	G309	
Stainless steel	Ferrite series	GNC132	GNC132		
Nickel base alloy	pure nickel	GNC132			