General Guidance on Welding Nickel Alloys

The majority of problems encountered when welding nickel alloys arise as a result of the different characteristics of nickel alloys compared to CMn or stainless steels. The following comments apply to most of the commonly used nickel alloys.

The fluidity of nickel alloys is low, causing a sluggish weld pool which does not wet out easily. To overcome this the weld pool needs to be manipulated or weaved; to enable this to be carried out easily the joint preparation may need to be wider than for CMn or stainless steel welds (~80° in a single V). The weave should not be excessive (no more than three times core wire diameter) and there should be a pause at each side of the weave to prevent undercut.

The penetration achieved with nickel base alloys is also significantly lower than with CMn steel. The penetration cannot be altered by increasing the current; this will only result in electrode overheating and eventually porosity. To ensure proper fusion the joint has to be designed appropriately ie. correct joint angle and thinner land or root face.

Hot cracking is not a common problem in practice but it is generally recognised that nickel alloy welds are, to some extent, naturally susceptible. The extent of the susceptibility to hot cracking will depend on the situation (such as weld restraint, weld bead profile, alloy type and level of impurities). Solidification cracking is a visibly significant form of hot cracking, typically occurring along the weld centreline or in the weld pool crater. When such cracking occurs it is usually associated with a flat/concave weld profile and can normally be prevented by producing a larger weld bead with a more convex profile. It is also beneficial to ensure that craters are well-filled, and some authorities insist that weld craters are removed by grinding.

Base metal cleaning is very important on nickel base alloys for two reasons – firstly to ensure heavy oxides are removed, secondly to remove potential contaminants eg. S, P, Pb, Zn, Sn. The oxide needs to be removed because it will not melt during welding owing to its very high melting point and can result in radiographic indications; removal is carried out by grinding, abrasive blasting or pickling. The second form of contaminant, which can be present in the form of machining lubricant, marking crayons, temperature indicating crayons, oil, grease, paint etc, can be removed with appropriate solvents. More resistant paints etc. may require proprietary cleaners. Care should be taken to ensure that contaminants are not introduced from grinding wheels, wire brushes or other tools.

Preheating of nickel alloys is not necessary, unless the material is below the workshop air temperature, in which case preheating to air temperature will prevent the formation of condensation and potential porosity problems. The majority of standard nickel base alloys do not require post weld heat treatment (PWHT) for normal service conditions. Some specialized age-hardenable alloys will require PWHT and some alloys eg. UNS N02200, may require PWHT for optimum stress corrosion resistance in certain environments.

Heat input and interpass temperatures are not as critical as for some alloys but to ensure optimum as-welded corrosion resistance those alloys (usually with high Cr + Mo) likely to see corrosive service should be welded with a maximum interpass temperature of 150°C and maximum heat input of 1.5kJ/mm.

For data on specific alloys contact Metrode Products Ltd.

Metrode Products Ltd
Hanworth Lane
Chertsey
Surrey
KT16 9LL
UK

Tel: +44 (0)1932 566721
Fax: +44 (0)1932 565168
Email: info@metrode.com

Website: www.metrode.com

Electrode *Wire*	Data sheet	Matching base material	Other nickel base alloys	Other materials [1]	Dissimilar [2]
Nimrod 182KS ***20.70.Nb***	D-10	None [3]	UNS N06600 UNS N06075	3-5% Ni steels	Ni alloys to CMn, low alloy and stainless steels
Nimrod AKS ***20.70.Nb***	D-11	None [3]	UNS N06600 UNS N06075 BS NA17 UNS K93600 UNS N06004	UNS N08800 3-9% Ni steels	Ni alloys to CMn, low alloy and stainless steels
Nimrod 625KS ***62-50***	D-20	UNS N06625		UNS N08800 UNS N08810 UNS N08825	Similar to above preferably not duplex
Nimrod C276KS ***HAS C276***	D-30	UNS N10276			Ni alloys to duplex
Nimrod 59KS ***HAS 59***	D-31	UNS N06059	UNS N06022 UNS N10276	UNS S31254 UNS N08367 UNS N08925 UNS S32654 UNS S34565	Ni alloys to duplex
Nimrod C22KS ***HAS C22***	D-32	UNS N06022	UNS N06059 UNS N10276	UNS S31254 UNS N08367 UNS N08925 UNS S32654 UNS S34565	Ni alloys to duplex
Nimrod 190 ***65NiCu***	D-60	UNS N04400			N04400 to CuNi
Nimrod 200Ti ***Nickel 2Ti***	D-50	UNS N02200 UNS N02201			Useful as a buffer layer for some cladding applications
Nimrod 617KS ***61-70***	D-40	UNS N06617	UNS N06601	UNS N08811 ASTM HP40Nb	Ni alloys to CMn, low alloy and stainless steels
Nimax B2L ***HAS B2***	D-80	UNS N10001 UNS N10665	UNS N10675 UNS N10629		N10665 to CMn and other alloys

The above electrodes are for joining and surfacing in all-positions; also available are Nimrod 182, Nimrod AB, Nimrod 625 and Nimrod C276 electrodes which are used predominantly for surfacing in the flat.

(1) Some of the materials listed in this column could also be welded with lower alloyed, near matching composition electrodes eg. UNS N08800/N08810/N08811 = Thermet 800Nb; UNS N08825 = E825L-15; HP40Nb = Thermet HP40Nb

(2) This only provides a selection of uses, most nickel alloys can be used for other dissimilar applications including cladding.

(3) These are weld metal compositions and have no directly equivalent base materials.