

Nickel Base Alloys

DATA SHEET

D-60

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NICKEL-COPPER ALLOY 400

Alloy type

Nickel-copper alloy based on alloy 400 with raised levels of manganese and titanium to suppress hot cracking and porosity.

Materials to be welded

ASTM-ASME	BS	DIN
UNS N04400	NA13	2.4360
UNS N04405	NA1 (cast)	2.4361
UNS N05500		2.4365 (cast)
A494 M-35-1 (cast)		
A494 M-35-2 (cast)		
Proprietary		
Monel alloy 400, R405, K500 (Special Metals)		
Nitorros (VDM)		

Applications

Nimrod 190 deposits 65%Ni-30%Cu weld metal based on Monel alloy 400 with raised levels of manganese and titanium to suppress hot cracking and porosity. It is optimised to give the highest as-welded ductility and strength attainable in weld metal of this type.

For welding alloy 400 and similar parent material to itself and to others in the Ni-Cu alloy system, such as pure nickel and cupronickel. Welds in alloy K500 are satisfactory, but cannot match the strength of this precipitation-hardened alloy. Castings of alloy 400 with up to about 1.5%Si are welded with Nimrod 190, but higher silicon grades such as BS3071 NA2 and ASTM A743 M35-2 are virtually unweldable because of HAZ cracking.

For **dissimilar** joints between alloy 400 and other alloys or steels, sensitivity to dilution by Fe (20-30%) or Cr (3-6%) can lead to low ductility (or bend-test fissuring) in weld metal close to the fusion boundary. Direct welds to mild or low alloy steels are satisfactory with dilution control, although ENiCrFe-X (ERNiCr-3 wire) is

preferable and necessary for stainless and higher chromium alloys (see data sheets D-10 and D-11). Alternatively, the steel or alloy can be buttered with pure nickel (see data sheet D-50) and this procedure is also useful when **surfacing** with alloy 400 consumables.

Alloy 400 has a useful combination of strength, thermal conductivity and resistance to corrosion by seawater, inorganic salts, sulphuric and hydrofluoric acids, hydrogen fluoride and alkalis. Applications include **heat exchangers, piping, vessels and evaporators** in the **offshore, marine, chemical, petrochemical and power engineering** industries.

Microstructure

Solid solution, single phase alloy, slightly ferromagnetic near room temperature.

Welding guidelines

No preheat required, maximum interpass temperature 150°C and no PWHT required.

Additional information


Alloy 400 parent material is noted for its good resistance to both **hydrofluoric acid** and **hydrogen fluoride vapour**. However, weld metal compositions within standard specification limits have inferior resistance to these media. A fully optimised composition for this specific application is not currently available. Contact Metrode for guidance.

Products available

Process	Product	Specification
MMA	Nimrod 190	AWS ENiCu-7
TIG/MIG/SAW	65NiCu	AWS ERNiCu-7

NIMROD 190

Nickel-copper MMA electrode for Monel alloy 400

Product description	<p>Special basic carbonate-fluoride-rutile flux system on matching 400 core wire to give low levels of residuals. Deoxidation system designed to ensure sound deposits. The raised levels of manganese and titanium help suppress hot cracking and porosity. Analysis is optimised to give the highest as-welded ductility and strength attainable in weld metal of this type. The smaller electrode sizes are particularly suitable for fixed pipework welds demanding qualification in the ASME 6G position.</p> <p>Recovery is about 110% with respect to core wire, 65% with respect to whole electrode.</p>																						
Specifications	AWS A5.11 BS EN 14172 DIN 1736		ENiCu-7 E Ni 4060 (EL-NiCu30Mn, 2.4366)																				
ASME IX Qualification	QW432 F-No 42																						
Composition (weld metal wt %)		C	Mn	Si *	S	P	Ni	Cu	Ti	Fe	Al												
	min	--	1.0	--	--	--	62.0	27.0	--	0.5	--												
	max	0.15	4.0	1.5	0.015	0.02	69.0	34.0	1.0	2.5	0.5												
	typ	0.08	3.5	1.2	0.005	0.01	63	30	0.9	1	0.03												
	* DIN maximum 1.0% Si																						
All-weld mechanical properties	As welded					min		typical															
	Tensile strength					MPa		480 520															
	0.2% Proof stress					MPa		200 320															
	Elongation on 4d					%		30 40															
	Elongation on 5d					%		27 35															
	Reduction of area					%		-- 40															
	Impact energy					- 30°C J		-- 110															
	Hardness					HV		-- 160-180															
Operating parameters	DC +ve 																						
	ø mm	2.5		3.2		4.0		5.0															
	min A	60		70		90		120															
	max A	80		110		145		190															
Packaging data	ø mm	2.5		3.2		4.0		5.0															
	length mm	300		350		350		350															
	kg/carton	12.6		13.5		15.0		15.0															
	pieces/carton	612		417		294		189															
Storage	<p>3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life. Direct use from tin is satisfactory for longer than a working shift of 8h. Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase the risk of porosity.</p> <p>For electrodes that have been exposed: Redry 200 – 250°C/1-2h to restore to as-packed condition. Maximum 350° C, 3 cycles, 10h total. Storage of redried electrodes at 50 – 200°C in holding oven or heated quiver: no limit, but maximum 6 weeks recommended. Recommended ambient storage conditions for opened tins (using plastic lid): < 60% RH, > 18°C.</p>																						
Fume data	Fume composition, wt % typical: <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Fe</th> <th>Mn</th> <th>Ni</th> <th>Cu</th> <th>F</th> <th>OES (mg/m³)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>7</td> <td>4</td> <td>16</td> <td>8</td> <td>1.2</td> </tr> </tbody> </table>											Fe	Mn	Ni	Cu	F	OES (mg/m ³)	1	7	4	16	8	1.2
Fe	Mn	Ni	Cu	F	OES (mg/m ³)																		
1	7	4	16	8	1.2																		

65NiCu

Solid wire for TIG, MIG & SAW to match Monel alloys

Product description	Solid wire for TIG/MIG/SAW.												
Specifications	AWS A5.14 ERNiCu-7 BS EN ISO 18274 SNi4060 BS 2901: Pt5 NA33 DIN 1736 (SG-NiCu30MnTi, 2.4377) Also known generically as filler metal 60 (FM60)												
ASME IX Qualification	QW432 F-No 42												
Composition (wire wt %)		C	Mn	Si	S	P	Ni	Cu	Ti	Fe	Al		
	min	--	3.0	--	--	--	62.0	28.0	1.5	--	--		
	max	0.15	4.0	1.2	0.015	0.020	69.0	32.0	3.0	2.5	1.2		
	typ	0.03	3.2	0.2	0.005	0.005	64	29	2.2	<1	0.1		
All-weld mechanical properties	Typical values as welded						min	TIG					
	Tensile strength						MPa	460	525				
	0.2% Proof stress						MPa	200	280				
	Elongation on 4d						%	--	41				
	Elongation on 5d						%	25	38				
	Impact energy						- 30°C	J	--	120			
Typical operating parameters		TIG			MIG			SAW					
	Shielding	Argon *			Ar or Ar-He			NiCu					
	Current	DC-			Pulsed			DC+					
	Diameter	2.4mm			1.2mm			2.4mm					
	Parameters	100A, 12V			150A, 29V (mean)			300A, 28V					
	* Also required as a purge for root runs.												
Packaging data	ø mm	TIG			MIG			SAW					
	1.2	--			15kg spool			--					
	1.6	2.5kg tube			--			--					
	2.4	2.5kg tube			--			25kg reel					
Fume data	MIG fume composition (wt %) (TIG fume negligible)												
		Fe	Mn	Cr ³	Ni	Cu	OES (mg/m ³)						
		3	5	<0.1	47	24	1						