

# Stainless Steels

DATA SHEET

B-11

METRODE PRODUCTS LTD  
 HANWORTH LANE, CHERTSEY  
 SURREY, KT16 9LL  
 Tel: +44(0)1932 566721  
 Fax: +44(0)1932 565168 Sales  
 Fax: +44(0)1932 569449 Technical  
 Fax: +44(0)1932 566199 Export  
 Email: info@metrode.com  
 Internet: http://www.metrode.com

## 410NiMo MARTENSITIC STAINLESS

### Alloy type

12%Cr-4.5%Ni-0.5%Mo (410NiMo) soft martensitic alloy.

### Materials to be welded

	wrought	cast
ASTM	F6NM	CA6NM
UNS	S41500	
BS EN / DIN	1.4313	G-X5CrNi 13 4
BS	--	425C11
AFNOR	--	Z6 CND 1304-M

### Applications

High strength (>760MPa) martensitic stainless steel with better resistance to corrosion, hydro-cavitation, sulphide-induced SCC, and good sub-zero toughness when compared with plain 12%Cr steels (e.g. type 410/CA15).

Weld metal of this type greatly overmatches the strength of equivalent parent material and is remarkably resistant to softening during PWHT. These properties can be exploited for welding martensitic precipitation-hardening alloys if corrosion conditions are compatible with lower alloy weld metal, with the advantage of a single PWHT at 450-620°C for tempering. The 410NiMo consumables are also used for **overlaying** mild and CMn steels.

13%Cr-4%Ni alloys are used in cast or forged form for **hydraulic turbines, valve bodies, pump bowls, compressor cones, impellers** and **high pressure pipes** in **power generation, offshore oil, chemical** and **petrochemical** industries.

### Microstructure

In the PWHT condition the microstructure consists of tempered martensite with some retained austenite.

### Welding guidelines

Preheat-interpass range of 100-200°C is recommended to allow martensite transformation during welding. Cool to room temperature before PWHT.

### PWHT

For maximum resistance to sulphide-induced SCC in sour oil conditions NACE MR0175 specifies a hardness of <23HRc. This is often difficult to achieve because weld metal and HAZ are very resistant to softening by PWHT. A double temper for 5-10h is necessary. Common practice is 675°C/10h + 605°C/10h with intermediate air cool to ambient. Recent work indicates 650°C + 620°C is optimum, and that intermediate air cooling to ambient or lower is essential. Another authority suggests raising the first PWHT cycle for full austenitisation anneal at 770°C/2h prior to final temper. Control of distortion may be more critical in this case. In the case of the Supercore 410NiMo flux cored wire it has not been possible to reduce the hardness to 23HRC irrespective of the PWHT carried out.


If 410NiMo consumables are considered for welding plain 12Cr martensitic stainless steels such as type 410 or CA15, the PWHT should not exceed about 650°C unless a second temper at 590-620°C is applied.

### Products available

Process	Product	Specification
MMA	<b>13.4.Mo.L.R</b>	AWS E410NiMo-26
TIG/MIG	<b>ER410NiMo</b>	AWS ER410NiMo
FCW	<b>Supercore 410NiMo</b>	AWS E410NiMoT1-1/4

## 13.4.Mo.L.R

## Rutile MMA electrode for 410NiMo

<b>Product description</b>	Rutile metal powder type made on pure low carbon core wire. Moisture resistant coating giving very low weld metal hydrogen levels. Diameters above 3.2mm are not recommended for positional welding. Recovery is about 130% with respect to core wire, 65% with respect to whole electrode.									
<b>Specifications</b>	<b>AWS A5.4</b>	E410NiMo-26								
	<b>BS EN 1600</b>	E 13 4 R 52								
	<b>BS 2926</b>	13.4.MoRMP								
	<b>DIN 8556</b>	E13 4 MPR 26 130								
<b>ASME IX Qualification</b>	<b>QW432</b> F-No 1, <b>QW442</b> A-No 6									
<b>Composition (weld metal wt %)</b>		C	Mn	Si	S	P	Cr	Ni	Mo	Cu
	min	--	--	--	--	--	11.0	4.0	0.40	--
	max	0.06	1.0	0.90	0.025	0.03	12.5	5.0	0.70	0.50
	typ	0.03	0.8	0.25	0.01	0.01	12	4.5	0.6	0.05
<b>All-weld mechanical properties</b>	Typical properties					min	PWHT (1)		As-welded (2)	
	Tensile strength				MPa	760	940		1000	
	0.2% Proof stress				MPa	500	695		780	
	Elongation on 4d				%	15	17		4.5	
	Elongation on 5d				%	15	16		3	
	Reduction of area				%	--	45		10	
	Impact energy				+ 20°C	J	--		45	
					- 40°C	J	--		35	
					- 60°C	J	--		30	
	Hardness				HV	--	270-300		350	
	(1) AWS & BS PWHT: 595-620°C for 1 hour, air cooled. See front page for details on PWHT.									
	(2) This weld metal is not usually recommended for use in the as-welded condition, except for surfacing applications where a hardness of 330-400HV is useful.									
<b>Operating parameters</b>	DC +ve or AC (OCV: 70V min)									
	∅ mm	2.5	3.2	4.0	5.0					
	min A	70	80	100	140					
	max A	110	140	180	240					
<b>Packaging data</b>	∅ mm	2.5	3.2	4.0	5.0					
	length mm	350	380	450	450					
	kg/carton	12.6	15.0	18.0	16.8					
	pieces/carton	534	363	240	171					
<b>Storage</b>	<b>3 hermetically sealed ring-pull metal tins</b> 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. For electrodes that have been exposed: <b>Redry</b> 300 – 350°C/1-2h to restore to as-packed condition. Maximum 420°C, 3 cycles, 10h total. <b>Storage</b> 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.									
<b>Fume data</b>	Fume composition, wt % typical:									
		Fe	Mn	Ni	Cr	Cu	Mo	V	F	OES (mg/m <sup>3</sup> )
		18	2	0.5	3	<0.2	<0.2	<0.2	18	1.7

# ER410NiMo

Solid wire for welding 410NiMo martensitic stainless steel

<b>Product description</b>	Solid wire for TIG and MIG.										
<b>Specifications</b>	<b>AWS A5.9</b> (ER410NiMo) <b>BS EN ISO 14343-A</b> 13 4 <b>BS EN ISO 14343-B</b> (SS410NiMo) <b>DIN 8556</b> SG X3CrNi 13 4 (1.4351)			Does not always strictly conform see composition.							
<b>ASME IX Qualification</b>	<b>QW432</b> F-No 6										
<b>Composition (wire wt %)</b>		C	Mn *	Si *	S	P	Cr	Ni	Mo	Cu	
	min	--	0.4	--	--	--	11.0	4.0	0.4	--	
	max	0.05	1.0	0.60	0.02	0.03	12.5	5.0	0.7	0.3	
	typ	0.02	0.8	0.4	0.005	0.015	12.3	4.5	0.5	0.1	
	* AWS requires 0.6%Mn max and 0.50%Si max.										
<b>All-weld mechanical properties</b>	Typical values after PWHT 610°C/1h:						TIG				
	Tensile strength						MPa	890			
	0.2% Proof stress						MPa	850			
	Elongation on 4d						%	23			
	Elongation on 5d						%	20			
	Impact energy						0°C	J	90		
							-50°C	J	60		
	Hardness cap/mid						HRC	25-30			
							HV	300			
<b>Typical operating parameters</b>						TIG	MIG				
	Shielding					Argon *	Ar with 1-2%O <sub>2</sub> or 1-5%CO <sub>2</sub> **				
	Current					DC-	DC+				
	Diameter					2.4mm	1.2mm				
	Parameters					100A, 12V	220A, 28V				
	* Also required as a purge for root runs.										
	** Proprietary gas mixtures with <5%CO <sub>2</sub> are also suitable.										
<b>Packaging data</b>	ø mm	TIG					MIG				
	1.2	--					15kg spool				
	1.6	2.5kg tube					--				
	2.0	To order					--				
	2.4	2.5kg tube					--				
<b>Fume data</b>	MIG fume composition (wt %) (TIG fume negligible)										
		Fe	Mn	Cr <sup>3</sup>	Ni	Mo	Cu	OES (mg/m <sup>3</sup> )			
		54	5	8	3.2	<0.5	<0.5	5			

# SUPERCORE 410NiMo

Flux cored wire for welding 410NiMo martensitic stainless steel

<b>Product description</b>	All-positional rutile flux cored wire made on a high purity stainless steel strip  Metal recovery about 90% with respect to wire.										
<b>Specifications</b>	<b>AWS A5.22</b>	E410NiMoT1-1/4									
	<b>BS EN ISO 17633-A</b>	T 13 4 P C/M 2									
	<b>BS EN ISO 17633-B</b>	TS410NiMo-FB1									
<b>ASME IX Qualification</b>	<b>QW432</b> F-No 6										
<b>Composition (weld metal wt %)</b>		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	Co
	min	--	--	--	--	--	11.0	4.0	0.4	--	--
	max	0.06	1.0	1.0	0.025	0.030	12.5	5.0	0.7	0.3	0.05
	Typ	0.03	0.7	0.4	0.005	0.017	11.8	4.5	0.5	0.03	0.03
<b>All-weld mechanical properties</b>	Typical values:					Min	610°C/1h	610°C/10h	650°C/10h +620°C/10h		
	Tensile strength	MPa				760	940	870	--		
	0.2% Proof stress	MPa				500	850	700	--		
	Elongation on 4d	%				15	20	23	--		
	Elongation on 5d	%				15	17	19	--		
	Reduction of area	%				--	50	55	--		
	Impact energy	+ 20°C			J	--	45	50	50		
		- 40°C			J	--	30	40	35		
	Hardness				HV	--	330	310	310		
					HRC	--	31	27	28		
	AWS PWHT = 593-621°C/1 hour. BS EN PWHT = 580-620°C/2 hours.										
<b>Operating parameters</b>	<b>Shielding gas</b> Ar-20%CO <sub>2</sub> or 100% CO <sub>2</sub> at 20-25l/min. <b>Current</b> DC+ve parameters as below (for 100%CO <sub>2</sub> increase voltage by 1-3V):										
	ø mm	range				typical	stickout				
	1.2	150-280A, 25-32V				180A, 29V	15-25mm				
	1.6	200-350A, 26-34V				260A, 30V	15-25mm				
<b>Packaging data</b>	Spools vacuum-sealed in barrier foil with cardboard carton: 15kg The as-packed shelf life is virtually indefinite. Resistance to moisture absorption is high, but to maintain the high integrity of the wire surface and prevent any possibility of porosity, it is advised that part-used spools are returned to polythene wrappers. Where possible, preferred storage conditions are 60% RH max, 18°C min.										
<b>Fume data</b>	Fume composition (wt %):										
		Fe	Mn	Cr <sup>VI</sup>	Ni	Mo	Cu	OES (mg/m <sup>3</sup> )			
		18	3	2.5	1	0.2	<0.5	2			