

Stainless Steels

DATA SHEET

B-11

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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	13.4.Mo.L.R	AWS E410NiMo-26
	13.4.Mo.L.B	AWS E410NiMo-25
TIG/MIG	ER410NiMo	AWS ER410NiMo
FCW	Supercore 410NiMo	AWS E410NiMoT1-1/4


13.4.Mo.L.R

Rutile MMA electrode for 410NiMo

Product description	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.											
Specifications	AWS A5.4		E410NiMo-26									
	BS EN 1600		E 13 4 R 52									
ASME IX Qualification	QW432 F-No 1, QW442 A-No 6											
Composition (weld metal wt %)		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		
All-weld mechanical properties	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.												
Operating parameters	DC +ve or AC (OCV: 70V min)											
	ø mm	2.5		3.2		4.0		5.0				
	min A	70		80		100		140				
	max A	110		140		180		240				
Packaging data	ø 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	570		363		240		171				
	Storage	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.										
For electrodes that have been exposed:												
Redry 300 – 350°C/1-2h to restore to as-packed condition. Maximum 420°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.												
Fume data	Fume composition, wt % typical:											
		Fe	Mn	Ni	Cr	Cu	Mo	V	F	OES (mg/m ³)		
		18	2	0.5	3	<0.2	<0.2	<0.2	18	1.7		

13.4.Mo.L.B

Basic MMA electrode for 410NiMo

Product description	Basic 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.									
Specifications	AWS A5.4		E410NiMo-25							
	BS EN 1600		E 13 4 R 62							
ASME IX Qualification	QW432 F-No 1, QW442 A-No 6									
Composition (weld metal wt %)		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	0.7	0.25	0.01	0.01	12	4.5	0.6	0.05
All-weld mechanical properties	Typical properties					min	PWHT (1)			
	Tensile strength					MPa	760	900		
	0.2% Proof stress					MPa	500	650		
	Elongation on 4d					%	15	17		
	Elongation on 5d					%	15	16		
	Reduction of area					%	--	45		
	Impact energy					+ 20°C J	--	50		
	(1) AWS PWHT: 595-620°C for 1 hour, air cooled. See front page for details on PWHT.									
Operating parameters	DC +ve 									
	∅ mm	2.5		3.2		4.0		5.0		
	min A	70		80		100		140		
	max A	110		140		180		240		
Packaging data	∅ mm	2.5		3.2		4.0		5.0		
	length mm	350		380		450		450		
	kg/carton	12.6		13.5		16.5		16.5		
	pieces/carton	570		375		225		144		
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 300 – 350°C/1-2h to restore to as-packed condition. Maximum 420°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:									
		Fe	Mn	Ni	Cr	Cu	Mo	V	F	OES (mg/m ³)
		18	2	0.5	3	<0.2	<0.2	<0.2	28	1.7

ER410NiMo

Solid wire for welding 410NiMo martensitic stainless steel

Product description	Solid wire for TIG and MIG.									
Specifications	AWS A5.9 (ER410NiMo) BS EN ISO 14343-A 13 4 BS EN ISO 14343-B (SS410NiMo) DIN 8556 SG X3CrNi 13 4 (1.4351)			Does not always strictly conform see composition.						
ASME IX Qualification	QW432 F-No 6									
Composition (wire wt %)		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.									
All-weld mechanical properties	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		
Typical operating parameters		TIG				MIG				
	Shielding	Argon *				Ar with 1-2%O ₂ or 1-5%CO ₂ **				
	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 ₂ are also suitable.									
Packaging data	ø mm	TIG				MIG				
	1.2	--				15kg spool				
	1.6	2.5kg tube				--				
	2.0	To order				--				
	2.4	2.5kg tube				--				
Fume data	MIG fume composition (wt %) (TIG fume negligible)									
		Fe	Mn	Cr ³	Ni	Mo	Cu	OES (mg/m ³)		
		54	5	8	3.2	<0.5	<0.5	5		

SUPERCORE 410NiMo

Flux cored wire for welding 410NiMo martensitic stainless steel

Product description	All-positional rutile flux cored wire made on a high purity stainless steel strip Metal recovery about 90% with respect to wire.										
Specifications	AWS A5.22	E410NiMoT1-1/4									
	BS EN ISO 17633-A	T 13 4 P C/M 2									
	BS EN ISO 17633-B	TS410NiMo-FB1									
ASME IX Qualification	QW432 F-No 6										
Composition (weld metal wt %)		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
All-weld mechanical properties	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.										
Operating parameters	Shielding gas Ar-20%CO ₂ or 100% CO ₂ at 20-25l/min. Current DC+ve parameters as below (for 100%CO ₂ 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				
Packaging data	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.										
Fume data	Fume composition (wt %):										
		Fe	Mn	Cr ^{VI}	Ni	Mo	Cu	OES (mg/m ³)			
		18	3	2.5	1	0.2	<0.5	2			