

# Stainless Steels

DATA SHEET

B-10

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## 12%Cr MARTENSITIC STAINLESS

### Alloy type

12%Cr (410) martensitic stainless steel; the 13.1.BMP electrode also has 1.5%Ni.

### Materials to be welded

	wrought	cast
ASTM	410, 403	A487 grade CA15
UNS	S41000, S40300	
DIN	1.4006 (X10Cr13) 1.4000, 1.4024	1.4006 (G-X10Cr13)
BS	410S21 (En56A) 403S17	410C21

The 13.1.BMP with 1.5%Ni is also suitable for ASTM A487 CA15M and DIN 1.4008 (G-X8CrNi13).

### Applications

These consumables are designed for welding wrought or cast martensitic 12%Cr (type 410) stainless steel. Fabrication welds of matching composition such as this must be tempered by appropriate PWHT, owing to high hardness (~450HV) and low ductility in the as-welded condition. Conventional 410 has variable toughness but following PWHT the 13.1.BMP electrode with 1.5%Ni has good impact properties down to -10°C or lower depending on the heat treatment schedule.

Plain 12%Cr steels are the most simple and economic alloys with stainless properties. Variants with Ti (409), Al (405) or low carbon (410S) are more or less fully ferritic with typically lower strength than type 410. These types, and the newer "utility ferritics", are normally welded without PWHT using 309/309L consumables (data sheet B-50). The same applies to type 410 when PWHT is not practicable.

Type 410 contains just sufficient carbon to enable air-hardening transformation to a predominantly martensitic microstructure. Structural properties below ambient are limited by its relatively high ductile-brittle transition temperature (particularly weldments), and up to about 550°C by its modest creep resistance. It has useful resistance to general corrosion in non-aggressive media, sulphide-induced SCC in sour crude oil service, and oxidation up to about 800°C.

Typical applications include **hydrocrackers, reaction vessels, distillation plants** and associated **pipework in refineries; furnace parts, linings; surfacing run-out rolls** in steel mills; cast **valve bodies, turbine parts** and **burner nozzles**.

### Microstructure

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

### Welding guidelines

Preheat of 150-250°C is required for heavier sections. Following welding, components should be cooled to room temperature before PWHT. Weld metal and HAZ's have poor ductility and toughness in the as-welded condition, careful handling is recommended prior to PWHT to minimise physical shock.

### PWHT

**Plain 410** - A typical industrial PWHT following welding for plain 410, consists of slowly cooling to room temperature to allow full transformation to take place (range is Ms-350°C Mf-100°C), then temper at 680-760°C followed by air cool. To ensure <22HRC (NACE) in the weld area, PWHT at 745°C is preferred.

**13.1.BMP** – The optimum properties are obtained after PWHT at around 700°C, close to the Ac<sub>1</sub> temperature for this weld metal, which (due to the added nickel) has a lower Ac<sub>1</sub> than plain 410. If needed PWHT time can be extended but higher temperatures may cause re-hardening with fresh martensite formation on cool-out. Superior toughness can be achieved with a double temper (cool to ambient between cycles) and this is recommended to conform to NACE, 22HRC maximum.

### Products available


Process	Product	Specification
MMA	<b>13.RMP</b>	AWS E410-26
	<b>13.1.BMP</b>	DIN E 13 1 MPB
TIG/MIG	<b>12Cr</b>	AWS ER410

## General data for all 410 MMA electrodes

<b>Storage</b>	<p><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.</p> <p>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 100 – 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): &lt; 60% RH, &gt; 18°C.</p>																		
<b>Fume data</b>	<p>Fume composition, wt % typical:</p> <table border="1"> <thead> <tr> <th>Fe</th> <th>Mn</th> <th>Ni</th> <th>Cr</th> <th>Cu</th> <th>Mo</th> <th>V</th> <th>F</th> <th>OES (mg/m<sup>3</sup>)</th> </tr> </thead> <tbody> <tr> <td>20</td> <td>2</td> <td>&lt;0.5</td> <td>3</td> <td>&lt;0.2</td> <td>&lt;0.1</td> <td>&lt;0.1</td> <td>18</td> <td>1.7</td> </tr> </tbody> </table>	Fe	Mn	Ni	Cr	Cu	Mo	V	F	OES (mg/m <sup>3</sup> )	20	2	<0.5	3	<0.2	<0.1	<0.1	18	1.7
Fe	Mn	Ni	Cr	Cu	Mo	V	F	OES (mg/m <sup>3</sup> )											
20	2	<0.5	3	<0.2	<0.1	<0.1	18	1.7											


### 13.RMP

13%Cr MMA electrode

<b>Product description</b>	<p>Rutile metal powder MMA electrode 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.</p> <p>Recovery is about 130% with respect to core wire, 65% with respect to whole electrode.</p>									
<b>Specifications</b>	<b>AWS A5.4</b> <b>BS EN 1600</b> <b>BS 2926</b> <b>DIN 8556</b>		E410-26 E 13 R 52 13.RMP E13 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	--	--	--
	max	0.08	1.0	0.90	0.025	0.030	13.5	0.60	0.5	0.50
	typ	0.06	0.5	0.30	0.010	0.015	11.5	0.4	0.2	0.05
<b>All-weld mechanical properties</b>	After PWHT						850°C/2h (1)		745°C/1h (2)	
							min	typical	min	typical
	Tensile strength				MPa		480	520	520	700
	0.2% Proof stress				MPa		250	270	--	610
	Elongation on 4d				%		--	36	20	21
	Elongation on 5d				%		20	34	--	18
	Reduction of area				%		--	52	--	59
	(1) BS & BS EN PWHT: 840-870°C for 2 hours, furnace cool to 595°C at 55°C/h. max. Air cool to ambient. This gives a relatively low strength condition. (2) AWS PWHT: 730-760°C for 1 hour, furnace cool to 315°C at 60°C/h max., air cool to ambient. This gives a higher strength tempered condition more representative of normal fabrication welds.									
<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		380		450	
	kg/carton		12.6		14.1		14.1		16.8	
	pieces/carton		609		378		219		150	

## 13.1.BMP

13%Cr-1.5%Ni MMA electrode

<b>Product description</b>	<p>Basic low hydrogen metal powder MMA electrode 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.</p> <p>Recovery is about 130% with respect to core wire, 65% with respect to whole electrode.</p>									
<b>Specifications</b>	<b>AWS A5.4</b> <b>BS EN 1600</b> <b>BS 2926</b> <b>DIN 8556</b>		(E410-15) (E 13 B 52) (13.BMP) E 13 1 MPB 26 130		} Nearest classifications					
<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	0.02	0.4	--	--	--	11.0	1.0	0.15	--
	max	0.06	1.0	0.50	0.025	0.030	14.0	2.0	0.50	0.5
	typ	0.04	0.7	0.25	0.01	0.02	13	1.5	0.3	0.05
	* Molybdenum is controlled to satisfy minimum requirements for ASTM A487 CA15M castings (0.15-1.0% Mo).									
<b>All-weld mechanical properties</b>	Typical after PWHT					min *	790°C/5h + 700°C/5h		680°C/2h + 620°C/2h	
	Tensile strength				MPa	620	655		760	
	0.2% Proof stress				MPa	450	455		685	
	Elongation on 4d				%	18	26		20	
	Elongation on 5d				%	15	23		17	
	Reduction of area				%	--	70		67	
	Impact energy			+ 20°C	J	--	105		--	
				- 10°C	J	--	90		60	
Hardness				HRC	<22 **	18		19		
* Tensile properties based on ASTM CA15 and CA15M castings. Specifications for wrought grades vary in tensile strength 415-700MPa.										
** For conformance to NACE a double temper is mandatory.										
<b>Operating parameters</b>	DC +ve or AC (OCV: 70V min)									
										
	∅ mm	3.2		4.0		5.0				
	min A	80		100		140				
max A	140		180		240					
<b>Packaging data</b>	∅ mm	3.2		4.0		5.0 *				
	length mm	380		450		450				
	kg/carton	15.0		16.5		16.5				
	pieces/carton	375		225		144				
	* 5mm made to order.									

# 12Cr

12%Cr solid wire for TIG & MIG welding of 410 stainless steel

<b>Product description</b>	Solid wire for TIG & MIG.										
<b>Specifications</b>	<b>AWS A5.9</b>		ER410								
	<b>BS 2901: Pt2</b>		410S94								
	<b>BS EN ISO 14343-A</b>		13								
	<b>BS EN ISO 14343-B</b>		SS410								
	<b>DIN 8556</b>		SG X 8Cr 14 (1.4009) nearest								
<b>ASME IX Qualification</b>	<b>QW432</b> F-No 6, <b>QW442</b> A-No 6										
<b>Composition (wire wt %)</b>		C *	Mn	Si	S	P	Cr	Ni	Mo	Cu	
	min	0.06	--	0.25	--	--	12.0	--	--	--	
	max	0.12	0.6	0.50	0.02	0.03	13.5	0.3	0.3	0.3	
	typ	0.1	0.4	0.3	0.01	0.02	12.5	0.2	0.03	0.2	
	* BS 2901: Pt2 requires 0.09-0.15%C.										
<b>All-weld mechanical properties</b>	Typical values after PWHT					MAG: Ar+20%CO <sub>2</sub>					
						740°C/1h (AWS)	740°C/3h				
	Tensile strength					MPa	695	675			
	0.2% Proof stress					MPa	530	510			
	Elongation on 4d					%	22	20			
	Elongation on 5d					%	19	18			
	Reduction of area					%	50	50			
	Impact energy					+ 20°C J	<20		20		
Hardness cap/mid					HV	225/230		215/220			
					HRC	--		18/21			
<b>Typical operating parameters</b>			TIG			MIG					
	Shielding		Argon *			Ar / 1-3%O <sub>2</sub> or Ar / 3-20%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.											
** Most economic gas is Ar-20%CO <sub>2</sub> . This gas provides the highest resistance to weld metal porosity and carbon content typically not exceeding 0.12%.											
<b>Packaging data</b>	ø mm		TIG			MIG					
	1.2		--			15kg spool					
	1.6		2.5kg tube			15kg spool					
	2.4		2.5kg tube			--					
<b>Fume data</b>	MIG fume composition (wt %) (TIG fume negligible)										
		Fe	Mn	Cr <sup>3</sup>	Ni	Cu	OES (mg/m <sup>3</sup> )				
		55	4	8	<0.1	<0.5	5				