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 550ºC 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 800ºC.

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-350ºC Mf-100ºC), then temper at 680-760ºC followed by air cool. To ensure <22HRC (NACE) in the weld area, PWHT at 745ºC is preferred.

13.1.BMP – The optimum properties are obtained after PWHT at around 700°C, close to the Ac_1 temperature for this weld metal, which (due to the added nickel) has a lower Ac_1 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	**13.RMP**	AWS E410-26
	13.1.BMP	DIN E 13 1 MPB
TIG/MIG	**12Cr**	AWS ER410

General data for all 410 MMA electrodes

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 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): < 60% RH, > 18°C.

Fume data

Fume composition, wt % typical:

Fe	Mn	Ni	Cr	Cu	Mo	V	F	OES (mg/m^3)
20	2	<0.5	3	<0.2	<0.1	<0.1	18	1.7

13.RMP

13%Cr MMA electrode

Product description

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.

Recovery is about 130% with respect to core wire, 65% with respect to whole electrode.

Specifications

AWS A5.4	E410-26
BS EN 1600	E 13 R 52
BS 2926	13.RMP
DIN 8556	E13 MPR 26 130

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	--	--	--
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

All-weld mechanical properties

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: 840-870ºC for 2 hours, furnace cool to 595ºC at 55ºC/h. max. Air cool to ambient. This gives a relatively low strength condition.
(2) AWS PWHT: 730-760ºC for 1 hour, furnace cool to 315ºC at 60ºC/h max., air cool to ambient. This gives a higher strength tempered condition more representative of normal fabrication welds.

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	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

Product description

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.

Recovery is about 130% with respect to core wire, 65% with respect to whole electrode.

Specifications

AWS A5.4	(E410-15)	Nearest classifications
BS EN 1600	(E 13 B 52)	
BS 2926	(13.BMP)	
DIN 8556	E 13 1 MPB 26 130	

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	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).

All-weld mechanical properties

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.

Operating parameters

DC +ve or AC (OCV: 70V min)

ø mm	3.2	4.0	5.0
min A	80	100	140
max A	140	180	240

Packaging data

ø mm	3.2	4.0	5.0 *
length mm	380	450	450
kg/carton	13.5	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

Product description

Solid wire for TIG & MIG.

Specifications

AWS A5.9	ER410
BS 2901: Pt2	410S94
BS EN ISO 14343-A	13
BS EN ISO 14343-B	SS410
DIN 8556	SG X 8Cr 14 (1.4009) nearest

ASME IX Qualification

QW432 F-No 6, **QW442** A-No 6

Composition (wire wt %)

	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.

All-weld mechanical properties

Typical values after PWHT			MAG: Ar+20%CO_2 740°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

Typical operating parameters

	TIG	MIG
Shielding	Argon *	Ar / 1-3%O_2 or Ar / 3-20%CO_2 **
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_2. This gas provides the highest resistance to weld metal porosity and carbon content typically not exceeding 0.12%.

Packaging data

ø mm	TIG	MIG
1.2	--	15kg spool
1.6	2.5kg tube	15kg spool
2.4	2.5kg tube	--

Fume data

MIG fume composition (wt %) (TIG fume negligible)

Fe	Mn	Cr^3	Ni	Cu	OES (mg/m^3)
55	4	8	<0.1	<0.5	5