

Stainless Steels

DATA SHEET

B-12

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MARTENSITIC PRECIPITATION HARDENING STAINLESS STEELS

Alloy type

High strength martensitic precipitation hardening stainless steels.

Materials to be welded

FV520 Types:

ASTM	A564, A693, A705; Grade XM-25
UNS	S45000
BS	3146 Grade ANC 20. 'S' grades; 2S.143; 3S.144; 3S.145
Proprietary	FV520B (Firth Vickers) Custom 450 (Carpenter)

630 / 17.4.PH Types:

ASTM	A564; Grade 630 A747; CB7Cu-1 (cast)
UNS	S17400
BS EN	10088-2; X5CrNiCuNb 16-4 (1.4542)
DIN	1.4548, 1.4549
Proprietary	17-4PH (Armco Steel) Custom 630 (Carpenter)

Applications

Used for welding very high strength martensitic stainless steels, precipitation hardened by additions of copper. Strength can be up to three times that of standard 300 series austenitic stainless steels.

The FV520/450 type alloys have corrosion resistance comparable to 304 stainless steel. The 630/17-4PH types, with no Mo and higher carbon, do not have such good resistance to intergranular and pitting corrosion as the FV520/450 types.

Applications include **pump shafts, impellers, hydraulic equipment** used in **oil and gas industries, petrochemical, marine and nuclear engineering.**

Microstructure

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

Welding guidelines

Preheat not usually necessary for thickness up to 15mm, for thicker restrained sections, a preheat-interpass temperature range of 100-200°C is recommended. Temperatures above 200°C will suppress martensite transformation with consequent microstructural coarsening.

PWHT

When matching composition consumables are used for welding these materials a PWHT must be carried out. Normal practice is for the materials to be used in the over-aged condition. PWHT for over-ageing consists of: 750°C for 2 hours, air cool to 15°C; followed by 550°C for 2 hours and air cool.

Additional information

On cooling the weld metal transforms from austenite to martensite (M_s) below about 250°C, but a significant fraction of austenite is still retained at ambient temperature. Since sub-zero cooling is impractical, this austenite is destabilised by annealing at 750-850°C. Carbide precipitation in the austenite raises its M_s temperature to enable complete transformation when cooled, ensuring more effective tempering and ageing during the second PWHT cycle. Omission of the inconvenient first PWHT cycle may give properties with greater batch variability. The use of 410NiMo (B-11) allows a simplified PWHT to be used, and when PWHT is not possible 2205 duplex (B-60) or superduplex (B-61 & B-62) consumables may allow PWHT to be avoided without compromising mechanical properties too much.

Products available


Process	Product	Specification
MMA	FV520-1	--
	17.4.Cu.R	(AWS E630-16)
TIG	FV520B	--
	17-4PH	AWS ER630
MCW	Metcore FV520	--

General Data for all MMA Electrodes

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	<p>Fume composition, wt % typical:</p> <table border="1" style="width: 100%; text-align: center;"> <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/m³)</th> </tr> </thead> <tbody> <tr> <td>15</td> <td>3</td> <td>0.5</td> <td>4</td> <td>0.8</td> <td>0.2</td> <td><0.1</td> <td>18</td> <td>1.2</td> </tr> </tbody> </table>	Fe	Mn	Ni	Cr	Cu	Mo	V	F	OES (mg/m ³)	15	3	0.5	4	0.8	0.2	<0.1	18	1.2
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15	3	0.5	4	0.8	0.2	<0.1	18	1.2											

FV520-1

MMA electrode for FV520 base material

Product description	<p>Rutile metal powder coating on pure low carbon steel core wire. Moisture resistant coating gives 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>																																												
Specifications	There are no national specifications for this electrode.																																												
ASME IX Qualification	QW432 F-No --, QW442 A-No --																																												
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All-weld mechanical properties	<table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th colspan="2">Typical properties PWHT</th> <th>Aged *</th> <th>Over-aged **</th> </tr> </thead> <tbody> <tr> <td>Tensile strength</td> <td>MPa</td> <td>1230</td> <td>980</td> </tr> <tr> <td>0.2% Proof stress</td> <td>MPa</td> <td>1110</td> <td>890</td> </tr> <tr> <td>Elongation on 4d</td> <td>%</td> <td>--</td> <td>16</td> </tr> <tr> <td>Elongation on 5d</td> <td>%</td> <td>10</td> <td>15</td> </tr> <tr> <td>Reduction of area</td> <td>%</td> <td>30</td> <td>37</td> </tr> <tr> <td>Hardness</td> <td>HV</td> <td>420</td> <td>345</td> </tr> </tbody> </table> <p>* 850°C/2 hours, air cool to 15°C + 450°C/4 hours, air cool. Not recommended for structural work. ** 750°C/2 hours, air cool to 15°C + 550°C/2 hours, air cool. More commonly applied PWHT.</p>	Typical properties PWHT		Aged *	Over-aged **	Tensile strength	MPa	1230	980	0.2% Proof stress	MPa	1110	890	Elongation on 4d	%	--	16	Elongation on 5d	%	10	15	Reduction of area	%	30	37	Hardness	HV	420	345																
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17.4.Cu.R

MMA electrode for 17-4PH base material

Product description	Rutile metal powder coating on pure low carbon steel core wire. Moisture resistant coating gives 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	There are no national specifications for this electrode but it is similar to AWS A5.4 E630-26.										
ASME IX Qualification	QW432 F-No --, QW442 A-No --										
Composition (weld metal wt %)		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	
	min	--	--	--	--	--	14.0	3.5	--	1.5	
	max	0.10	1.0	0.8	0.030	0.030	16.5	4.5	0.5	2.5	
	typ	0.02	0.7	0.25	0.01	0.01	15	4	0.2	2	
All-weld mechanical properties	Typical properties PWHT					Over-aged *					
	Tensile strength					MPa	1035				
	0.2% Proof stress					MPa	635				
	Elongation on 4d					%	10				
	Elongation on 5d					%	9				
	Reduction of area					%	24				
	Hardness					HV	330				
* 750°C/2 hours, air cool to 15°C + 550°C/2 hours, air cool.											
Operating parameters	DC +ve or AC (OCV: 70V min)										
	∅ mm	2.5			3.2			4.0			
	min A	70			80			100			
max A	110			140			180				
Packaging data	∅ mm	2.5			3.2			4.0			
	length mm	350			380			450			
	kg/carton	12.3			15.0			18.6			
	pieces/carton	528			345			246			

FV520B

Solid TIG wire for welding FV520 stainless steel

Product description	Solid wire for TIG.											
Specifications	There are no national specifications for this wire.											
ASME IX Qualification	QW432 F-No --, QW442 A-No --											
Composition (wire wt %)		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	Nb	
	min	--	0.5	0.2	--	--	13.2	5.0	1.2	1.2	0.15	
	max	0.07	1.0	0.5	0.03	0.03	14.7	6.0	2.0	2.0	0.5	
	typ	0.05	0.7	0.3	0.01	0.02	14	5.5	1.6	1.7	0.3	
All-weld mechanical properties	Typical PWHT					Aged *	Over-aged **	Over-aged ***	single cycle 550°C			
	Tensile strength					MPa	1345	1100	1025	1200		
	0.2% Proof stress					MPa	1240	1050	760	1000		
	Elongation on 4d					%	5	19	22	19		
	Elongation on 5d					%	5	16	21	16		
	Reduction of area					%	15	50	60	50		
	Impact energy					+ 20°C	J	7	60	125	125	
						- 20°C	J	--	20	85	75	
	Hardness mid					HV	450	380	315	400		
	* 850°C/2 hours, air cool to 20°C + 450°C/4 hours, air cool. Not recommended for structural work.											
** 750°C/2 hours, air cool to 20°C + 550°C/2 hours, air cool. More commonly applied PWHT.												
*** 750°C/2 hours, air cool to 20°C + 620°C/2 hours, air cool.												

FV520B (continued)

Typical operating parameters		TIG						
	Shielding	Argon *						
	Current	DC-						
	Diameter	2.4mm						
	Parameters	120A, 14V						
	* Also required as a purge for root runs.							
Packaging data	∅ mm	TIG						
	1.6	5kg tube						
	2.4	5kg tube						
Fume data	Fume composition (wt %) (TIG fume negligible)							
		Fe	Mn	Cr ³	Ni	Mo	Cu	OES (mg/m ³)
		52	4	11	4	<0.5	2.7	4.5

17-4PH

Solid TIG wire for welding 17-4PH stainless steel

Product description	Solid wire for TIG welding.										
Specifications	AWS A5.9		ER630								
ASME IX Qualification	QW432 F-No 6										
Composition (wire wt %)		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	Nb
	min	--	0.25	--	--	--	16.00	4.5	--	3.25	0.15
	max	0.05	0.75	0.75	0.03	0.03	16.75	5.0	0.75	4.00	0.30
	typ	0.03	0.6	0.4	0.005	0.02	16.3	4.8	0.2	3.5	0.2
All-weld mechanical properties	Typical PWHT					Over-aged *					
	Tensile strength					MPa	930				
	0.2% Proof stress					MPa	740				
	Elongation					%	10				
* 750°C/2 hours, air cool to 15°C + 550°C/2 hours, air cool; or 1040°C, air cool + 620°C/4 hours.											
Typical operating parameters		TIG									
	Shielding	Argon *									
	Current	DC-									
	Diameter	2.4mm									
	Parameters	120A, 14V									
	* Also required as a purge for root runs.										
Packaging data	∅ mm	TIG									
	1.6	2.5kg tube									
	2.4	2.5kg tube									
Fume data	Fume composition (wt %) (TIG fume negligible)										
		Fe	Mn	Cr ³	Ni	Mo	Cu	OES (mg/m ³)			
		50	4	13	3.5	<0.5	5.5	3.6			