

High Temperature Alloys

DATA SHEET

C-13

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316H TYPE CONSUMABLES

Alloy type

For 316/316H materials used at elevated temperatures.

Materials to be welded

ASTM	316/316H CF10M
BS	316S51 316S52 316S53 316C16 316C71
UNS	S31609

Applications

These consumables are designed for welding 316/316H austenitic stainless steels operating at high temperatures (500-800°C) under long term creep conditions. The 17.8.2.RCF MMA electrode is a modified 316H weld metal of lean composition to resist thermal embrittlement.

The consumables can also be used for welding 321/321H and 347/347H grades in high temperature structural service. This is particularly important in thick highly restrained weldments, since the possibility of premature service failure by intergranular HAZ cracking is reduced by using more ductile weld metal rather than 347H.

Used for welding **steam piping, superheater headers, furnace parts, some gas and steam engine turbine components**, in the **petro-chemical industry**, in **fossil and nuclear fuelled power stations**.

Microstructure

Austenite with delta ferrite typically controlled in the range 2-8FN.

Welding guidelines

Preheat not required, maximum interpass temperature 250°C. PWHT not required.

Additional information

There is a Metrode Technical Profile available covering 3XXH consumables and their use in refinery cat crackers.

Related alloy groups

See also the consumables in the related alloy groups of 308H (C-10), 347H (C-11) and 16.8.2 (C-12).

Products available

Process	Product	Specification
MMA	17.8.2.RCF	BS 17.8.2.R
	Ultramet 316H	AWS E316H-16
TIG/MIG/SAW	316S96	AWS ER316H
SAW flux	SS300	BS EN SA AF2 AC
	SSB	BS EN SA AF2 DC

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 150 – 200°C/1-2h to restore to as-packed condition. Maximum 250° 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 style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <tr> <td style="border: none;"></td> <td style="border: none; text-align: center;">Fe</td> <td style="border: none; text-align: center;">Mn</td> <td style="border: none; text-align: center;">Ni</td> <td style="border: none; text-align: center;">Cr</td> <td style="border: none; text-align: center;">Mo</td> <td style="border: none; text-align: center;">Cu</td> <td style="border: none; text-align: center;">F</td> <td style="border: none; text-align: center;">OES (mg/m³)</td> </tr> <tr> <td style="border: none;"></td> <td style="border: none; text-align: center;">8</td> <td style="border: none; text-align: center;">5</td> <td style="border: none; text-align: center;">0.7</td> <td style="border: none; text-align: center;">5</td> <td style="border: none; text-align: center;">0.1</td> <td style="border: none; text-align: center;">< 0.2</td> <td style="border: none; text-align: center;">16</td> <td style="border: none; text-align: center;">1</td> </tr> </table>		Fe	Mn	Ni	Cr	Mo	Cu	F	OES (mg/m ³)		8	5	0.7	5	0.1	< 0.2	16	1
	Fe	Mn	Ni	Cr	Mo	Cu	F	OES (mg/m ³)											
	8	5	0.7	5	0.1	< 0.2	16	1											


17.8.2.RCF

Rutile electrode for 316 at elevated temperature

Product description	<p>MMA electrode with a rutile (low silica) flux on high purity 304L core wire, giving a tightly controlled level of silicon and residual elements to minimise formation of intermetallic phases (sigma, chi) during service.</p> <p>Designed primarily for downhand and HV welding although for structural applications it is usable positionally.</p> <p>Recovery is about 120% with respect to core wire, 65% with respect to whole electrode.</p>																												
Specifications	<p>AWS A5.4 (E16.8.2-16) nearest BS 2926 17.8.2.R</p>																												
ASME IX Qualification	<p>QW432 F-No -, QW442 A-No -</p>																												
Composition (weld metal wt %)		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	FN																		
	min	0.06	0.5	--	--	--	16.5	8.0	1.5	--	3																		
	max	0.10	2.5	0.50	0.030	0.040	18.5	9.5	2.5	0.50	8																		
	typ	0.08	1.6	0.25	0.008	0.02	17	8.5	2	<0.1	5																		
All-weld mechanical properties	As welded						Room Temperature		High Temperature																				
							min	typical	650°C	732°C	815°C																		
	Tensile strength					MPa	560	> 630	369	274	191																		
	0.2% Proof stress					MPa	--	> 460	287	197	147																		
	Elongation on 4d					%	--	> 30	--	--	--																		
	Elongation on 5d					%	25	> 30	28	44	53																		
	Reduction of area					%	--	> 45	55	61	75																		
	Impact energy			-100°C		J	--	> 50	--	--	--																		
Operating parameters	<p>DC +ve or AC (OCV: 70V min)</p> <div style="text-align: right;"> </div> <table style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <tr> <td style="border: none;"></td> <td style="border: none; text-align: center;">ø mm</td> <td style="border: none; text-align: center;">2.5</td> <td style="border: none; text-align: center;">3.2</td> <td style="border: none; text-align: center;">4.0</td> <td style="border: none; text-align: center;">5.0</td> </tr> <tr> <td style="border: none;"></td> <td style="border: none; text-align: center;">min A</td> <td style="border: none; text-align: center;">60</td> <td style="border: none; text-align: center;">75</td> <td style="border: none; text-align: center;">100</td> <td style="border: none; text-align: center;">130</td> </tr> <tr> <td style="border: none;"></td> <td style="border: none; text-align: center;">max A</td> <td style="border: none; text-align: center;">90</td> <td style="border: none; text-align: center;">120</td> <td style="border: none; text-align: center;">155</td> <td style="border: none; text-align: center;">210</td> </tr> </table>												ø mm	2.5	3.2	4.0	5.0		min A	60	75	100	130		max A	90	120	155	210
	ø mm	2.5	3.2	4.0	5.0																								
	min A	60	75	100	130																								
	max A	90	120	155	210																								
Packaging data		ø mm	2.5	3.2	4.0	5.0																							
		length mm	300	350	350	450																							
		kg/carton	12.6	14.4	14.7	18.6																							
		pieces/carton	684	411	267	165																							

ULTRAMET 316H

Rutile coated MMA electrode for 316H stainless steel

Product description	Rutile coated electrode made on high purity 304 core wire, previously called Metrode E316H-16 . The higher alloy content compared to 17.8.2.RCF does increase the risk of intermetallic formation during service at elevated temperatures (500-800°C).										
Specifications	AWS A5.4		E316H-16								
	BS EN 1600		E 19 12 2 R 3 2								
	BS 2926		19.12.3.R								
ASME IX Qualification	QW432 F-No 5, QW442 A-No 8										
Composition (weld metal wt %)		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	FN
	min	0.04	0.5	--	--	--	17.0	11.0	2.0	--	3
	max	0.08	2.0	0.90	0.025	0.030	20.0	13.0	3.0	0.5	8
	typ	0.05	1	0.6	0.01	0.02	18	12	2.2	0.1	5
All-weld mechanical properties	As welded					Room Temperature		High Temperature			
						min	typical	650°C	732°C	815°C	
	Tensile strength					MPa	550	570	352	268	197
	0.2% Proof stress					MPa	350	450	264	204	152
	Elongation on 4d					%	30	35	--	--	--
	Elongation on 5d					%	25	33	32	43	54
Reduction of area					%	--	50	58	53	60	
Operating parameters	DC +ve or AC (OCV: 50V min)										
											
	∅ mm	2.5		3.2		4.0		5.0			
	min A	60		75		100		130			
	max A	90		120		155		210			
Packaging data	∅ mm	2.5		3.2		4.0		5.0			
	length mm	300		350		350		450			
	kg/carton	11.4		13.5		13.5		16.5			
	pieces/carton	633		393		261		159			

316S96

Solid wire for TIG/MIG and SAW of 316H

Product description	Solid wire for TIG, MIG and SAW which can not only be used in conjunction with E316H-16, but also with 17.8.2.RCF and other 300H consumables.										
Specifications	AWS A5.9		ER316H								
	BS EN ISO 14343-A		19 12 3 H								
	BS EN ISO 14343-B		SS316H								
	BS 2901: Pt2		316S96								
	DIN 8556		(Nearest SG X5CrNiMo 19 11 1.4403)								
ASME IX Qualification	QW432 F-No 6, QW442 A-No 8										
Composition (wire wt %)		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	FN
	min	0.04	1.0	0.30	--	--	18.0	11.0	2.0	--	3
	max	0.08	2.5	0.65	0.02	0.025	20.0	14.0	3.0	0.3	8
	typ	0.05	1.8	0.5	0.01	0.02	19	13	2.2	0.15	4
All-weld mechanical properties	Typical values as welded					typical					
	Tensile strength					MPa	650				
	0.2% Proof stress					MPa	460				
	Elongation on 4d					%	35				
Typical operating parameters		TIG		MIG		SAW					
	Shielding	Ar		Ar + 2%O ₂ /CO ₂		SS300 or SSB flux					
	Diameter	2.4		1.2		2.4					
	Current	DC-		DC+		DC+					
	Parameters	100A, 12V		220A, 26V		350A, 30V					

316S96 (continued)

Packaging data	ø mm	TIG	MIG	SAW			
	1.2	--	15kg reel	--			
	1.6	2.5kg tube	--	--			
	2.4	2.5kg tube	--	25kg spool			
Fume data	MIG fume composition (wt %) (TIG & SAW fume negligible):						
	Fe	Mn	Cr ³	Ni	Mo	Cu	OES (mg/m ³)
	30	12	15	11	1.5	< 0.5	3.3

SS300 and SSB FLUXES

Sub-arc fluxes

Product description	SS300 and SSB are agglomerated basic fluxes producing weld deposits with minimal Si pick-up and low Mn and Cr losses. SS300 has a BI of ~1.6 and SSB has a BI of ~2.2.										
Specifications		SS300 flux				SSB flux					
	BS EN 760	SA AF2 AC				SA AF2 DC					
ASME IX Qualification	QW432 F-No -, QW442 A-No -										
Composition (weld metal wt %)		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	
	wire (316S96)	0.05	1.8	0.5	0.01	0.02	19	13	2.2	0.15	
	Deposit (with SS300/SSB flux)	0.04	1.6	0.6	0.01	0.02	18	13	2.2	0.15	
All-weld mechanical properties	As welded (with SS300/SSB flux)				typical						
	Tensile strength		MPa		650						
	0.2% Proof stress		MPa		460						
	Elongation on 4d		%		35						
Operating parameters	Current: DC+ve ranges as below:										
	ø mm	amp-volt range				typical			stickout		
	2.4	250-450A, 28-32V				350A, 30V			20-25mm		
Packaging data	Metrode SS300 Flux is supplied in sealed moisture resistant 25kg metal drums and SSB Flux in 20kg metal drums. Preferred storage conditions of opened drums: <60%RH, >18°C. If the flux has become damp or has been stored or has been stored for a long period, it should be redried in the range 250-400°C/1-3h.										