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	**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** 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.
Fume data	Fume composition, wt % typical:

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

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.

Designed primarily for downhand and HV welding although for structural applications it is usable positionally.

Recovery is about 120% with respect to core wire, 65% with respect to whole electrode.

Specifications

AWS A5.4 (E16.8.2-16) nearest
BS 2926 17.8.2.R

ASME IX Qualification

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

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

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

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)

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	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.