Low Alloy Steels

DATA SHEET A-13

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2¼Cr-1Mo CREEP RESISTING STEEL

Alloy type

2¼Cr-1Mo alloyed steel consumables for elevated temperature service.

Materials to be welded

ASTM	BS EN & DIN
A387 Gr 21 & 22	11CrMo9-10 (1.7383)
A182 F22	10CrMo 9-10 (1.7380)
A217 WC9	GS-18CrMo 9 10 (1.7379)
A234 WP22	GS-12CrMo 9 10 (1.7380)
A199 T21, T22	6CrMo 9 10 (1.7385)
A200 T21, T22	12CrMo 9 10 (1.7375)
A213 T22	
A335 P22	
A234 WP22	**BS**
	1501 Gr 622
Also Cr-Mo-V steels	1503 Gr 622
BS 1503 Gr 660	1504 Gr 622
BS 1504 Gr 660	3100 Gr B3
BS 3100 Gr B7	3604 Gr 622
BS 3604 Gr 660	3059 Gr 622/640 & 622/490

Applications

These consumables are designed for prolonged elevated temperature service up to 600°C. Main areas of application are associated with **steam generating power plant**, eg **piping, turbine castings, steam chests, valve bodies** and **boiler superheaters**. Some of the consumables will also find service in refineries where they are used for **corrosion resistance** to sulphur bearing crude oil at 250-450°C. Some of the consumables will also find applications in the chemical and petro-chemical industries where they are used for **resistance to hydrogen attack** in the fabrication of **hydrocrackers, coal liquefaction plant** and **NH_3 pressure vessels** operating at up to 450°C. In the as-welded condition the consumables also provide a useful source of 300HV hardness weld deposit for build-up or hardsurfacing to resist metal-to-metal wear, heavy impact and the repair of P20 mould steel.

Microstructure

After PWHT, the microstructure consists of tempered bainite.

Welding guidelines

Preheat and interpass temperature 250°C minimum, up to 300°C for thick sections. Maintain throughout welding cycle and some time after completion of welding.

PWHT

Apart from some special applications, PWHT will always be required. PWHT temperature is typically 690°C with time being dependent on section thickness.

Additional information

There are Technical Profiles available which cover some of the consumables on this data sheet. Additional information is available on Chromet 2X and Cormet 2.

Products available

Process	Product	Specification
MMA	**Chromet 2**	AWS E9018-B3
	Chromet 2L	AWS E8015-B3L
	Chromet 2X *	AWS E9018-B3
TIG/MIG	**2CrMo**	BS EN CrMo2Si
	ER90S-B3	AWS ER90S-B3
SAW	**SA 2CrMo**	AWS EB3
	LA436	BS EN SA AB 1
FCW	**Cormet 2**	AWS E91T1-B3
	Cormet 2L	AWS E91T1-B3L

* Chromet 2X is the temper embrittlement resistant (TER) version of Chromet 2.

General Data for all 2¼Cr-1Mo Electrodes

Description

Basic flux, metal powder type coatings on low carbon high purity core wire. Recovery is approximately 115% with respect to the core wire and 65% with respect to whole electrode. Moisture resistant coating gives very low weld metal hydrogen levels.

Storage

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life. Direct use from tin will give hydrogen < 5ml/100g for longer than a working shift of 8h.
For electrodes that have been exposed:
Redry 250 – 300°C/1-2h to ensure H_2 < 10ml/100g, 300 – 350°C/1-2h to ensure H_2 < 5ml/100g. 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.

Operating parameters

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

ø mm	2.5	3.2	4.0	5.0	6.0
min A	70	80	100	140	200
max A	110	140	180	240	300

Fume data

Fume composition, wt % typical:

Fe	Mn	Cr	Ni	Cu	F	OES (mg/m³)
15	5	1	< 0.1	< 0.2	18	5

CHROMET 2

2¼Cr-1Mo MMA electrode

Product description

MMA electrode meeting AWS and BS EN national standards suitable for most power generation applications.

Specifications

AWS A5.5	E9018-B3
BS EN ISO 3580-A	E CrMo2 B 3 2
BS EN ISO 3580-B	E 6216-2C1M
BS 2493	(2CrMo B H)
DIN 8575	ECrMo 2 B 2 6
NATIONAL POWER	Conforms to specification requirements.

ASME IX Qualification

QW432 F-No 4, **QW442** A-No 4

Composition (weld metal wt %)

	C	Mn*	Si	S	P	Cr	Mo	Cu	Sn	As
min	0.05	0.50	--	--	--	2.00	0.90	--	--	--
max	0.10	0.90	0.80	0.015	0.020	2.50	1.20	0.15	0.010	0.035
typ	0.07	0.8	0.40	0.012	0.015	2.25	1.05	< 0.10	<0.006	<0.010

* Mn may exceed AWS 0.90% max.

All-weld mechanical properties

PWHT 690°C/1h			min	typical
Tensile strength		MPa	630	700
0.2% Proof stress		MPa	540	620
Elongation on 4d		%	17	22
Elongation on 5d		%	18	19
Reduction of area		%	--	65
Impact energy	+ 20°C	J	47	140
	-10°C	J	--	80
Hardness	(AW)	HV	--	300-320
	(PWHT)	HV	--	220-250

Preheat 200 – 300°C (BS & BS EN), 160 – 190°C (AWS), 200 – 350°C (DIN).

Packaging data

ø mm	2.5	3.2	4.0	5.0	6.0
length mm	350	380	450	450	450
kg/carton	12.0	15.0	16.2	17.1	16.2
pieces/carton	621	396	228	156	105

CHROMET 2L

Low carbon 2¼Cr-1Mo MMA electrode

Product description

MMA electrode – 2¼Cr-1Mo deposit with low carbon which produces lower hardness and residual stresses for resistance to sulphide stress corrosion cracking when operating in wet 'sour' environments. The lower hardness of **Chromet 2L** can also be beneficial for welds that cannot be subsequently PWHT.

Specifications

AWS A5.5	E8015-B3L
BS EN ISO 3580-A	E CrMo2L B 3 2
BS EN ISO 3580-B	E 5516-2C1ML
BS 2493	(2CrMo L B H)
DIN 8575	ECrMo 2 B 2 6

ASME IX Qualification

QW432 F-No 4, **QW442** A-No 4

Composition (weld metal wt %)

	C	Mn*	Si	S	P	Cr	Mo	Cu
min	0.03	0.50	--	--	--	2.00	0.90	--
max	0.05	0.90	0.80	0.015	0.020	2.50	1.20	0.15
typ	0.04	0.8	0.40	0.012	0.015	2.25	1.05	<0.10

* Mn may exceed AWS 0.90% max.

All-weld mechanical properties

PWHT 690°C/1h			min	typical
Tensile strength		MPa	550	630
0.2% Proof stress		MPa	460	540
Elongation on 4d		%	17	24
Elongation on 5d		%	18	20
Reduction of area		%	--	70
Impact energy	+ 20°C	J	--	160
	-10°C	J	--	90
Hardness	(AW)	HV	--	250-260
	(PWHT)	HV	--	210-220

Packaging data

ø mm	2.5	3.2	4.0
length mm	350	380	450
kg/carton	12.0	15.0	17.4
pieces/carton	621	396	228

CHROMET 2X

2¼Cr-1Mo alloyed MMA electrode for temper embrittlement resistance

Product description

MMA electrode – 2¼Cr-1Mo deposit which meets specific requirements for improved temper embrittlement resistance after prolonged service at 400-600°C. Relevant trace elements (P, Sn, As, Sb) are controlled to ensure low Bruscato (X) and Watanabe (J) factors.

Specifications

AWS A5.5	E9018-B3
BS EN ISO 3580-A	E CrMo2 B 3 2
BS EN ISO 3580-B	E 6216-2C1M
BS 2493	2CrMo B H
DIN 8575	ECrMo 2 B 2 6

ASME IX Qualification

QW432 F-No 4, **QW442** A-No 4

Composition (weld metal wt %)

	C	Mn*	Si*	S	P	Cr	Mo	Cu	Sn	As	Sb
min	0.05	0.50	0.15	--	--	2.00	0.90	--	--	--	--
max	0.10	0.90	0.30	0.015	0.012	2.50	1.20	0.15	0.005	0.010	0.005
typ	0.06	0.7	0.25	0.012	0.010	2.25	1.05	<0.05	0.002	0.003	<0.002

* Mn+Si < 1.10%

Bruscato factor (X) : $\frac{10P + 5Sb + 4Sn + As}{100}$ (ppm) = 15 max

Watanabe factor (J) : $(Mn+Si) \times (P + Sn) \times 10^4$ = 180 max

CHROMET 2X (continued)

All-weld mechanical properties

PWHT 690°C/1h [1] (SC = step cooled)			min	typical	690°C/5h typical	690°C/5h + SC typical
Tensile strength		MPa	630	670	660	650
0.2% Proof stress		MPa	540	570	560	550
Elongation on 4d		%	17	22	27	25
Elongation on 5d		%	18	19	24	20
Reduction of area		%	--	65	70	65
Impact energy	+ 20°C	J	47 [2]	140	170	170
	- 30°C	J	--	80	140	110
Hardness	(AW)	HV	--	300-320	--	--
	(PWHT)	HV	--	220-250	195	205

[1] BS & AWS PWHT 690°C/1h, DIN 690°C/>30min, BS EN 720°C/1h.
[2] DIN & BS EN minimum average.

Packaging data

ø mm	2.5	3.2	4.0	5.0
length mm	350	380	450	450
kg/carton	13.5	13.8	18.0	17.1
pieces/carton	681	375	270	156

2CrMo

Solid welding wire for TIG & MIG.

Product description

Copper coated wire for TIG and MIG welding of 2¼Cr-1Mo steels, conforming to European specifications.

Specifications

AWS A5.28	ER90S-G	
BS EN ISO 21952-A	CrMo2Si	(W = TIG, G = MIG)
BS 2901: Pt1	A33	
DIN 8575	(SG CrMo 2)	

ASME IX Qualification

QW432 F-No 6, **QW442** A-No 4

Composition (wire wt %)

	C	Mn	Si	S	P	Cr	Ni	Mo	Cu
min	0.06	0.80	0.50	--	--	2.30	--	0.90	--
max	0.12	1.20	0.80	0.020	0.020	2.70	--	1.10	0.4
typ	0.1	1	0.6	0.010	0.015	2.4	<0.1	1	0.15

All-weld mechanical properties

PWHT 690°C/4h (AWS=1h)			min	typical TIG	typical MIG
Tensile strength		MPa	620	660	655
0.2% Proof stress		MPa	540	550	540
Elongation on 4d		%	17	22	23
Impact energy	-10°C	J	--	> 150	> 95
Hardness		HV(HB)	--	225(220)	220(215)

Typical operating parameters

	TIG	MIG
Shielding	Argon	Ar-5%CO_2
Current	DC-	DC+
Diameter	2.4mm	1.2mm
Parameters	100A, 12V	280A, 26V

Packaging data

ø mm	TIG	MIG
0.8	--	15kg reel
1.2	--	15kg reel
1.6	5kg tube	--
2.0	To order	--
2.4	5kg tube	--
3.2	5kg tube	--

Fume data

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

Fe	Mn	Cr^3	Ni	Mo	Cu	OES (mg/m^3)
55	5	1.3	< 0.1	< 0.5	1.2	5

ER90S-B3

Solid welding wire for TIG & MIG.

Product description

Copper coated wire for TIG and MIG welding 2¼Cr-1Mo creep resisting steels, conforming to the AWS/ASME specification.

Specifications

AWS A5.28	ER90S-B3
BS EN ISO 21952-B	2C1M
BS 2901: Pt1	(A33)
DIN 8575	--

ASME IX Qualification

QW432 F-No 6, **QW442** A-No 4

Composition (wire wt %)

	C	Mn	Si	S	P	Cr	Ni	Mo	Cu
min	0.07	0.40	0.40	--	--	2.30	--	0.90	--
max	0.12	0.70	0.70	0.020	0.020	2.70	0.20	1.20	0.35
typ	0.1	0.5	0.5	0.010	0.015	2.4	<0.1	1	0.1

All-weld mechanical properties

PWHT 690°C/4h (AWS=1h)			min	typical	
				TIG	MIG
Tensile strength		MPa	620	660	655
0.2% Proof stress		MPa	540	550	540
Elongation on 4d		%	17	22	23
Hardness		HV(HB)	--	225 (220)	220(215)
Impact energy	- 10°C	J	--	> 150	> 95

Typical operating parameters

	TIG	MIG
Shielding	Argon	Ar - 5% CO_2
Current	DC -	DC+
Diameter	2.4mm	1.2mm
Parameters	100A, 12V	280A, 26V

Packaging data

ø mm	TIG	MIG
0.8	--	15kg reel
0.9	--	15kg reel
1.0	--	15kg reel
1.2	--	15kg reel
1.6	5kg tube	--
2.4	5kg tube	--

Fume data

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

Fe	Mn	Cr^3	Ni	Mo	Cu	OES (mg/m^3)
55	5	1.3	<0.1	<0.5	1.2	5

SA2CrMo

Solid welding wire for SAW.

Product description

Solid wire for Sub Arc Welding of 2¼Cr-1Mo steels, conforming to European specifications.

Specifications

AWS A5.23 EB3
BS EN 12070 SCrMo2

ASME IX Qualification

QW432 F-No 6, **QW442** A-No 4

Composition (typical)

	C	Mn	Si	S	P	Cr	Mo
SA2CrMo wire	0.10	0.6	0.12	0.010	0.012	2.4	1.0
Deposit with LA436	0.08	0.8	0.4	<0.01	<0.02	2.1	1.0

All-weld mechanical Properties (LA436 flux)

PWHT 690°C/1h			min	typical
Tensile strength		MPa	620	640
0.2% Proof stress		MPa	540	560
Elongation on 4d		%	17	24
Elongation on 5d		%	18	23
Impact energy	+20°C	J	47	>47

Typical operating parameters

Current: DC or AC; DC+ve is preferred
For 2.4mm: 300-500A, 28-36V, 350-700mm/min travel

Packaging data

ø mm	SAW
2.4	25kg coil
3.2	25kg coil

Fume data

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

Fe	Mn	Cr^3	Ni	Mo	Cu	OES (mg/m^3)
55	5	1.3	< 0.1	< 0.5	1.2	5

LA436

Sub-arc flux

Product description

LA436 is agglomerated aluminate basic flux (Boniszewski BI ~1.6) with silicon pick-up of ~0.3% and manganese pick-up of ~0.4%.

Specifications

AWS A5.23 F9 P0-EB3 B3
BS EN 760 SA AB 1 67 AC H5

ASME IX Qualification

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

Composition (typical)

	C	Mn	Si	S	P	Cr	Mo
SA2CrMo wire	0.10	0.6	0.15	0.010	0.012	2.4	1.0
Deposit with LA436	0.08	0.8	0.4	<0.01	<0.02	2.1	1.0

All-weld mechanical properties

			Typical PWHT 690-720°C/1-2h
Tensile strength		MPa	640
0.2% Proof stress		MPa	560
Elongation on 4d		%	24
Impact energy	+20°C	J	>47

Typical operating parameters

Current: DC or AC; DC+ve is preferred
For 2.4mm: 300-500A, 28-36V, 350-700mm/min travel

Packaging data

Metrode **LA436** flux is supplied in sealed moisture resistant 25kg metal drums. Preferred storage conditions for opened drums: < 60%RH, > 18°C. If the flux has become damp or has been stored for a long period, it should be redried in the range 300-350°C/1-2h.

CORMET 2 / 2L

All-positional flux cored wires

Product description

Cormet 2 is an all-positional flux cored wire suitable for welding fixed pipework. Made using a high purity steel sheath with a metal recovery of about 90% with respect to the wire.

Cormet 2L, which is the low carbon version, is available to order; this wire finds applications for **as-welded repairs** in **power generation** plant and the lower hardness may provide some benefits in some **petrochemical** applications.

Specifications

	Cormet 2	**Cormet 2L**
AWS A5.29	E91T1-B3C/M	E91T1-B3LC/M
BS EN ISO 17634-B	T62T1-1C/M-2C1M	T62T1-1C/M-2C1ML

ASME IX Qualification

QW432 F-No 6, **QW442** A-No 4

Composition (weld metal wt %)

	C*	Mn	Si	S	P	Cr	Mo	Cu
min	0.05	--	--	--	--	2.00	0.90	--
max	0.12	1.25	0.80	0.030	0.030	2.50	1.20	0.30
typ	0.06	1.0	0.3	0.01	0.01	2.3	1.0	0.05

* Cormet 2L C ≤ 0.05%, typical 0.04%

All-weld mechanical properties

PWHT 690°C/1-2h			min	Cormet 2 typical	Cormet 2L typical (as-welded)
Tensile strength		MPa	620	725	--
0.2% Proof stress		MPa	540	625	--
Elongation on 4d		%	17	22	--
Elongation on 5d		%	15	20	--
Impact energy	+ 20°C	J	--	> 70	50
Hardness		HV	--	235	280

Operating parameters

Shielding gas: 80%Ar-20%CO_2 at 20-25l/min. Proprietary gases may be used but argon should not exceed 80%. The wire is also suitable for use with 100%CO_2. (Note: for 100%CO_2 shielding gas, voltage should be 1-2V higher.)

Current: DC+ve ranges as below:

ø mm	amp-volt range	typical	stickout
1.0	120 – 220A, 22 - 30V	150A, 25V	15 – 25mm
1.2	160 – 260A, 24 - 30V	190A, 25V	15 – 25mm
1.6	220 – 350A, 26 – 32V	260A, 28V	15 – 25mm

Packaging data

15kg spools vacuum-sealed in barrier foil with cardboard carton.
The as-packed shelf life is virtually indefinite.
Resistance to moisture absorption is high, but to maintain the high integrity of the wire surface and prevent any possibility of porosity, it is advised that part-used spools are returned to polythene wrappers.
Where possible, preferred storage conditions are 60% RH max, 18°C min.

Fume data

Fume composition (wt %)

Fe	Mn	Ni	Cr^3	Cr^6	Cu	F	OES (mg/m^3)
20	8	< 0.5	1	< 1	< 1	8	5