Low Alloy Steels

DATA SHEET **A-60**

METRODE PRODUCTS LTD
HANWORTH LANE, CHERTSEY
SURREY, KT16 9LL
Tel: +44(0)1932 566721
Fax: +44(0)1932 565168 Sales
Fax: +44(0)1932 569449 Technical
Fax: +44(0)1932 566199 Export
Email: info@metrode.com
Internet: http//www.metrode.com

HIGH STRENGTH Ni-Mo LOW ALLOY

Alloy type

A range of Mn-Ni-Mo low alloy consumables covering tensile strength requirements from 620MPa (90ksi) up to 825MPa (120ksi). Some are designed for as-welded applications whilst others are predominantly used following a stress relief PWHT.

Materials to be welded

These consumables are used for a variety of high strength steels. Depending on strength requirements, some examples are:

Tufmet 1NiMo	API 5A L80; BS 4360 grade 55F; RQT 601 (Corus); HY80; Navy Q1(N).
E11018-M	Q1(N); HY80; RQT 701 (Corus); QT445; NAXTRA 70; Hystal77.
Tufmet 3NiMo	HY80 & Q1(N); possibly HY100 & Q2(N).

Applications

All the consumables are used for a range of high strength low alloy steels. The **E11018-M** and **Tufmet 3NiMo** electrodes in particular are used for military applications by the MoD and US Navy for construction and repair of **naval craft** and **submarines**. The **Tufmet 1NiMo** was developed for the **offshore industry** where high strength and –50°C toughness is required in the as-welded condition.

All of the consumables also have applications for general structural steel fabrications in HSLA steels, which may be used for **cranes**, **earth moving equipment**, and other **highly stressed** structural components.

Microstructure

The microstructure of all the consumables is predominantly ferrite; some will contain high proportions of acicular ferrite for optimum as-welded toughness (eg. Tufmet 1NiMo and Tufmet 3NiMo).

Welding guidelines

Preheat according to base material and thickness, although materials likely to be welded by the higher strength consumables will normally require 100°C minimum preheat.

With some HSLA steels interpass temperatures above 200°C may result in a reduction of strength and toughness.

PWHT generally dependent on base material and application, the solid wire ER110S-G is not recommended for applications requiring PWHT. Further information can be found under each individual product.

Related alloy groups

The 1NiMo.B electrode (data sheet A-61) is used for applications requiring maximum retained strength after extended PWHT.

The MnMo consumables (data sheet A-50) may be suitable for some of the same applications.

Products available

Process	Product	Specification
MMA	**Tufmet 1NiMo**	AWS E9016-G
	E11018-M	AWS E11018-M
	Tufmet 3NiMo	AWS E12016-G
TIG/MIG	**ER110S-G**	AWS ER110S-G

General Data for all MMA Electrodes

Storage	**3 hermetically sealed ring-pull metal tins** per carton, with unlimited shelf life. Direct use from tin will give **hydrogen** <5ml/100g weld metal during 8h working shift. 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 100 – 200°C in holding oven, or 50 – 150°C in heated quivers: no limit, but maximum 6 weeks recommended.
Fume data	Fume composition, wt % typical:

Fe	Mn	Ni	Cr	Cu	F	OES (mg/m^3)
14	<7	<0.5	<0.5	0.2	18	5

TUFMET 1NiMo

All-positional MMA electrode with high strength and toughness

Product description	MMA electrode with a low hydrogen basic flux on a high purity mild steel core wire. Moisture resistant coating ensures very low weld metal hydrogen levels. Provides minimum strength of 620MPa (90ksi) in the as-welded and stress-relieved condition. Recovery is about 110% with respect to core wire, 65% with respect to whole electrode.
Specifications	**AWS A5.5** E9016-G **DIN 8529** (EY 5576 Mn1NiMo B) **Approval:** Statoil R-SF-163
ASME IX Qualification	**QW432** F-No 4, **QW442** A-No 10

Composition (weld metal wt %)

	C	Mn	Si	S	P	Ni	Mo
min	0.030	1.30	0.25	--	--	0.6	--
max	0.075	1.80	0.60	0.02	0.02	1.0	0.3
typ	0.05	1.5	0.35	0.008	0.01	0.85	0.15

All-weld mechanical properties

Typical values as-welded and PWHT			min	As-welded	PWHT 600°C/4-8h
Tensile strength		MPa	620-730	670	630
0.2% Proof stress		MPa	550-660	600	525
Elongation on 4d		%	20	28	--
Elongation on 5d		%	20	25	--
Impact energy	0°C	J	--	--	130
	- 50°C	J	60	>100	>100

Operating parameters

AC (OCV: 60V min) or DC -ve
Operation on DC+ve is not as favourable as above,

ø mm	2.5	3.2	4.0	5.0
min A	60	80	100	140
max A	100	140	180	240

Packaging data

ø mm	2.5	3.2	4.0	5.0
length mm	350	450	450	450
kg/carton	13.5	15.0	18.0	16.8
pieces/carton	663	447	300	180

E11018-M

All-positional MMA electrode with high strength and toughness

Product description

MMA electrode with a low hydrogen basic, metal powder type, flux on a high purity mild steel core wire. Moisture resistant coating ensures very low weld metal hydrogen levels.

Conforms to military electrode specification used for Q1(N) and HY80 type steels used in naval construction by MoD and US Navy. Also suitable for similar high strength steels requiring a minimum strength of 760MPa (110ksi) in the as-welded and stress-relieved condition.

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

Specifications

AWS A5.5	E11018-M
BS 2493	2NiMo.BH
DIN 8529	(EY 6965 Mn2NiCrMo B)

ASME IX Qualification

QW432 F-No 4, **QW442** A-No 12

Composition (weld metal wt %)

	C	Mn	Si	S	P	Cr	Ni	Mo	V
min	--	1.30	--	--	--	--	1.50	0.25	--
max	0.10	1.80	0.60	0.030	0.030	0.40	2.50	0.50	0.05
typ	0.05	1.7	0.35	0.012	0.012	0.2	2.2	0.4	0.02

All-weld mechanical properties

Typical as welded and PWHT			min	As-welded	PWHT 620°C/2h
Tensile strength		MPa	760	820	830
0.2% Proof stress		MPa	680-760	730	760
Elongation on 4d		%	20	23	--
Elongation on 5d		%	20	22	16
Reduction of area		%	--	65	--
Impact energy	+ 20°C	J	--	125	--
	- 50°C	J	30	80	40
Lateral expansion	- 50°C	mm (mils)	--	0.9 (37)	--

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	450	450
kg/carton	12.0	14.1	16.2	16.8
pieces/carton	582	381	234	153

TUFMET 3NiMo

All-positional MMA electrode with high strength and toughness

Product description

MMA electrode with a low hydrogen basic flux on a high purity mild steel core wire. Moisture resistant coating ensures very low weld metal hydrogen levels.

The electrode was specially designed for welding HY80 and Q1(N) castings which are N+T following welding. Also suitable for other high strength steels requiring minimum tensile strength of about 820MPa (120ksi) in the as-welded and stress-relieved condition; or yield strength up to about 800MPa in the as-welded condition.

Recovery is about 110% with respect to core wire, 65% with respect to whole electrode.

Specifications

AWS A5.5 E12016-G
Approvals: MoD NES 769 for Q1(N) in Q+T condition.

ASME IX Qualification

QW432 F-No 4, **QW442** A-No 10

Composition (weld metal wt %)

	C	Mn	Si	S	P	Cr	Ni	Mo
min	0.02	0.8	--	--	--	0.6	3.5	0.4
max	0.06	1.5	0.5	0.025	0.025	1.0	4.5	0.8
typ	0.045	1.2	0.4	0.01	0.015	0.8	4	0.5

All -weld mechanical properties

Typical values:			min	As-welded	Stress relieved 600-620°C/1h	Q+T 900°C/1-6h WQ + 635-650°C/1-6h WQ
Tensile strength		MPa	830	950	920	710-770
0.2% Proof stress		MPa	740	870	870	590-660
Elongation on 4d		%	14	20	22	--
Elongation on 5d		%	--	18	20	20-25
Reduction of area		%	--	55	58	65-70
Impact energy	0°C	J	--	65	--	--
	- 50°C	J	--	45	30	65-135
CTOD	- 5°C	mm	--	--	--	>0.46

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	13.8	17.7	16.5
pieces/carton	381	267	156

ER110S-G

High strength solid TIG and MIG wire

Product description

Solid copper wire for TIG and MIG welding of Q+T steels requiring as-welded tensile strength up to about 760MPa (110ksi). It is not recommended for applications requiring PWHT.

Specifications

AWS A5.28 ER110S-G (Classified on the basis of mechanical properties in the as-welded condition)
BS EN ISO 16834-A (Mn3Ni1CrMo)

ASME IX Qualification

QW432 F-No 6, **QW442** A-No 12

Composition (wire wt %)

	C	Mn	Si	S	P	Cr	Ni	Mo	V	Cu
min	0.05	1.4	0.4	--	--	0.2	1.2	0.2	0.04	--
max	0.12	1.8	0.8	0.020	0.020	0.4	1.8	0.4	0.13	0.25
typ	0.1	1.6	0.5	0.01	0.01	0.3	1.4	0.3	0.09	0.1

All-weld mechanical properties

Typical values as welded			min	TIG	MAG Ar+5%CO_2	MAG Ar+20%CO_2
Tensile strength		MPa	760	940	835	730
0.2% Proof stress		MPa	660	870	740	660
Elongation on 4d		%	15	23	21	21
Impact energy	- 20°C	J	--	120	60	50
Hardness cap/mid		HV	--	300	280	255

* Minimum values for AWS ER110S-G MAG welds are typically obtained with low CO_2 content shielding gases; more oxidising gases give AWS ER100S-G properties, as shown above.

Typical operating parameters

	TIG	MIG
Shielding	Argon	Ar + 5-20%CO_2 *
Current	DC-	DC+
Diameter	2.4mm	1.2mm
Voltage	120A, 14V	280A, 26V

* Ar + 5%CO_2 provides the highest strength and best impact properties, see above. Other proprietary gas mixtures also suitable.

Packaging data

ø mm	TIG	MIG
1.0	--	20kg spool
1.2	--	15kg spool
1.2	--	20kg spool
2.4	5kg tube	--

Fume data

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

Fe	Mn	Cr^3	Ni	Mo	Cu	OES (mg/m^3)
50	10	1	0.4	<1.5	1.2	5