Nickel Base Alloys

DATA SHEET **D-30**

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CORROSION RESISTANT ALLOY C276

Alloy type

Alloy C276 is a Ni-15%Cr-16%Mo-4%W-5%Fe nickel base alloy.

Materials to be welded

	wrought	cast
ASTM	UNS N10276	A494 CW-12MW A743/A744 CW-12M
DIN	2.4819 (NiMo16Cr15W)	2.4883 (G-NiMo16Cr)

Proprietary alloys:
Hastelloy™ Alloy C-276 (Haynes International Inc)
Inco Alloy C-276 (Special Metals)
Nicrofer 5716hMoW (VDM)

Applications

The weld deposit composition matches parent alloy C276 with Ni-15%Cr-16%Mo-4%W-5%Fe. Carbon and silicon are controlled as close as possible to the very low levels of the wrought alloy to minimise carbide and intermetallic phase precipitates which can reduce as-welded corrosion resistance. Cast versions of the alloy typically have higher carbon and silicon (like the original wrought Hastelloy alloy C, now obsolete), but repair welds are usually solution treated for optimum corrosion resistance.

Alloy C276 has high resistance to corrosion in a wide range of acids and salts under oxidising and especially reducing conditions. These include hydrochloric and hydrofluoric acids, hypochlorites, chlorides and wet chlorine gas, sulphuric, phosphoric and many organic acids. Exceptional resistance to crevice corrosion and pitting in seawater and chloride-induced stress-corrosion cracking (superior to alloy 625). High temperature stability is limited by intermetallic phase formation.

In addition to fabrication welds in alloy C276, these consumables have good tolerance to dilution by most ferrous and high nickel alloys, and are suitable for surfacing and dissimilar welds which exploit the corrosion resistance, strength and toughness. Excellent properties to below -196^{0}C allow its use for welding 5-9%Ni cryogenic installations.

Applications include **pumps, valves, pipework** and **vessels** for use in aggressive environments in **chemical process plants**; also in equipment for **flue gas desulphurisation** and critical equipment in **offshore oil** and **gas production**.

Microstructure

In the as-welded condition the weld metal consists of austenite with some carbides.

Welding guidelines

Preheat is not required, interpass temperature should preferably be kept below 100°C and heat input restricted to 1.5kJ/mm.

Related alloy groups

Alloy 59 (D-31) and alloy C22 (D-32) are also NiCrMo alloys but with higher Cr for improved corrosion resistance.

Products available

Process	Product	Specification
MMA	**Nimrod C276**	AWS ENiCrMo-4
	Nimrod C276KS	AWS ENiCrMo-4
TIG/MIG	**HAS C276**	AWS ERNiCrMo-4
SAW	**HAS C276**	AWS ERNiCrMo-4
	NiCr flux	BS EN SA FB2

General Data for all C276 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 250 – 300°C/1-2h to restore to as-packed condition. Maximum 350° 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)
1	4	10	5	5	0.2	16	1

NIMROD C276

Rutile C276 electrode primarily used for surfacing

Product description

MMA electrode manufactured on special nickel-chromium core wire, with an alloyed basic-rutile flux coating to ensure low carbon and silicon transfer and a high refining capacity to remove undesirable impurities. Primarily used for surfacing and cladding; for joining applications the Nimrod C276KS is preferred.

Recovery is about 130% with respect to core wire, 65% with respect to whole electrode.

Specifications

AWS A5.11	ENiCrMo-4
BS EN 14172	E Ni6276
DIN 1736	EL-NiMo15Cr15W (2.4887)

ASME IX Qualification

QW432 F-No 43

Composition (weld metal wt %)

	C	Mn	Si	S	P	Cr	Ni	Mo	W	Fe	V	Cu	Co
min	--	--	--	--	--	14.5	50.0	15.0	3.0	4.0	--	--	--
max	0.02	1.0	0.2	0.015	0.02	16.5	--	17.0	4.5	7.0	0.35	0.50	2.5
typ	0.02	0.3	0.20	0.01	0.01	15.0	58.0	16.0	4.0	5.0	0.1	0.05	0.05

All-weld mechanical properties

As welded			min	typical
Tensile strength		MPa	690	770
0.2% Proof stress		MPa	400	550
Elongation on 4d		%	25	26
Elongation on 5d		%	22	25
Hardness *	Cap/mid	HV	--	230/255

* Work hardens to about 450HV.

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	260	310	310	310
kg/carton	12.0	13.5	14.1	13.2
pieces/carton	600	378	234	141

NIMROD C276KS

All-positional pipe welding electrode for alloy C276

Product description

MMA electrode with special basic flux coating on matching nickel-chromium-molybdenum core wire to provide clean and homogenous weld metal. Nimrod C276KS has exceptional operability, optimised for DC+ welding in all positions including fixed pipework qualified in the ASME 6G (inclined overhead) position.

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

Specifications

AWS A5.11	ENiCrMo-4
BS EN 14172	E Ni6276
DIN 1736	EL-NiMo15Cr15W (2.4887)

ASME IX Qualification

QW432 F-No 43

Composition (weld metal wt %)

	C	Mn	Si	S	P	Cr	Ni	Mo	W	Fe	V	Cu	Co
min	--	--	--	--	--	14.5	50.0	15.0	3.0	4.0	--	--	--
max	0.02	1.0	0.2	0.015	0.02	16.5	--	17.0	4.5	7.0	0.35	0.50	2.5
typ	0.02	0.3	0.20	0.01	0.01	15.0	58.0	16.0	4.0	5.0	0.1	0.05	0.05

All-weld mechanical properties

As welded			min	typical
Tensile strength		MPa	700	780
0.2% Proof stress		MPa	400	520
Elongation on 4d		%	25	30
Elongation on 5d		%	25	28
Impact energy	-50°C	J	--	65
	-196°C	J	--	55
Hardness *		HV	--	240

* Work hardens to about 450HV.

Operating parameters

DC +ve

ø mm	2.5	3.2	4.0
min A	60	75	100
max A	80	110	155

Packaging data

ø mm	2.5	3.2	4.0
length mm	250	300	350
kg/carton	11.4	13.5	15.0
pieces/carton	789	435	294

HAS C276

Solid wire for TIG/MIG/SAW welding of alloy C276

Product description

Solid wire for TIG, MIG and SAW.

Specifications

AWS A5.14	ERNiCrMo-4
BS EN ISO 18274	SNi6276
BS 2901: Pt5	NA48
DIN 1736	SG-NiMo16Cr16W (2.4886)
UNS	N10276

ASME IX Qualification

QW432 F-No 43

Composition (wire wt %)

	C	Mn	Si	S	P	Cr	Ni	Mo	W	Fe	V	Cu	Co
min	--	--	--	--	--	14.5	bal	15.0	3.0	4.0	--	--	--
max	0.02	1.0	0.08	0.015	0.020	16.5	--	17.0	4.5	7.0	0.3	0.50	2.50
typ	0.005	0.5	0.05	0.005	0.01	16	58	16	3.5	6	0.2	0.05	0.50

All-weld mechanical properties

Typical values as welded		min	TIG
Tensile strength	MPa	700	740
0.2% Proof stress	MPa	400	500
Elongation on 4d	%	--	46
Elongation on 5d	%	30	43
Reduction of area	%	--	50

Typical operating parameters

	TIG	MIG
Shielding	Ar *	Argon or Ar-He
Current	DC-	Pulsed
Diameter	2.4mm	1.2mm
Parameters	100A, 12V	160A, 28V (mean)

* Also required as purge for root runs.

Packaging data

ø mm	TIG	MIG
0.9	--	12.5kg spool
1.0	--	15kg spool
1.2	--	15kg spool (to order)
1.6	2.5kg tube	--
2.0	To order	--
2.4	2.5kg tube	--
3.2	2.5kg tube	--

Fume data

MIG fume composition (wt %) (TIG and SAW fume negligible):

Fe	Mn	Cr^3	Ni	Mo	Cu	OES (mg/m^3)
14	3	10	28	11	1	1.8