High Temperature Alloys

DATA SHEET **C-90**

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SPECIAL ELECTRODE FOR IN-657

Alloy type

50Cr-50Ni alloy for high temperature corrosion resistance.

Materials to be welded

Inco IN-657, IN-671
ASTM A560 Grade 50Cr-50Ni-Cb
DIN 2.4678, 2.4680, 2.4813
Paralloy N50W (Doncasters Paralloy)
Duraloy 50/50Cb

Applications

Nimrod 657 (formerly 50.50.Nb) was developed in conjunction with Inco to match their proprietary cast alloy IN-657 produced by licenced foundries world-wide. It is also suitable to weld the Ti-bearing wrought version IN-671.

Alloy 657 with its high chromium content has exceptional resistance to hot corrosion (800-950°C) by fuel ash containing vanadium pentoxide and alkali metal sulphates arising from the combustion of low grade heavy fuel oils.

IN-657 castings are used in a wide range of components in oil-fired furnaces and boilers such as **tube sheets**, **tube hangers**, supports and **spacers** in **ships**, **power stations**, **refineries**, and **petrochemical plants**.

Microstructure

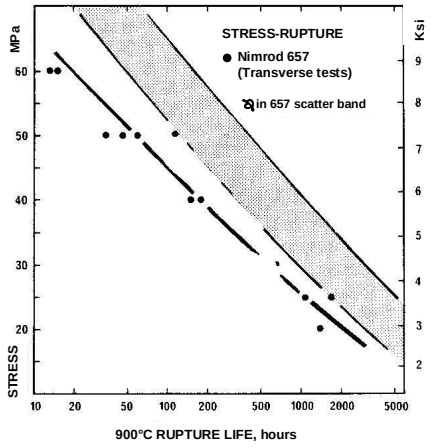
Very careful control of chromium and niobium is maintained to minimise the risk of weld metal cracking. The microstructure of IN-657 castings and Nimrod 657 weld metal consists of two phases: a chromium-rich alpha phase (bcc) and a nickel-rich gamma phase (fcc). The precise structure obtained is complicated by thermal history and composition, but has an important effect on the control of weld metal cracking. At lower chromium and niobium contents, the primary dendrites which form during solidification are gamma phase and this tends to promote sensitivity to solidification cracking. Higher chromium and niobium contents result in a primary alpha dendritic phase which is less ductile and hence more prone to cold cracking during cooling. An undesirable but infrequent eutectic phase may also occur. The composition of both weld metal and castings is therefore carefully balanced to minimise detrimental microstructural components and so reduce the risk of cracking. Carbon and nitrogen also reduce ductility and are kept as low as practicable.

Welding guidelines

Arc length should be kept low to avoid nitrogen pick up. Preheating is usually necessary; 150-200°C at 10mm thick with 200-250°C for most applications and up to 450°C for the thickest sections. Maintain interpass temperatures and slow cool.

Additional information

Weldment stress-rupture tests have been carried out on transverse specimens extracted from 25 mm thick centricast IN-657 tube. Tests were carried out at 900°C and the results are shown in the graph. It can be seen that about 75% joint efficiency is achieved in the long-term tests.



References

Thornley J.C. 'Welding of 50Ni-50Cr and 50Ni-50Cr-1.5Nb Alloys' Parts 1 & 2, Metal Construction Nov 1976, pp 480-487, and Dec 1976, pp 535-541.
'High chromium Cr-Ni alloys to resist residual fuel oil ash corrosion'. Inco publication No. 4299 (1975).
'IN-657 cast-nickel-chromium-niobium alloy for service against fuel-ash corrosion'. Inco publication no. 4320 (1974).

Products available

Process	Product	Specification
MMA	**Nimrod 657**	AWS ENiCr-4

NIMROD 657

MMA electrode for alloy 657/671

Description

MMA electrode made on a special nickel-chromium core wire, with a basic lime-fluorspar flux covering.

Recovery is approx 160% with respect to core wire, 65% with respect to whole electrode.

Specifications

AWS A5.11 ENiCr-4

ASME IX Qualification

QW422 P-No -, **QW432** F-No -

Composition (weld metal wt %)

	C	Mn	Si	S	P	Cr	Ni	Nb	Fe	N	Cu
min	--	--	--	--	--	48	bal	1.0	--	--	--
max	0.10	1.5	1.0	0.02	0.02	52	--	2.5	1.0	0.16	0.25
typ	0.07	1.0	0.5	0.01	0.01	50	47	1.8	0.5	0.07	0.05

All-weld mechanical properties

As-welded		min Nimrod 657	typical Nimrod 657	IN-657 (as cast)
Tensile strength	MPa	760	830-985	600-700
0.2% Proof stress	MPa	--	570-725	330-400
Elongation on 4d	%	--	2-4	10-40
Hardness	HV	--	340	210-260

Note: Weld metal tensile properties are much higher than those of as-cast IN-657, mainly because pre-ageing takes place during multipass welding. IN-657 responds similarly at high temperature and differences between the two are effectively eliminated during service.

Operating parameters

DC +ve AC(OCV:70V)

ø mm	2.5	3.2	4.0
min A	70	85	110
max A	95	120	160

Packaging data

ø mm	2.5	3.2	4.0
length mm	260	305	305
kg/carton	10.5	12.0	12.0
pieces/carton	450	300	195

Storage

3 hermetically sealed ring-pull metal tins per carton, with unlimited shelf life. Direct use from tin is satisfactory for much 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 %)

Fe	Mn	Ni	Cr	Mo	Cu	F	OES (mg/m^3)
1	2	2.5	8	0.1	0.1	23	0.6