Uniform Shipping Laws Code 2008

Section 5I: Construction – Copper Nickel

(CTH, NSW, QLD, SA, NT, TAS, VIC & WA)

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The official version is that last published by the Australian Government Publishing Service, Canberra, copies of which can be obtained from the National Marine Safety Committee.

SUB-SECTION I

Copper Nickel

This Section is divided into Parts as follows:

I.1 Application

I.1.1 This Sub-section forms part of the Construction Section and shall be read in conjunction with its other Sub-sections.

1.1.2 The Construction Section shall be read in conjunction with the Introduction, Definitions and General Requirements Section.

I.2.1 Composition

This sub-section relates to the marine use of a copper-nickel (Cu-Ni) alloy having the following composition:

Alloy No. CA706

Composition 90% Copper 10% Nickel

I.2.2 Physical Properties

The physical properties of CA706 are:

Density 8940 kg/m^3

Melting range 1100° – 1150°C

Thermal conductivity (20°C) 45W/m/°K

Coefficient of thermal expansion 17.3 x 10-^{6} / °C (20° – 300°C)

Specific heat 377 joule / kg / °K

Electrical resistivity 19.1 micro-ohm-cm

Modulus of elasticity (tension) 129 x 10^{3}MPa

Modulus of rigidity 49 x 10^{3}MPa

I.2.3 Mechanical Properties

Typical mechanical properties are:

	Tensile Strength MPa	*Yield Strength t(0.5% extension) MPa*	*Elongation (% m 508 mm*
Annealed strip	309	105	40
Hard strip (37% red)	475	425	5
Annealed tube (.025mm)	309	110	42
Lightdrawn Tube	414	394	10

I.3 Usage

I.3.1 This Sub-section is based on experience gained to date in the construction and operation of Cu-Ni and Cu-Ni/steel vessels. Design and fabrication were standard and so special equipment was required.

Experience has shown that Cu-Ni plating slightly thinner than the steel plating which would normally be used may be adopted satisfactorily, provided due care is taken. These requirements will be modified as experience is gained in the use of Cu-Ni.

I.4 Edge Preparation

Hull plates may be cut using air-arc cutting. For example 6.5mm plates have been successfully cut in this way by using a 5mm electrode at a cutting speed of 25mm per minute.

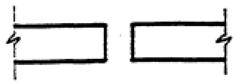
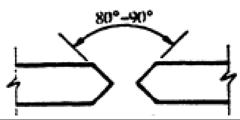
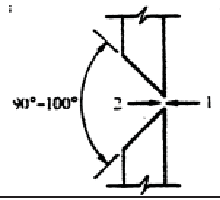
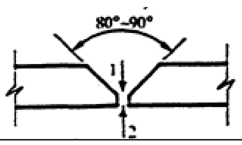
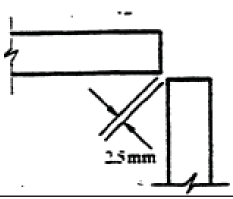
Alternative methods which may be used are metal band saw, plasma, powder.

Cut edges should be ground smooth and prepared for welding. Plates may be trimmed to size with a hand nibbler.

Edge preparation for 6.5mm plates is as shown in Table 1.

TABLE 1

Joint preparation for joining 90/10 copper nickel 6.5mm plate, ECu-Ni electrode (70-30 Cu-Ni)

Configuration	*Position*	*Gap mm*	*Current amps*	*Electrode 1st Pass*	*Size in 2nd Pass*
	Downhand	3	115/120	3	3
	Vertical*	2.5-3	85/90	2.5	2.5
	Horizontal	1.5-3	100	2.5	3
	1) Downhand 2) Overhead	2.5-3	110/115 95/100	3	2.5
	Vertical*	2.5	85	2.5	

*Welding Upwards

Note:

Grind out slag between passes, tack weld every 125mm.

Surfaces cleaned for welding by grinding.

I.5 Welding

I.5.1 Welding Processes and Filler Metals

Copper-nickel alloys may be welded by the manual shielded arc (coated electrode) process, (gas tungsten arc (TIG)), manual or automatic, gas metal arc (MIG) semi-automatic or fully automatic may also be used.

Copper nickel alloys are welded using an electrode or wire of composition 70% copper-30% nickel. Such weld metal has adequate corrosion resistance and mechanical properties, a minimum tensile strength of 350 MPa in the welds.

The base metal should be free of oil, grease and other foreign materials. Substances such as oil, crayon markings, paints which are potential sources of sulphur and lead may cause cracking when welds are made under conditions of high restraint.

I.5.2 Preparation for welding

Commonly used joint designs for various thicknesses of material are:

Thickness	*Joint Design*
less than 3 mm	Square built
3 mm and over but less than 12.5 mm	Vee
12.5 mm and over	U

I.5.3 Preheat and Postheat

Preheat is not necessary except where the material is very thick or a thick section is to be joined to a thin one. In any case welding should not be started if the material is below 20ºC. Stress relief heat treatment is usually not necessary for copper-nickel weldments.

I.5.4 Manual Metallic Arc Welding

When manual metallic arc welding is carried out using coated electrodes the rod should be electrically positive and the work negative. Electrode manufacturers normally specify the amperage appropriate to the electrode diameter. This should be checked by welding scrap material of the same thickness and in the same position as the work.

Electrodes normally may be used direct from the container, but in any case should be stored in an area that is dry and has low humidity. If the electrode coatings have absorbed moisture, then the manufacturer's advice on re-drying the electrodes should be sought.

Electrodes which have moisture in their coatings lead to porous welds.

Since copper-nickel alloy weld metal is not as fluid as carbon or low alloy steel weld metal, care must be taken in manufacturing the electrode in order to obtain a satisfactory bead contour.

A short arc must be maintained. When electrodes are changed, a 'T' type restrike should be used. The arc should be struck at the leading edge of the crater and carried back to its extreme rear at a normal drag bead speed. The direction of travel should then be reversed, weaving started and the weld continued.

This type of restrike has three advantages:

- The welder has an opportunity to establish the correct arc length.
- Some preheat is applied to the cold crater.
- The first few drops of quenched or rapidly cooled weld metal are placed where they will be remelted, minimising porosity.

A weave bead is generally preferred to ensure a satisfactory bead contour and wash. It is important that the weave not exceed three times the core wire diameter.

If necessary, a straight drag or string bead with a minimum of weaving may be used in the bottom of a deep groove.

In order to obtain a quality weld, the slag must be completely removed from each bead before the next one is deposited. All starts and stops should be examined, and defects removed by chipping, grinding, or other suitable methods.

There should be no pronounced spatter when using these electrodes. When spatter does occur, it is due to one of the following:

1. The arc is too long
2. Excessive amperage is being used
3. The polarity is incorrect

I.5.5 Inert Gas Welding

There are two types of inert gas welding:

- gas tungsten arc process
- gas metal arc process

The selection of welding grade shielding gas, preparation of the tungsten electrode, starting techniques, amperage, and wire extension used in inert gas welding should follow normal procedure. When using a filler wire, it is advisable to select a copper-nickel wire that has been made specifically for welding.

I.5.6 Gas Tungsten-Arc Welding (TIG)

The recommended current for gas tungsten arc welding, is direct current straight polarity (electrode negative, work positive). Alternating current with a superimposed high frequency current, may be used for automatic welding if close control of the arc length is possible.

When copper-nickel alloys are welded using the gas tungsten arc process without a filler metal, porosity may occur in the weld. Frequently the external appearance is satisfactory but radiographs of such welds often disclose some porosity. If welds are made without a filler, an automatic process should be used to ensure close control of arc length. The shielding gas may be argon or helium.

When materials over 1.5 mm thick are welded, filler metal must be added. Either helium or argon can be used as the shielding gas, although better arc control is possible with argon. Regardless of which gas is used, the roundness of the weld is dependent to a large extent upon the arc length maintained during welding. While an arc length of 0.5 to 0.75 mm is preferred, sound welds have been produced with an arc length of 1.25 mm.

I.5.7 Gas Metal Arc Welding (MIG)

The consumable electrode process (MIG) is normally used on materials over 6.5 mm thick. While either helium or argon may be used as the shielding gas, metal transfer is quieter and less spatter is encountered with argon. High purity welding grade oxygen-free argon should be used. The recommended current is direct current reversed polarity (electrode positive, work negative). Wire feed to current density relationship should be adjusted to produce a spray type transfer and hence proper penetration and bead contour welding in the lower portion of the current range that will give this type of transfer is preferred. The proper current also depends on the electrode diameter and the extension beyond the contact tip.

I.6 Scantlings

Scantlings for vessels of less than 35 metres in length may be identical with those appropriate to a steel vessel of the same length. However an Authority may permit a 20% reduction in scantlings having regard to panel size and stiffener scantlings and corrosion allowance.