

**90-10 Copper-Nickel
for Resistance to Corrosion
and Marine Biofouling**

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Copper Development Association

Copper Development Association is a non-trading organisation sponsored by the copper producers and fabricators to encourage the use of copper and copper alloys and to promote their correct and efficient application. Its services, which include the provision of technical advice and information, are available to those interested in the utilisation of copper in all its aspects. The Association also provides a link between research and user industries and maintains close contact with other copper development associations throughout the world.

Website: www.cda.org.uk

Email: helpline@copperdev.co.uk

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90-10 Copper-Nickel

Typical Composition: 10-11% Ni, 1-2% Fe, 0.5-1.0% Mn, 0.05% max. C, REM. Cu

Copper-nickels have high resistance to sea water environments. The 10% nickel alloy is the most widely used for sea water handling service.

Types of Application

Sea Water Pipe Work

Copper-nickel is an established pipe work alloy for many of the world's navies. It is also used in merchant shipping, the power industry and offshore for a variety of purposes.



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Offshore Fire Water Systems

Sea water deluge fire extinguishing systems in copper-nickel have been selected for offshore platforms over many years.

Heat Exchangers and Condensers

Good thermal conductivity and corrosion resistance to the sea water flow rates required have allowed copper-nickel tubing to remain an established alloy where high reliability is called for.

Sea Water Intakes

Build up of fouling on intakes and intake screens can restrict water flow and if detached cause blockages to heat exchangers or cause mechanical damage to pumps and valves. Copper-nickel with its high resistance to macrofouling can be very beneficial in this application.

Sheathing of Legs and Risers on Offshore Platforms

Copper-nickel is used for splash zone corrosion protection on oil/gas platform legs and riser pipes either as welded sheet or as a composite with neoprene. In an insulated form it provides antifouling properties too, which reduces wave drag and cleaning operations on the structures. More novel applications include sub-sea markers made from copper-nickel wire gauze which remain fouling free to help divers identify submerged structural areas.

Boat Hulls

Copper-nickel is one of the few engineering materials with good inherent resistance to both corrosion and biofouling making the alloy a suitable material for boat hulls without recourse to cathodic protection or antifouling and anticorrosion paints.

Hydraulic Lines

With adequate strength to withstand pressures in most marine hydraulic and instrumentation systems, copper-nickel provides good service, combined with ease of manipulation at installation.

Desalination Units

Considerable quantities of 90-10 copper-nickel are used in Multi-Stage Flash Desalination Units predominately located in the Middle East. The alloy is a prime condenser tubing material for the Heat Recovery Section and is also used for water boxes, tube plates and other fabrications as solid material or as clad steel plate.

Alloy Properties

Low General Corrosion Rates in Sea Water

General corrosion rates are normally in the order of 0.0025-0.025mm/yr which makes the alloy suitable for requirements in most marine applications.

Resistance to Stress Corrosion Cracking Due to Ammonia in Sea Water

Copper based alloys can be susceptible to ammoniacal stress corrosion cracking, e.g. brass. However copper-nickel has the highest resistance to this and stress corrosion in sea water is not known to be a problem.

High Resistance to Crevice Corrosion, and Stress Corrosion due to Chlorides

Copper-nickel is not susceptible to the type of crevice corrosion and stress corrosion cracking found in stainless steels. As such there is not a related temperature limitation for use in chloride environments.

Good Pitting Resistance

The resistance to pitting in clean sea water is good and if pits do occur they tend to be broad and shallow in nature rather than undercut.



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Readily Weldable and No Post Weld Heat Treatment Required

Copper-nickel is straightforward to weld by conventional welding techniques. The alloy can also be welded to steel.

Easy to Fabricate

Hot and cold working techniques can be used but because of the good ductility of the alloy, cold working is normally preferred.

Sea Water Piping Systems can last a Ship's Lifetime

Experience over the last 40 years has confirmed the durability of copper-nickel.

Inherent Resistance to Biofouling

The protective oxide surface film which forms naturally on copper-nickel in sea water also provides an inhospitable surface to deter marine growth.

The 90-10 alloy is only one of a family of copper-nickel alloys. 70-30 copper-nickel and a 70-30 alloy with 2% manganese and 2% iron are also available where higher strength and greater resistance to sea water velocity or sand abrasion are required. Further information is available from CDA.

International Designations:

ASTM UNS C70600; BS CN102; ISO CuNi10Fe1Mn W.Nr 2.0872; AFNOR CuNi10Fe1Mn;
Proposed Euronorm designations: EN 12449 CuNi10Fe1Mn, CW352H.

Typical Mechanical Properties

(Exact values with composition, size and heat treatment)

Form	Conditions	0.1% Proof Strength N/mm ²	Tensile Strength N/mm ²	Elongation per cent	Hardness Hv 10
Tube	Annealed	140	320	40	85
	Cold drawn (hard)	460	540	13	165
	Temper Annealed	190-320	360-430	30-38	115-140
Plate	Annealed	120	320	42	85
	Hot Rolled	140-190	340-360	40	95-105
Sheet	Annealed	120	320	42	85
	Cold Rolled	380	420	12	125

Physical Properties

Density: 8.9g/cm³

Melting point: 1100-1145°C

Permeability:<1.05 when annealed and cooled quickly so that all iron is in solution.

Modulus of Elasticity (20°C): 135 GPa

Modulus of Rigidity (20°C): 50 GPa

Specific Heat 20°C: 380J/kg K

Thermal Conductivity (20°C): 45W/mK

Corrosion Resistance

90-10 copper-nickel lies mid way in the galvanic series and is compatible with other copper alloys. It is less noble than stainless steels and high nickel alloys and more noble than steel, aluminium and zinc.

With low general corrosion rates and good resistance to localised corrosion the alloy shows excellent performance under many sea water conditions.

In continuous flowing sea water experience has shown that 90-10 copper-nickel behaves well for condensers and heat exchangers with water velocities up to 2.5m/s. For pipeline systems velocities are permitted up to 3.5m/s for larger diameter pipes. Note, under intermittent flow, typical of fire mains, copper-nickel can tolerate short periods of high water velocities up to 5-10 times the normal pipework maximum. The hydrodynamics around a boat hull allow higher velocities than in a pipe; a 24knot (12m/s) vessel over 14 months service experienced no impingement attack on hull panels.

90-10 copper-nickel also has good resistance to a wide range of other environments including dilute reducing acids and caustic, dry gases, brine and brackish water. The alloy is not advised for polluted water as sulphides can cause pitting and higher corrosion rates. Solutions of ammonia also lead to higher corrosion rates.

Biofouling Resistance

The alloy possesses a high inherent resistance to macrofouling which is similar to copper itself. Best resistance to macrofouling is achieved when the alloy is freely exposed and not cathodically or other wise galvanically protected.

Welding

When welding the alloy itself, the 70-30 copper-nickel weld consumable is preferred as it produces a sound weld and is slightly more noble than the base metal. For welding the alloy to steel, a 65% nickel-copper consumable is recommended.

Relevant CDA Publications

TN30 Copper-Nickel Alloys - Properties and Applications.

TN31 Copper-Nickel 90/10 and 70/30 Alloys - Technical Data.

Preventing Biofouling with Copper Alloys - CDA Publication 113.

Joining of Copper and Copper Alloys - CDA Publication 98.

CDA Datadisk 'Copper-Nickel Alloys and Aluminium Bronze Alloys'.

Copper Development Association

5 Grovelands Business Centre

Boundary Way

Hemel Hempstead

HP2 7TE

Website: www.cda.org.uk

Email: helpline@copperdev.co.uk