OSNA®-10 Copper-Nickel Sheathing
on Boatlandings

KME Germany GmbH & Co. KG
Copper-Nickel-Sheathing on Boatlandings
[GB]

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Copper-nickel sheathing on offshore structures –
the most cost-effective, long-term alternative to conventional coating systems

Corrosion protection of offshore wind farm structures is an important requirement which is currently under much scrutiny, since wind energy is widely recognised as a keystone in the future supply of energy. However, offshore locations expose the structures to heavy stresses and a severely corrosive environment. Coatings must withstand and protect the steel structures against seawater, reflecting UV light as well as tidal and wave action in order to achieve acceptable service lives. One thing that these systems have in common is that they have to be repaired and partially renewed regularly to achieve their designed lifetime. Experience has shown that, in reality, the **actual service life** of conventional **coating systems** is **well below** the expected **15 years**. Furthermore, the growth of **marine fouling** is **still a serious problem** for wind farm owners. The **transition piece**, in particular, causes considerable expense. **All time high maintenance** and **operational costs** have become a significant problem.

How to improve the durability of offshore wind farm structures?

Cathodic protection is very effective in zones that are permanently immersed in water but is largely ineffective in transition and splash zones because the metal is not continuously in contact with seawater (the electrolyte).

Another method of corrosion protection was first tried out successfully in 1949 in the Gulf of Mexico and has since been used for installations subject to particularly aggressive conditions in the oil and gas industries such as steel legs and hot risers. The method involves sheathing the steel supports with nickel-copper alloys. In the first installations, alloys containing high levels of nickel were used, but, for economic reasons, improved copper-nickel alloys have also been used in more recent times.

Sheathing steel columns
with copper-nickel sheets in the tidal zone – the solution against corrosion attack and biofouling

Copper-nickel 90/10 is known to be a seawater-resistant alloy that is widely used in marine applications because of its excellent **high resistance** to both **fouling** and **corrosion**. It is used for seawater and firewater piping systems, and to sheath the steel jackets of oil and gas platforms. One of the first large projects in which CuNi 90/10 was used as corrosion protection in tidal and splash zones was in 1984 on the columns of the platforms in the Morecambe Field, a large gas deposit in the Irish Sea.

In this project all the accommodation and drilling platforms were sheathed in copper-nickel sheets. The height of the sheathed areas ranged from +13 to -2 m above and below the lowest astronomical tide level. The metal sheets are 4 mm thick and were welded directly on to the steel, as the main purpose of the sheathing in this case was corrosion protection and not so much anti-fouling. The underwater part of the columns was protected cathodically with zinc anodes fixed directly to the steel.

***Copper-nickel 90/10** corrosion protection of tidal and splash zones on steel columns (Morecambe Field Gas Platform in the Irish Sea) has **provided** nearly **30 years free of maintenance against heavy fouling and corrosion**.*

Because of the extremely corrosive atmosphere that structures are exposed to, the classification companies specify a corrosion allowance of 12 mm when steel and conventional coating systems are to be used. This allowance is not necessary with 90/10 copper-nickel sheathing, which meant that, in the case shown in photographs above, it was possible to **save** almost **700 t steel**. Together with much lower maintenance costs of the corrosion protection compared to conventional systems, this variant was chosen as the least expensive.

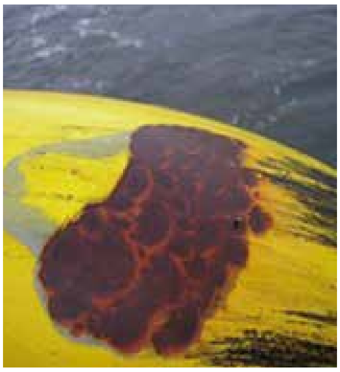
Regular inspections have found no indication of corrosion on the 90/10 copper-nickel cladding. No repairs in the zone protected by the 90/10 copper-nickel have been necessary, since mechanical damage to the corrosion protection, such as may occur in service which conventional coatings were prevented by the robust nature of the copper-nickel plates.

Thanks to the absence of the need for a corrosion coating on the steel columns in the transition and splash zones, and the lack of repairs or maintenance of any kind required in this area, the cladding of offshore load-bearing structures with 90/10 copper-nickel plate has been demonstrated to be a more durable and economic alternative than conventional protection methods.

Copper-nickel sheathing
on Boatlandings

In this context, KME has designed and developed **a new type** of **Boatlanding**. A Boatlanding is a docking site for boats to transfer people from the boat to the wind farm. For the KME prototype, it is **completely sheathed** with **copper-nickel 90/10** to provide a protective cloak around vulnerable areas (e.g. tidal zone and splash zones) as a defence against humidity, high salinity and, in particular, growth of marine fouling.

There is also a further benefit as in spite of protective rubber coatings around ship hulls, to protect them when mooring alongside, coatings on the Boatlanding can still be damaged. Compared to coating systems, copper-nickel easily absorbs such docking manoeuvres. Furthermore, a smooth transfer from the ship to the Boatlanding may be threatened if the Boatlanding is completely covered with mussels and this can be significantly reduced by the copper-nickel.



The 3rd coating layer of the transition piece, boatlanding and j-tube damaged due to tie-up of the service ships.

Several areas of damages on the boatlanding/steel surface.

After several years the transition piece is completely covered with mussels and the ladder has disappeared amidst the growth.

Properties of copper-nickel alloys

The properties of copper-nickel alloys are described below using copper-nickel 90/10 (CuNi 90/10) as an example.

Comparison of Standard Specifications for OSNA®-10 (CuNi 90/10)

	KME Alloy OSNA®-10 (CuNi 90/10)	DIN CEN/TS 13388 CW352H	DIN 86019 WL 2.1972	BS 2871 [1] CN 102	DIN EN 12449	EEMUA 144-1987 UNS C 7060 x	MIL-T-16420K ASTM B 466 [2] C 70620	JIS H 3300 C 7060 T
Ni %	10.0 – 11.0	9.0 – 11.0	9.0 – 11.0	10.0 – 11.0	9.0 – 11.0	10.0 – 11.0	9.0 – 11.0	9.0 – 11.0
Fe %	1.5 – 1.8	1.0 – 2.0	1.5 – 1.8	1.0 – 2.0	1.0 – 2.0	1.5 – 2.0*	1.0 – 1.8	1.0 – 1.8
Mn %	0.6 – 1.0	0.5 – 1.0	0.5 – 1.0	0.5 – 1.0	0.5 – 1.0	0.5 – 1.0	max. 1.0	0.2 – 1.0
C %	max. 0.02	max. 0.05	max. 0.05	max. 0.05	max. 0.05	max. 0.05	max. 0.05	
Pb %	max. 0.01	max. 0.02	max. 0.01	max. 0.01	max. 0.02	max. 0.01	max. 0.02	max. 0.05
S %	max. 0.005	max. 0.05	max. 0.005	max. 0.05	max. 0.05	max. 0.02	max. 0.02	
P %	max. 0.02	max. 0.02	max. 0.02		max. 0.02	max. 0.02	max. 0.02	
Zn %	max. 0.05	max. 0.50	max. 0.05		max. 0.50	max. 0.20	max. 0.50	max. 0.50
Sn %		max. 0.03			max. 0.03			
other imp.	max. 0.20	max. 0.20	max. 0.20	max. 0.30	max. 0.20	max. 0.30		
Cu %	rem.	rem.	rem.	rem.	rem.	rem.	rem.	+Ni+Fe+Mn min. 99.5

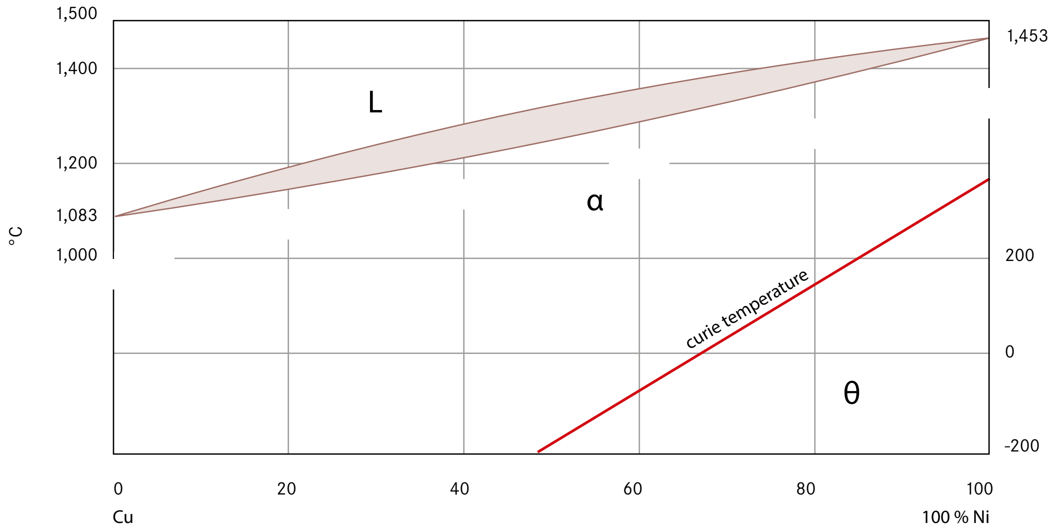
1) *no longer valid*
2) *equal to C 70600 for subsequent welding*
* *the iron content has been specified to improve corrosion resistance*

Mechanical Properties

Tensile Strength				0,2 % Proof Stress		Elongation	Hardness
N/mm²		PSI		N/mm²	PSI	% min.	HV5
min.	max.	min.	max.			on L=5.65 $\sqrt{S_0}$	max.
280	–	40.611	–	105	15.229	30	120

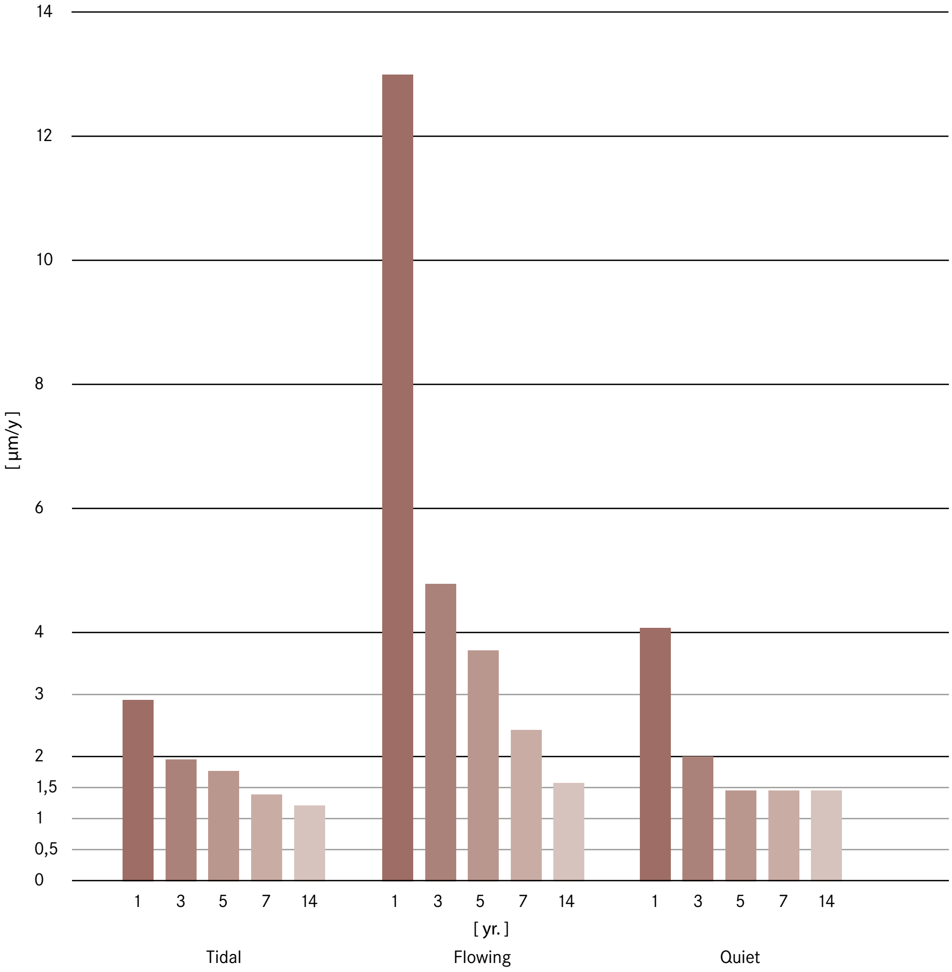
The alloy

Copper-nickel alloys are easy to work and have outstanding weldability properties, as copper and nickel are completely miscible and form a face-centred cubic crystal lattice across the entire alloy area.



The corrosion behaviour of copper-nickel 90/10

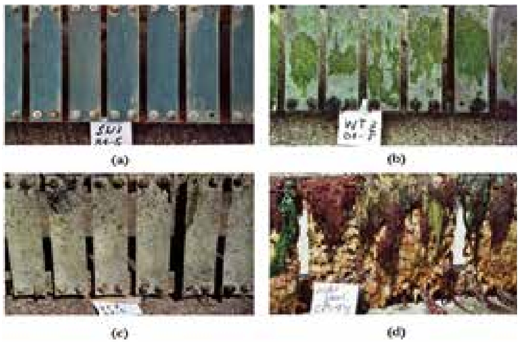
Copper-nickel 90/10 has a very good resistance to uniform and localized corrosion in seawater and, in comparison with brass and bronze alloys, has high resistance to stress corrosion cracking. The required corrosion allowance for seawater applications for 20 years is 0.5 mm (Lloyd´s Register).



Anti-fouling

CuNi 90/10 samples exposed to the tidal region of the North Sea (Helgoland) (a: SWZ, b: WTZ, c: DTZ) after two years and a comparison steel sample (d: DTZ) after one year. [SWZ = splash zone, WTZ = alternate immersion zone, DTZ = permanent immersion zone]

The photos clearly show the anti-fouling properties of CuNi 90/10 compared to normal construction steel.



Galvanic effects of coupling with steel

When steel components are sheathed with copper-nickel alloys, two distinctly different methods are used:

- The sheath is insulated from the steel column.
- The sheath is welded directly on to the steel column.

In the first case, a copper-nickel sheath is slid over the steel column and the gap is filled with concrete or a polymer; both metals are therefore electrically insulated from each other. The result of this is that the behaviour of the copper alloy is not affected galvanically by the behaviour of the steel or its cathodic protection. In other words, it completely retains its inherent anti-fouling and seawater-resistant properties while protecting the underlying steel. In the underwater zone, where the sheath ends and the steel is directly exposed to seawater, the cathodic protection takes effect.

In the second case, the two metals are electrically coupled, which, on the one hand, causes a partial loss in the copper alloy‘s anti-fouling properties, but on the other hand, reduces the rate of corrosion even further.

Original concerns about galvanic corrosion of the steel adjacent to the ends of the sheathing, have never materialised. At the top of the sheathing which is exposed to the marine atmosphere, coatings are applied for a short distance down the copper-nickel. The lower, submerged end of the sheathing is normally protected by the structure’s cathodic protection system. Even so, it has been found by trials that this may not be necessary as the copper alloy becomes polarised so that galvanic corrosion is unlikely to occur or occurs at a much reduced level.

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