OSNA®-10 Copper-Nickel Sheathing
on Offshore Structures

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

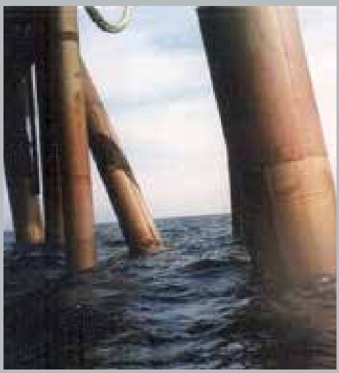

Photo: © Centrica Energy

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

As for offshore oil and gas platforms, life expectancy of more than 20 years for offshore wind turbine installations requires that corrosion protection plays an important role. Apart from the durability of the corrosion protection, maintenance should also be as little as possible during the planned operating period , since any type of repair offshore is very expensive.

Cathodic protection is very effective in zones of structures 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). Normally, the steel components here are protected with polyurethane or epoxy resin-based coating systems that have a life of roughly 15 years. One thing that these systems have in common is that they have to be repaired and partially renewed regularly to achieve their designed life time. The transition zone, in particular, causes considerable expense.

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 alloys containing nickel and copper. 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.

Properties of copper-nickel alloys

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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

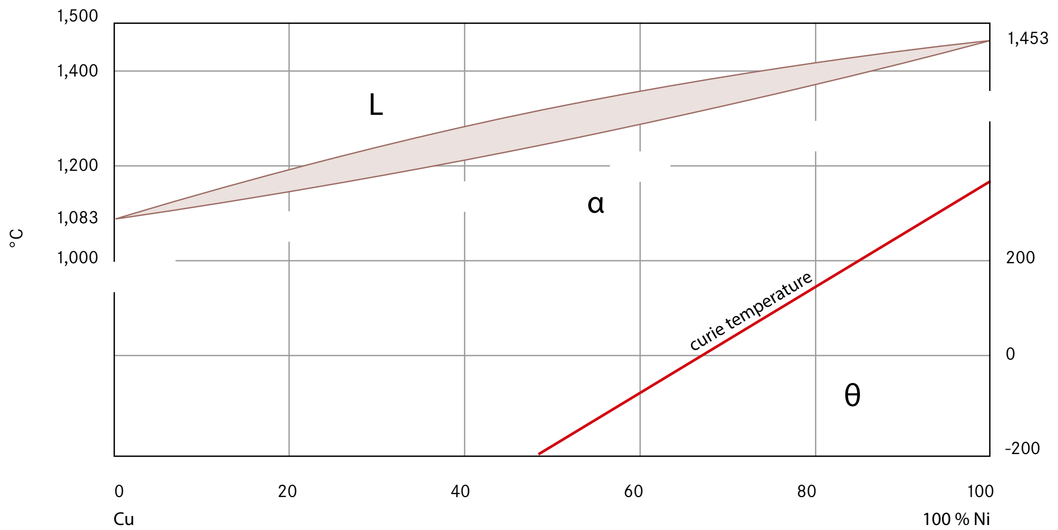
[1] *no longer valid*
[2] *equal to C 70600 for subsequent welding*
* *the iron content has been specified to improve corrosion resistance*

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

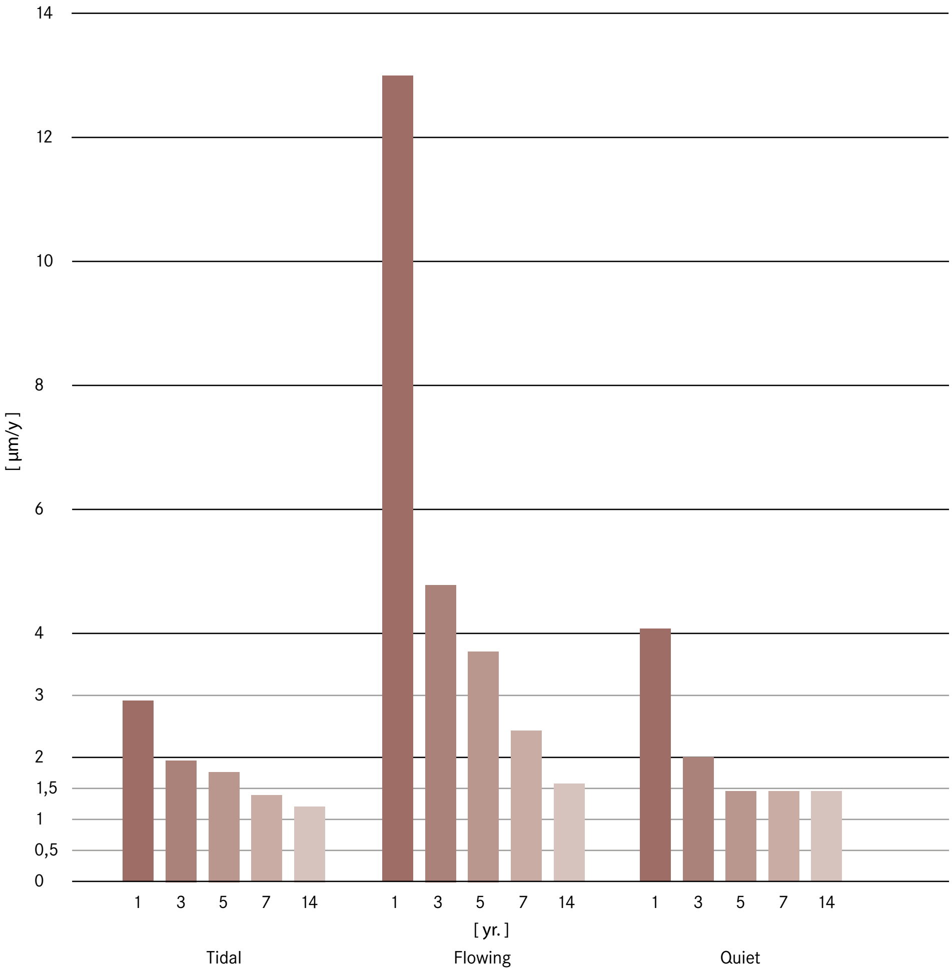
The alloy

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

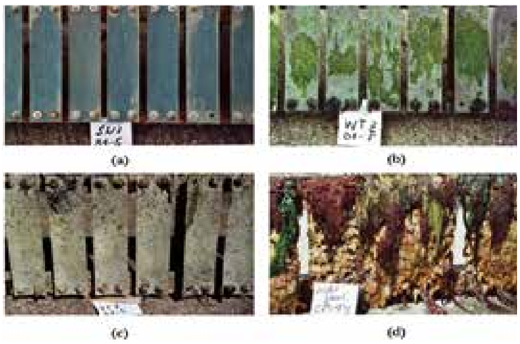
Copper-nickel 90/10 has a very good resistance to uniform and local corrosion in seawater and, as opposed to other copper alloys, is not as susceptible to stress corrosion cracking. The required corrosion allowance for seawater applications for 20 years is 0.5 mm (Lloyd´s Register).



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.

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

Copper-nickel 90/10 is known to be a seawater-resistant alloy that is used in many areas of the offshore industry. Its main properties – anti-fouling and resistance to seawater – are utilised mainly in seawater pipeline systems, to clad ships' hulls 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 Bay Gas Field, a large gas deposit in the Irish Sea.

In this project all the accommodation, production 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 water 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.

Photo: © Fotolia

*Several areas of **mechanical damages** and **heavy fouling** on **conventional coating systems** on the transition piece and boatlanding station of offshore wind farm structures in the splash and tidal zone.*

Because of the extremely corrosive atmosphere 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 the 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 steel or on the 90/10 copper-nickel cladding. No repairs in the zone protected by the 90/10 copper-nickel were 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.

Special Products

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