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Copper-nickel sheathing improving jacket performance

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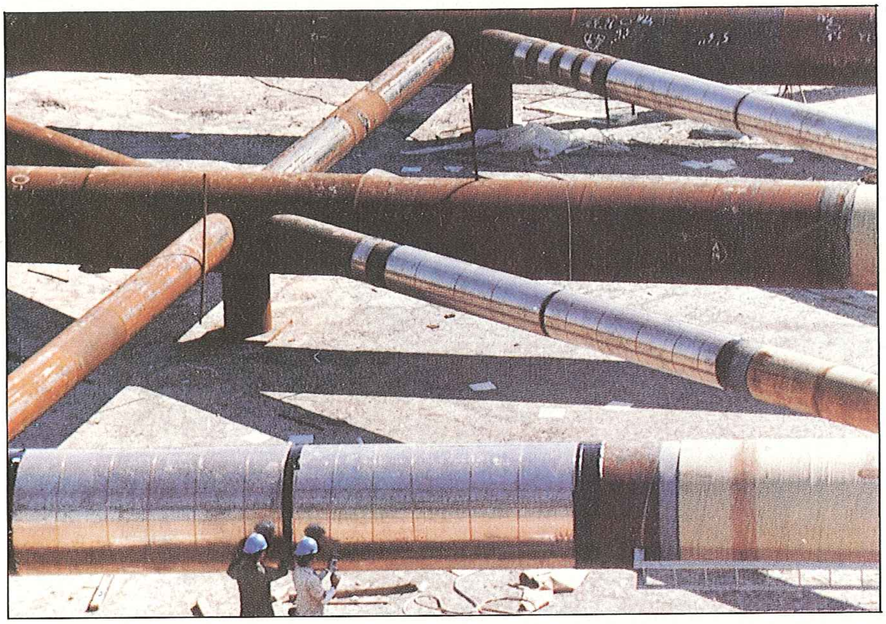
As the industry builds larger platforms to accommodate hostile environments and deep waters, the costs of dealing with bio-fouling rise proportionally. Jacket over-design, extra steel, and periodic cleaning are all necessary.

A sheathing for jacket support legs, diagonals, and conductors in the splash and tidal zones such as copper-nickel (90% Cu, 10% Ni) alloy can provide a reduced overall cost in initial construction and reduced maintenance expense over the life of the structure.

The problems of marine biofouling, corrosion and frictional drag are acute in the splash/tidal zone, where tides, swells and spray intermittently wet the metallic surfaces.

The corrosion rates of offshore steel support structures vary with each of five distinct marine zones: atmospheric, splash, tidal, continuously submerged, sub-soil or mud. Corrosion rates for steel columns peak at about 17 mils (.017 in.) per year (mpy) in the splash zone.

Protection of the steel support structure can be effected by various means throughout the corrosion zones. The three generally accepted and proven methods are: cathodic protection, sheathing, painting or coating.



The silver bands on this jacket section are copper-nickel/elastomer sheathing applied in the splash zone as a protection from bio-fouling.

Splash zone critical

The critical areas are the tidal and splash zones. While various coatings, such as coal-tar, epoxy, vinyl, galvanized, sprayed zinc, and sprayed aluminum, have been applied to support structures for corrosion protection in marine environments, long life has not been achieved, and repair and/or replacement has been difficult, if not impossible, to effect in the marine environment.

It is suggested that 90-10 Cu-Ni sheathing, insulated from the steel to gain the advantage of its inherent biofouling resistance, is a more cost-effective choice.

There are currently several systems available incorporating the insulated 90-10 Cu-Ni sheathing concept for corrosion and biofouling protection of conductors, support legs and diagonals in the splash and tidal zones. One such system uses a 1/16-in. thick Cu-Ni sheet and a ¼-in. thick butyl-base insulating/adhesive elastomer.

Fourteen steel pilings using this sheathing system have been driven at the LaQue Center for Corrosion Technology, Inc. in Wrightsville Beach, North Carolina to document long-term corrosion and biofouling protection of the splash and tidal zones. After one year in the water, the sheathed pilings were essentially free of biofouling growth, in contrast to a solid layer of marine growth on the steel control pilings. All pilings are protected with anodes. Electrical measurements confirm the protection offered by the Cu-Ni sheathing due to the reduced demand made on the anodes, and also confirm the insulating stability of the elastomer in use.

A small evaluation section of the same system has been in place on a producing platform in the southern California waters for 18 months. The section was mounted on a 10-in. diameter horizontal diagonal over a circumferential weld joint. It was made removable by layering a 2 mil thick polyethylene film on the steel-rubber interface of the insulation. Its purpose was to demonstrate the prevention of marine growth on the weld, which must be periodically inspected.

Removing marine growth

The major cost of the inspection in biofouling waters is not the weld inspection, but removal of marine growth prior to inspection. For example, a section of insulated 90-10 Cu-Ni exposed for a period of 18 months was virtually free of marine growth while the adjacent areas of the unprotected steel member had hardshell marine growth up to 8 in., increasing the diameter of the member by 2.6 times.

Nine hundred square feet of the Cu-Ni sheathing system was placed on a platform due for June 1985 deployment in the Gulf of Mexico. Based on material requirements and actual field installation cost for sheathing platform legs, diagonals and conductors, this system shows an installed cost of approximately $19 per sq ft.

Metal surface maintenance cost comparison (£ millions)

	Paint	Neoprene	Monel	Cu-Ni
Initial cost (extra steel)	2.3	2.3	-	-
Protective material, labor	0.1	0.3	2.2	0.95
Maintenance cost	2.4*	**	0.15	0.15***
Extra weight (tonnes)	660	660	180	180

**5-8-year life cycle*
***No repairs assumed in less than 18 years*
****Maintenance confined mainly to accident repair*

20-year life cycle costs for pipe

System	Capital cost	Maint-enance cost	Salvage value	Total cost
90/10 Cu-Ni (8-in. dia)	92,250	12,221	3,898	100,573
90/10 Cu-Ni (6-in. dia)	80,425	12,221	2,920	89,726
Steel	75,610	62,751	-	138,351
Steel with Chlorination	86,060	48,919	-	134,979

Reducing weight

While eliminating the problem of marine growth is a major cost improvement, the largest savings to be realized from sheathing a jacket with Cu-Ni is the reduction in design jacket weight that can result. The environment (wind, waves, current) places great strain on the jacket, and as the members increase in diameter due to marine growth, wave loading increases substantially. Jackets must be designed to support the additional weight of marine growth and resist the increased wave loading.

A study performed by Exxon Production Research evaluated the potential cost savings associated with attaching Cu-Ni sheathing to offshore platforms in the areas of jacket weight and corrosion protection. The study examined conceptual platform designs for 23 conditions.

The range of potential cost saving in dollars per meter of sheathing was determined for various environments and water depths. The potential cost

Eureka's 60 conductors protected by alloy

The first large commercial application of elastomer/copper-nickel sheathing was the coating of 60 conductors on Shell's Eureka platform off California in 1984. Shell has used the concept in various forms since 1963.

The Shell patented process to prevent biofouling has been licensed to Mark Tool Co. of Lafayette, Louisiana. The firm uses a yellow elastomer named Splashtron to bond the Cu-Ni alloy to the steel members.

Shell saved 250 tons of steel in the jacket design and calculates a cost reduction of $70,000 every 18 months by eliminating water blasting, say Mark Tool officials.

Conductors bonded in this way have a ½-in. coating of elastomer and a 1/16-in. later of Cu-Ni alloy. The bond is able to withstand hammer driving forces during installation. □

One of the Eureka jacket's 60 conductors is coated in the splash zone with Mark Tool's Bio-shield, a thin Cu-Ni alloy bonded to the pipe with an elastomer.

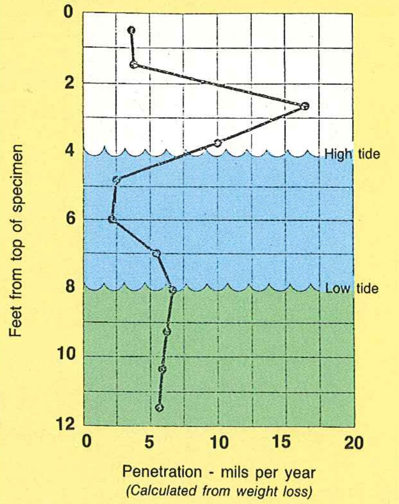
savings presented excludes all material and installation expenses associated with Cu-Ni sheathing. Net cost savings, or expense, can be estimated by comparing the savings per sheathed area to the sheathing material and installation unit costs for various locations throughout the world.

A review of the Exxon analysis shows that the use of Cu-Ni sheathing produces a significant steel reduction for severe environments typical of the North Sea, with a lower savings for more moderate environments such as Malaysia and the Gulf of Mexico.

In the North Sea, with a design wave height of 90 ft, Cu-Ni sheathing reduces the total platform and pile cost by about 9%, or roughly $8.7 million, based on 1983 costs. In mild environments such as Malaysia (design wave height of 34 ft), weight reductions of 4% and a cost savings of $480,000 of the reference platform cost can be achieved. In moderate environments, typical of the Gulf of Mexico (design wave height of 71 ft), the weight savings for the extreme case amounted to about 6%, or $880,000.

Where heavy marine growth is prevalent, offshore cleaning costs (not included in this study) can range as high as $100,000 and may be required every one or two years. The use of Cu-Ni sheathing can reduce, if not eliminate, the need for this.

Corrosion penetration rate for platform members



The reduced wave loading achieved as a result of the sheathing contributes to the potential cost savings in four other areas: offshore pile installation time, corrosion protection, joint thickness needed for fatigue protection, and, post-weld heat treatment. In the North Sea case, sheathing reduced the required number of piles by four, with an installation time savings of $1.2 million.

Cu-Ni sheathing protects the steel from corrosion, thus reducing the number of anodes required, and eliminates the corrosion allowance often provided on structural members in the splash zone.

Cost savings (not included in this study) can also be realized in reducing joint thickness needed to prevent fatigue damage. By reducing the member stress, sheathing helps reduce the required thickness and also helps reduce, or eliminate, the need for post-weld heat treatment to stress relieve very thick joints.

Cu-Ni sheathing has proven effective on other platforms. Several platforms in the Morecambe Bay field were sheathed with approximately ⅛-in. (3mm) 90-10 Cu-Ni sheet in the splash/tidal zone for corrosion protection. The sheathing was directly welded to the steel. As a result, the biofouling resistant property of the Cu-Ni was not utilized.

The certifying authorities required sacrificial steel (½-in. thickness) in this highly corrosive area when a paint system or neoprene wrap is specified. Sacrificial steel is not required with a Cu-Ni (or Monel) metal wrap system. The economic justification was based on a platform life of 15 years. All maintenance costs were discounted to net present value at 10%. The application had a net cost savings of 52-77%, compared to other systems evaluated.

The 90-10 Cu-Ni alloy for sheathing support members and conductors has been commercially applied and is fulfilling its performance expectations. □

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