Weka

Press Release

Weka Boxcoolers BV
Industrieweg 8
NL-2921 LB Krimpen a/d IJssel
The Netherlands

Tel 0031 180 516 588
Fax 0031 180 516 064
info@weka.biz
www.weka.biz

For your business and technology editors

Dutch company presents environmentally sound ship protection against fouling and corrosion

Krimpen, October 18, 2004 – Weka Boxcoolers today announced an environmentally sound alternative for the protection of ship and boxcooler. The combination of Weka boxcoolers made of environmentally friendly copper-nickel alloys with an improved passive protection system meets the requirements of environmentalists as well as of ship-owners.

The protection of ships from fouling by barnacles and mussels is a traditional problem. Many protection systems based on the impressed current anti fouling principle release large amounts of copper ions into the water. Such protection is regularly applied around water inlets, boxcoolers, propulsion and rudders on the ship.

Release of potentially poisonous copper ions into water is an environmental issue. In line with its commitment to the environment, Weka has further developed boxcoolers and protection systems. Today's announcement of a fully passive system means a reduction of the release of some 700 kg of copper per ship per year. For comparison, the commonly referred to environmental problem of anti-fouling paint on ships, which has been banned for leisure boats in many countries, is estimated to correspond to 500 kg per year for all ships in one country researched [Sweden].

The Weka passive protection of components on the ship exposed to sea water is based on the use of copper-nickel alloys, and controlled balancing of the difference in potential between different materials. Copper-nickel alloys are naturally resistant to bio-fouling, by forming a protective surface shield. The release of copper ions into water is almost negligible. The corrosion protection is made possible by recent break-through in the understanding of galvanic corrosion related to potential difference between different materials.

Due to the natural anti-fouling properties and the efficient corrosion prevention, Weka boxcoolers made of copper-nickel tubes show much lower life-time costs than traditional cooling systems for ship engines, such as plate heat exchanger inside the ship or boxcoolers made from galvanized steel or aluminium-brass tubes.

While conventional cooling systems for ships require extensive maintenance, the new boxcooler series are virtually maintenance-free. This reduces direct investment cost, but also reduces the time a ship has to spend in dock for maintenance.

Cees de Kwant, managing director of Weka Boxcoolers:

> - We know that boxcoolers have a much lower installation cost than plate heat exchangers. We now know that copper-nickel boxcoolers need much less maintenance than steel or aluminium-brass boxcoolers. This has a profound impact on the operating cost of a vessel over its life-time. Environmental issues are getting attention, and it is no longer seen as acceptable for environmental reasons to release free copper ions for protection of ships. Another environmental issue with materials such as aluminium-brass is that if the protection fails, e.g., when a copper anode falls off the ship, cleaning must be made using strong chemicals.

Weka (www.weka.biz) develops marine technology solutions. Weka is the leading global boxcooler company. Based on extensive development, Weka has taken on a leading environmental role.

The acceptance of boxcoolers is rapidly expanding. Reasons for this include low purchase and installation costs, and low maintenance costs. In total, low life-time costs. Environmental aspects support copper-nickel boxcoolers with adequate corrosion protection.

Two articles enclosed describe the background and development of the boxcooler and the environmental issues related to anti-fouling measures and corrosion protection of ships. Both articles are contributed without copy-right protection. Captions (pictures in .jpg-format) may be downloaded from www.weka.biz/press.php

RELEASE OF COPPER IONS - AN ENVIRONMENTAL ISSUE FOR ACTIVE SHIP PROTECTION SYSTEMS

Modern ships are complex constructions using a variety of materials. Combined, different materials may cause material corrosion. Bio-fouling causes ships to sail slower, cause water inlets to be clogged, and cause a range of further disadvantages. Anti-fouling paint actively releasing copper ions are prohibited for non-commercial ships in many countries. Environmental concerns are spreading. The prohibition of active paint releasing copper is just one example.

Environmental concerns have also been raised about the release of copper from other sources, such as active impressed current anti-fouling systems. The advantage with protection systems actively releasing copper is that cheaper materials may be used; e.g., coated boxcoolers for ship engine cooling. Without the active release of copper ions around the coated boxcooler, bio-fouling would shortly render the coated boxcooler in-efficient. The disadvantages are paid for by nature.

One ship equipped with an impressed current anti-fouling system may release 700 kg copper ions per year. This is based on information from one supplier of aluminium-brass coated boxcoolers (see Box Boxcooler for an explanation of the boxcooler concept). The actual use is probably higher due to non-perfect conditions, un-necessarily high impressed current, etc.

Ship components made of copper-nickel do not need active systems for their protection. Copper-nickel alloys form a protective shield against bio-fouling and emit very low amounts of poisonous copper ions. Weka, one supplier of boxcoolers made from copper-nickel tubes, has developed a protection system which manages to fully protect the ship and boxcooler from corrosion while at the same time eliminating the need for anode protection.

Caption 0 [cuni versus coated[: protection against bio-fouling is necessary, but copper-nickel alloys is naturally protected. The left part of the picture shows a traditional coated boxcooler, the right part with tubes of copper-nickel

Dutch company Weka, the leading boxcooler company, has completely abandoned aluminium-brass and active anti-fouling systems in their boxcoolers. Weka's choice of copper-nickel alloys for the tubes in the boxcooler is based on economical and environmental reasons, says Cees de Kwant, head of Weka Boxcoolers BV:

"Copper-Nickel is a perfect material for boxcoolers. It has good manufacturing properties and is naturally protective against the fouling by animal. Earlier difficulties to adequately protect CuNi boxcoolers from galvanic corrosion, especially during welding at construction, have been solved. We regard the minimal issue of copper ions as a very strong argument for CuNi tubes, and we see yards and ship-owners increasingly prepared to accept the slightly higher initial cost. During the ship's operative life-time, the higher cost for CuNi tubes is paid back many times by lower maintenance costs."

Contemporary arguments around long-term environmental issues offer two major options: the wait-and-see-take-action-when-proven view, and the view that the most dangerous case must be considered: what might happen if. The argument that the oceans are big, and some pollution is solved in a huge volume of water disregards both the local implications (what happens on the spot) and long-term implications (what happens when oceans, like many lakes already decades ago, are full with pollution.

Boxcooler

The boxcooler is an innovative way of cooling a ship's engine (and other heat generating equipment). The basic idea is that instead of taking cold sea water into the ship, as in traditional plate heat exchangers, the heat exchanger is placed in a sea-chest (the "box") in the ship. Sea water has free access to the sea-chest. The heat in the boxcooler is exchanged to the sea water as the sea water is passing the tubes of the heat exchanger.

Caption 1 [thermo syphon]: assembly of boxcoolers in sea chest

The advantages of the boxcooler are manifold:

- much cheaper installation. Total cost advantage is 40 to 60 percent compared to traditional heat exchangers placed in the ship
- less risk for clogging due to animals or dirt in the cooling water as in a plate heat exchanger where the sea water is taken into the heat exchanger – in the boxcooler, the heat exchanger is filled with fresh water from the engine
- less environmental implications due to lower risk for leakage of polluted water from the engine into the sea
- low maintenance costs. The boxcooler is virtually maintenance free

Caption 2 [complete boxcooler]: complete boxcooler before assembly into the ship

The boxcooler has been manufactured since about 1964. During the past forty years, more than one hundred thousand boxcoolers and gridcoolers have been put into use on ships all over the world.

Caption 3 [cees or Cdekwant]: Cees de Kwant, whose father invented the boxcooler, has considerably contributed to the development of the boxcooler industry

From original use only on Dutch inland waterways, boxcoolers are nowadays used on most types of ships, on barges, and on platforms. Earlier boxcoolers were produced by steel protected by galvanizing, or by coated aluminium-brass. Modern boxcoolers are produced by copper-nickel alloys. Considering the development of protection systems for copper-nickel in recent years, Weka recommends CuNi for all boxcooler applications. Weka is the market leader in boxcoolers, having produced alone more than 30,000 boxcoolers over the last 40 years.

Caption 4 [mast]: Mats Hjortberg is the application expert who has proposed most innovative applications of boxcoolers

Caption 5 [roxy]: boxcoolers can be efficiently used on large as well as on small ships, such as this trawler

Copper-Nickel alloys

Copper-Nickel alloys, one of the most frequently used alloys for demanding applications in sea water, partly due to its excellent natural anti-fouling capability, releases small amounts of copper until its natural level of antifouling has been built up. Thereafter the release necessary to maintain its anti-fouling properties is only 0.02 mm per year.

Caption 6 [bending]: bending of copper-nickel tubes

Copper-nickel alloys offer several advantages, such as on boxcoolers:

- lower cost to ship owner (no active protective anodes necessary, fewer dry-dockings)
- good performance in water, while resistant to fouling: no marine growth
- environmentally friendly (does not pollute, no chemical cleaning necessary)

Caption 7 [expansion]: expansion of tubes into the tube sheet

Influence of copper ions on nature and man

Copper has severe effects on nature. While copper is needed by man in small doses, the difference between beneficial and necessary levels, and dangerous levels, is thin for copper. Copper is a heavy metal whose unbound ions are toxic.

Most organisms are receptive for copper. Bladderwrack and algae are examples of especially receptive organisms. Experts seem to agree that more than1.3 mg copper per litre water is unhealthy for man. Amounts of copper as small as a gram can be lethal.

Caption 8 [coral alive]: CuNi tubes with passive protection through natural corrosion helps to prevent environmental damage

As the negative effects of copper increase dramatically with increased volumes of copper released, it is important to monitor the amount of copper released. This thinking is behind the ban on anti-fouling paint introduced in many countries. An example from Sweden shows that anti-fouling paint applied on leisure boats amount to 13 tonnes of copper per year. The corresponding amount for professional ships was 0.5 tons per annum.

Anti-fouling paint is an example of an active system: the paint is releasing copper during its life-time.

The patina formed on copper roofs is an example of a passive system: once the patina is formed, the release of copper is reduced to almost nothing.

Active protective systems, such as impressed current antifouling systems, release large amounts of copper (actually, copper ions, Cu2+).

Until the effects of copper on man and nature have been fully understood, an approach of caution is taken by many regulatory authorities. Taken into perspective, release of 13 tonnes for all leisure boats in a country was considered bad enough to justify a ban on anti-fouling paint releasing copper. Not more than about twenty ships equipped with active anti-fouling systems release as much as all leisure boats in this country, before being banned.

Reefs are sensitive to pollution, such as from actively generated Cu ions.

Caption 9 coral dead - same as caption 8, but in B/W or toned colour]: coated and active impressed current systems emit poisonous copper ions

A VIEW INTO THE FUTURE: THE EVOLUTION OF BOXCOOLERS - FROM UNPROTECTED STEEL TO PROTECTED COPPER-NICKEL BOXCOOLERS

Boxcoolers were originally fabricated from carbon steel but bare steel corrodes in seawater even if the hull of the ship is fitted with cathodic protection. The internals of a boxcooler are difficult to protect even when sacrificial anodes are fitted inside; this is because of the complex shape and the limited space available.

To prevent the corrosion of steel boxcoolers, various paint coatings have been tried, but these have limited life. Anti-corrosion paints have a life to first maintenance of a few short years and blast-cleaning and re-painting is very difficult to achieve in these confined spaces. Also, paints do not prevent biofouling by various forms of marine life such as barnacles, mussels and algae. Biofouling reduces water flow and heat transfer, rendering a boxcooler, whether bare or coated, ineffective within as little as a few weeks.

What is obviously required is a material of construction with good corrosion resistance and inherent anti-fouling properties. Some copper alloys have these properties and several are widely used for many seawater handling applications on ships, offshore platforms, coastal power stations etc. The corrosion rate of the more resistant copper alloys in clean seawater falls to around 0.01-0.02mm/year[1] when their protective oxide film has developed. Experience with copper-nickel cladding of offshore platforms[2] has shown that when coupled to steel the alloy still exhibits anti-fouling behaviour, presumably because some corrosion still takes place.

Aluminium brass is a useful seawater material but it has limitations, for example it is susceptible to stress corrosion cracking when ammonia pollution is present[3], as it is in many coastal and estuarine waters. In order to prevent galvanic corrosion between the aluminium brass cooler and nearby steel, these boxcoolers are usually coated. However, coating the aluminium brass causes fouling to occur on top of the coating. To prevent this, active copper ions and/or chlorine generating systems are used. Copper ions are toxic to most forms of marine life, with the exception of certain algae. Hence there is an unwanted side effect to the use of copper ion antifouling technology. Following the banning of other toxic elements such as mercury (from sacrificial anodes) and organotin compounds (in antifouling coatings), concern has been expressed over the damaging effects of copper on marine life. In 2003 the Danish government moved to reduce total copper ion discharge into seawater by banning[4] the use of antifouling paints that release more than a certain quantity of copper. Copper-containing antifouling paints have been banned for use on pleasure craft by the Netherlands Pesticide Authorisation Board[5] since March 1999. Other governments such as Norway's advise[6] against the use of copper antifouling coatings. Sweden is another example. It is possible that they may be banned altogether in future international legislation[7].

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[1] 'Guidelines for the use of copper alloys in seawater', A. H. Tuthill, Materials Performance September 1987.

[2] 'Applications for and advantages of 90/10 copper nickel on offshore platforms', G. Wildsmith, NITO/NiDI International Conference May 1987.

[3] 'Effects of pollution on corrosion of copper alloys in seawater', R. Francis, British Corrosion Journal, (4), 1985.

[4] Statutory Order 792, Danish Environmental Protection Agency.

[5] http://www2.vrom.nl/pagina.html?id=4882

[6] http://www.sft.no/publikasjoner/kjemikalier/1898/ta1898_07.html

[7] http://www.csa.com/hottopics/biofoul/biblio36.html

90/10 copper-nickel is superior to aluminium brass in many respects, including in resistance to erosion corrosion (which occurs at areas of turbulent flow) with and without sulphide pollutants present in the seawater3.

The natural resistance to fouling of aluminium brass, copper-nickel and other copper alloys is of great benefit, but this can only be realised if the alloy is bare and allowed to corrode. Galvanic corrosion between steel and copper alloys is a problem because of the large potential difference that exists between these alloys and steel; this is up to 0.3V for some copper alloys[8]. Stray current corrosion is another problem that commonly occurs in seawater systems. These forms of corrosion can be prevented by coating the copper alloy, but this is not a logical solution to the problem since the benefits of the copper alloy are lost; its inherent corrosion resistance is not used and biofouling occurs on top of the coating.

It is clear that the way forward is to use 90/10 copper-nickel alloy (UNS C70600) and to ensure that it is allowed to corrode (so as to prevent fouling) but that stray current corrosion is prevented. This has now been achieved with Weka's new Protector Type S. This system has been designed to prevent the stray currents that often flow when welding is carried out on the vessel and the galvanic currents that flow between the boxcooler and the hull during operation of the ship. Thus corrosion problems posed by stray currents and galvanic differences between different materials of construction are prevented.

Equally importantly the system permits the copper-nickel to corrode slightly when in service. This gives the user the benefits of its natural anti-fouling properties without releasing toxic levels of copper ions into the sea. The rate of this corrosion and hence the rate of copper ion production is low, therefore no local toxicity risk is created for other marine life. Copper-nickel hulled vessels such as the yacht Asperida have been operating trouble-free since 1968[9]. However, even copper alloys are not completely immune to biofouling, and some buildup of micro- and macro- fouling must always be expected. Fortunately, the fouling that develops on these alloys is readily removed.

Mick Schofield
Corrosion Engineer

[8] NACE Corrosion Engineer's Reference Book, 3rd edition, 2002.

[9] 'Copper nickel alloys for seawater corrosion resistance and anti-fouling – a state of the art review', C. A. Powell, Corrosion/2000, NACE.