IMPROVING EFFICIENCY IN OPERATIONAL COSTS OF POWER PLANTS THROUGH THE USE OF HIGH-PERFORMANCE COATING TECHNOLOGY

GREATER COST OPTIMISATION. GREATER RELIABILITY. GREATER PRODUCTIVITY.

Authors: Dr. Felicia Kreiselmaier and Theresa Moloney
plastocor- international SA, CH-Sierre

Summary

The optimisation of budgets is fundamental in reducing operational and maintenance costs in power plants. At plastocor-international SA, we offer smart, simple and sustainable solutions to allow plant operators maximise the performance of cooling water cycle equipment. As experts in corrosion and erosion protection and repair for condensers and heat exchangers, we know the importance of planning and equipment availability so as to guarantee avoided loss of revenue due to unplanned downtimes and loss of production. This, we have seen, results in enormous operational costs for the power generation industry annually. plastocor® one-stop turnkey solutions provide a smart and simple technology to enhance protection and efficiency along the entire cooling water cycle – resulting in increased and secured energy output and reduced operational costs due to loss of equipment life, and thus in improved revenues.

Throughout the following pages we will illustrate how state-of-the-art plastocor® Technology leads to improved performance in condensers, heat exchangers, water boxes, flanges and all circulating water pipelines. Our High-Performance Coating Systems provide optimal life-extension of cooling water equipment and an excellent, sustainable return on investment (ROI). World leaders in providing solutions to common problems of erosion and corrosion found in the cooling water cycle, plastocor® Systems are an attractive alternative to otherwise major economic outlays such as retubing or the replacement of equipment.

1. One-stop turnkey solutions provide maximum optimisation and protection from Day One

For more than 60 years, plastocor-international SA has been a world leader in supplying state-of the-art solutions for the protection and repair of corrosion and erosion damage found in the condenser and along the entire cooling water cycle. We understand that erosion and corrosion (especially galvanic corrosion and dealloying), fouling, leakages, tube-to-tube-sheet joint cracks, hydrogen embrittlement, hairline cracks and step-erosion are just some of the problems that can lead to less efficiency of the condenser and consequently the entire power plant. Not to forget, higher operational costs and reduced lifespan of units, as well as, reduced reliability in power output.

Applying plastocor® Technology for condensers and heat exchangers, i.e. Cladding, Inlet, Full-Length Tube Lining and High-Performance Coating Systems, minimises the costs of loss of equipment life by guaranteeing a life-extension of up to 25 years (even 40 years in some proven cases), and thus considerably improves condenser and heat exchanger performance.

2. plastocor® Technology – holistic approach to condenser protection and upgrading

Retubing, which involves replacing corroded and eroded tubes with new ones, is traditionally used to reduce and eliminate unforeseen shutdowns, due to worn tubes and leakages in and between the tubes and tube-sheet-joint. This results in major costs and lengthy downtimes.

Heat exchanger and condenser fouling is another major economic problem, with extremely high maintenance costs resulting from chemical cleaning, for example. plastocor® Technology has been engineered so as to deal with these problems in their specificity and to endure the extreme conditions that the individual parts of the condenser are exposed to. It consists of two different component, 100% solids, non-VOC, solvent free, epoxy coating systems and is designed to cure at ambient room temperature, within hours. As a result, the systems are suitable for application in confined spaces and in areas where other work is taking place, without major modifications to work schedules or jeopardising worker safety.

2.1 plastocor® Cladding System for tube sheets

The original two component epoxy plastocor® Cladding System, applicable at a thickness of 3-5 mm or more, is a thick film coating system used for long-term protection of new tube sheets or the complete renewal of old ones. It offers protection against galvanic corrosion, dealloying, fouling, tube-to-tube-sheet joint leakage and erosion for both the tube sheets and tube inlets. In addition, because of its unique conic design at the inlet of the tubes, it reduces the cavitation at the inlet as well as further down the tube until laminar flow is achieved. As a result, it is not only suitable for the protection of new tube sheets, but also for rebuilding corroded and eroded tube sheets to a like-new condition, at a fraction of the cost and time of a new condenser tube sheet.

plastocor® Cladding is compatible with almost all metal types of tube sheets. It replaces cathodic protection systems as corrosion protection, where the water boxes have also been coated. The durability of the cladded tube sheet is comparable to at least the life expectancy of the tubes themselves and its resistance is comparable to titanium cladding solutions. This plastocor® system has even been used to repair titanium tube sheets, where problems can occur because of the over rolling of tubes, weld imperfections between the tubes to the tube sheet and hydrogen embrittlement as a direct result of cathodic protection systems.

Example 1: plastocor® Cladding System after 25 Years of Operation

Fig.1a: Before cleaning

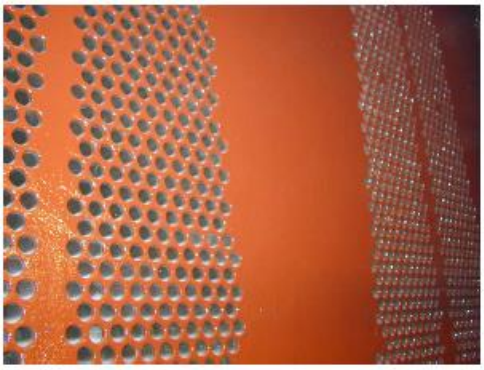

Fig.1b: After cleaning

2.2 plastocor® Inlet System for tube inlet and outlet

The original epoxy plastocor® Inlet System is applicable to both tube inlets and outlets. It is used to repair old and protect new condenser and heat exchanger tubes from inlet and outlet end erosion and corrosion. The application of a special feathered coating eliminates the risk of step-erosion, which is a common problem with the use of plastic or metal inserts. A specially engineered method of applying a multi-layered thin film of abrasion resistant epoxy coating system to small calibre tubes, at a depth of up to 1 metre and more, is installed. This further contributes to optimising budget and operational planning for the plant operator as the different layers allow them to monitor erosion/corrosion of the tube inlets and outlets before problems are encountered.

By ensuring a leak tight sealing of the tube-to-tube-sheet joint and preventing erosion of the tube inlets and outlets, the plastocor® Inlet System in conjunction with the corresponding plastocor® Cladding System offers a viable alternative to costly retubing. Used in combination, the systems offer an optimal life-extension of over 20 years at a fraction of the costs involved in retubing.

Example 2: plastocor® Inlet System on Titanium Tubes

Fig.2a After plastocor® Inlet

Fig.2b After plastocor® grit blasting

CASE STUDIES – Efficiency increase and economic benefits thanks to plastocor® Inlet System

- EDF CRUAS Nuclear Power Station (France) was experiencing severe damage due to leaking tubes and cooling water intake in the vacuum. By applying plastocor® Inlet System, the reduction of 57 detected leakages resulted in an additional operational profit of €1.18m in 13 months.
- In EDF ST ALBAN Nuclear Power Plant (France) a sustainable return on investment was achieved thanks to plastocor® Inlet System. The reduction of leakages by 60% during their regular scheduled 10-year maintenance outage led to approx. €6m in savings due to avoided loss of power production at an initial investment of not even 10%.

2.3 plastocor® Tube Lining System for internal full-length tube protection

The original and patented plastocor® Tube Lining System supplies a unique form of recuperating already lost tubes and preventing costly retubing of condensers. Small calibre tubes (3-4 mm) and up to 20 meters in length can be lined with a thin film epoxy coating of no more than 50-60 microns.

Despite the thinness of the coating, tube lining condenser tubes can recuperate damaged tubes and extend their lifespan by over 10 years. It is engineered to endure extreme conditions of erosion, corrosion and fouling in different cooling water environments (sea water, brackish water and sweet water). In addition, it helps prevent fouling, thus increasing the flow rate as well as eliminating the need for chemical cleaning.

Assuming that a condenser may suffer from 10-15% reduced performance due to plugged tubes, a reasonable kW value on the heat transfer rate, illustrates that plastocor® Tube Lining though impacting the general heat transfer rate of the condenser, still increases the general performance of the condenser by enabling a recuperation of 75% of 15% of damaged tubes. Furthermore, a specially

engineered and patented turbo grit blasting nozzle ensures that even tubes with more than 60% loss of wall thickness may be blasted to the required surface roughness and then tube lined. The lining of 40,000 12m tubes can be executed within a normal outage of 45 days generating near to new tubes at roughly 30-40% of the costs of retubing. Endoscopic analysis or Eddy Current Testing may then be carried out to ensure that all pit holes and leakages have been solved.

Example 3: plastocor® Tube Lining System

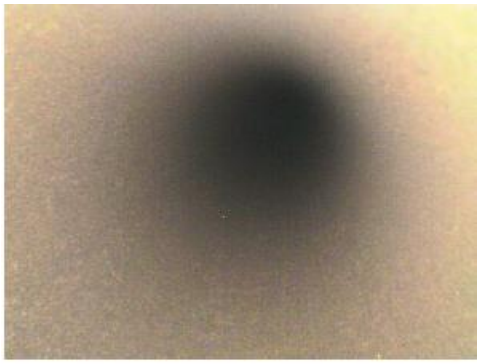

Fig.3a: After grit blasting

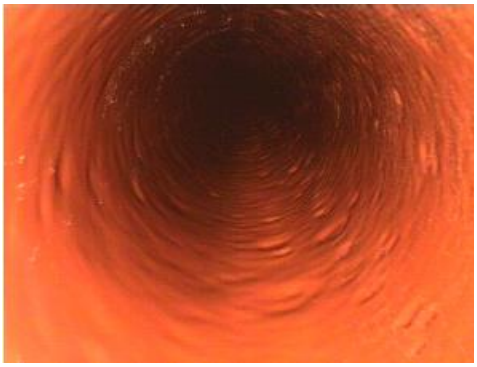

Fig.3b: After plastocor® Tube Lining

CASE STUDY: CEA PHENIX Nuclear Power Plant - economic and ecological benefits

- At the CEA PHENIX Nuclear Power Plant (France) on the banks of the Rhone River, by applying plastocor® Tube Lining the plant was able to avoid two unplanned shutdowns related to corrosion induced tube ruptures in a period of 18 months. Each shutdown implied five days at approx. €170,000 per day, resulting in an average gain of €5.6m per 18 months in avoided shutdowns.

  Furthermore, tests conducted by the plant operator showed that plastocor® Tube Lining of the full length of the tubes reduced heavy metal discharge via the cooling water into the Rhone River. In accordance with ISO 14000 and ISO 14001, the yearly heavy metal discharge was eliminated for copper by 8.2 tons, for zinc by 3.8 tons and arsenic by 7 kg, thus having a direct impact on drastically improving the water quality of the Rhone River.

2.4 plastocor® High-Performance Coating Systems for water boxes and other cooling water equipment

As the final system of plastocor® Technology illustrates, adding plastocor® High-Performance Coating System to the water box fully eliminates the occurrence of galvanic corrosion to the tube sheet and ensures condenser protection from start to finish. A special addition to the system ensures that the flange area is also accordingly protected by a flexible caulk joint. Applied in combination, our high-

performance coatings serve as an alternative to rubber lining or ebonite protection of water boxes and can also be used to repair rubber lined water boxes to a near to new state without having to remove the latter.

Example 4: Water boxes coated with a flexible caulk joint on the tube sheet side

Fig.4a: Flexible Caulk Joint

Fig.4b: Water Box interior

3. Enhanced efficiency for optimal condenser and heat exchanger performance

A team of highly trained and local plastocor® Approved Applicators are available at short notice, allowing our solutions to be applied anywhere around the world, within days. Our one-stop turnkey solutions involve initial analysis and diagnosis of a given problem, on-site inspection and evaluation, surface preparation, system application and maintenance, supply of highly skilled workmanship, plus aftersales services. This bespoke approach allows us to quickly understand a client's need and provide a made-to-measure solution.

Easy to apply in a few coats to almost any thickness required, we recommend applying these coating systems from Day One of operations to guarantee the maximum lifetime extension of cooling water equipment and long-term, maintenance-free protection from corrosion and erosion. This preventative approach dramatically increases the lifespan of units and improves equipment availability and reliability.

The solutions described here protect the entire cooling water cycle and are suitable for use across the entire power generation industry. Furthermore, these systems can be applied to a variety of substrates, including carbon steel structures, cast iron and concrete. plastocor® Systems are designed so as to endure extreme conditions and can be applied in all climatic conditions.

Key to solving the multiple challenges in condensers and heat exchangers is the selection and use of 100% solids, zero VOC, non-flammable, solvent-free polymeric epoxy-based materials. The products are less toxic to the environment than, and significantly outperform, conventional solvent-based and polyurethane coatings. plastocor® Systems are not only smart and simple, they are also sustainable as they help eliminate heavy metal discharges to the cooling water, such as copper, zinc, arsenic, as well as, chemical cleaning, in compliance with strict environmental standards.

Conclusion – optimising cooling water equipment performance for enhanced cost optimisation

As we have seen, by applying plastocor® Technology the efficiency of the entire power plant is enhanced, thereby directly and positively impacting on operational costs. Long-term, maintenance-free protection, repair and upgrading of corroded units, significant lifetime extension of equipment all lead to increased productivity and greater savings. plastocor® one-stop turnkey solutions provide plant operators with essential tools for maximising reliability and power output, while at the same time, reducing operational costs. All of this is carried out at a fraction of the cost of other costly alternatives, while also ensuring strict compliance with environmental protection standards, offering both economic and ecological benefits.