YOKOGAWA'S ECP MONITORING SYSTEM

Yokogawa ECP electrodes are designed to respond to the non-reversible corrosion activity or potential (Ecorr) that is taking place on the metal surface of generator's tubing, thereby providing a valuable measurement tool for minimizing downtime and costly generator maintenance.

The ECP Monitoring System can be thought of as a real time *corrosion coupon* for the specific metal in question. You can monitor and protect your equipment before corrosion problems occur.

A Yokogawa Commitment to Industry

vigilance®

quality innovation foresight

What does **vigilance®** mean to Yokogawa? For starters, always, always making sure the products and solutions that leave our research and development labs are the best the world has seen - from day one throughout your business life cycle. Our innovative technologies and committed experts help design, install and manage your production systems efficiently and dynamically. In an ever-changing business environment, we help plan for the future to ensure continuity and flexibility in your automation strategies. Yokogawa goes the extra mile to do things right. Let us be vigilant about your business.

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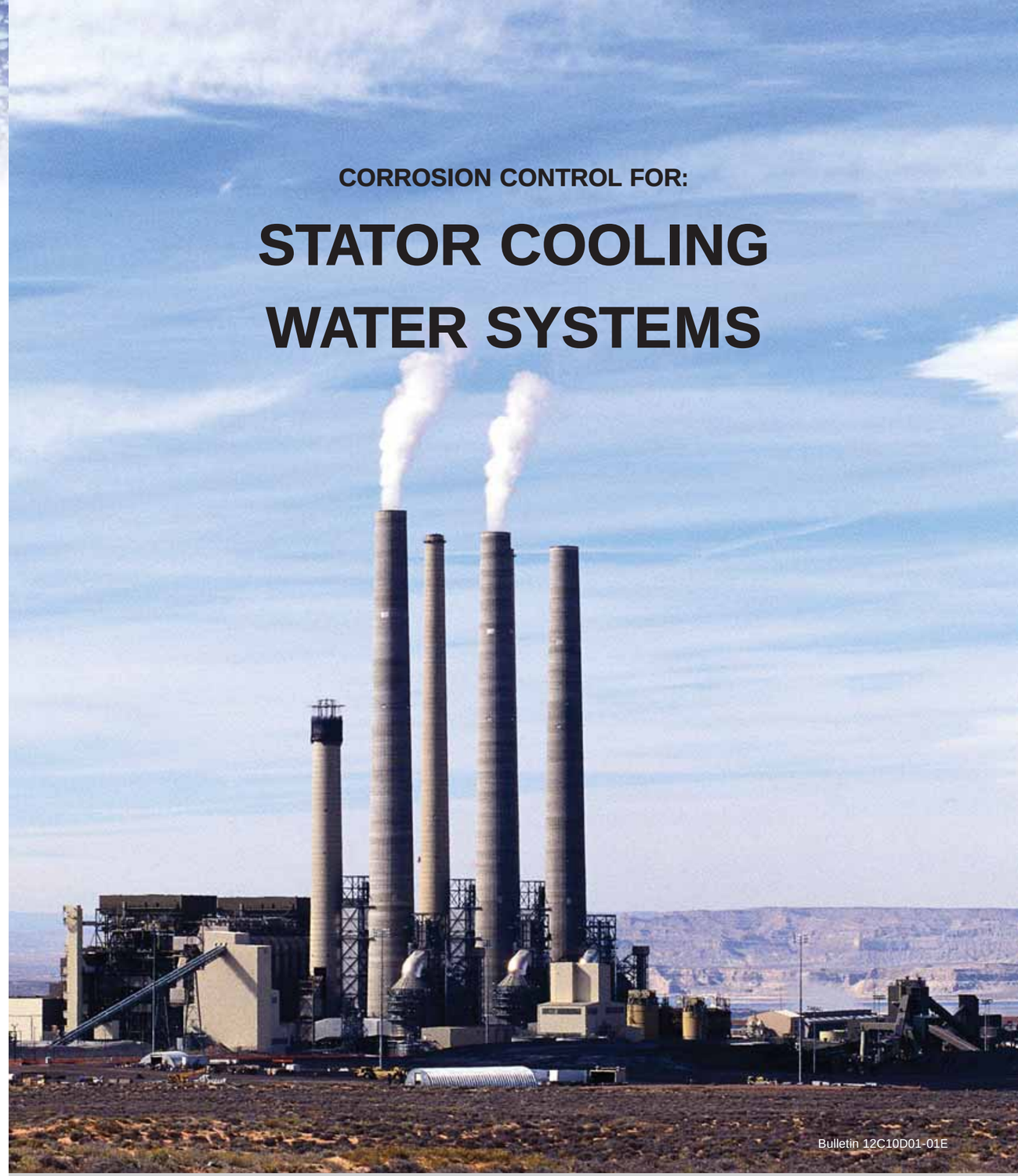
Represented by:

YOKOGAWA

CORROSION CONTROL FOR:

STATOR COOLING WATER SYSTEMS



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Corrosion Control:

STATOR COOLING WATER

Corrosion in the stator cooling system of power generators is a primary source of maintenance costs and plant downtime.

Effective heat dissipation of power generator stator windings is a key component to maintaining generator power output and winding performance. Therefore, maintaining the operational reliability of the stator cooling system is very important.

The power generator stator cooling system is a group of small diameter copper tubes (strands) that carries water around the generator stator windings. Corrosion in the system is exhibited as copper oxide flakes in the strands which reduces water flow and inhibits the cooling efficiency of the system. This can lead to derating the generator and eventually may necessitate cleaning or replacing the strands. Plugged strands often lead to winding “hot spots” which can ultimately cause generator failure.

All corrosion is electrochemical in nature, and therefore can be monitored by applying appropriate electrochemical measuring techniques. Traditional methods of cooling water quality control measure the dissolved oxygen concentration. Systems use either aerated water maintained at a dissolved oxygen (DO) level greater than 2 ppm or with deaerated water with a DO level held to less than 50 ppb.

In either instance a thin layer of copper oxide forms on the tubing creating a protective (passivated) barrier against damaging corrosion. At the higher DO level cupric oxide forms (CuO) while cuprous oxide (Cu_2O) forms at the lower DO levels.

If the process can be maintained at either of these DO levels the integrity of the copper in the system can be satisfactorily maintained. The process of copper flaking called spalling occurs when copper oxides on the strand walls change from cuprous oxide (Cu_2O) to cupric oxide (CuO), or the reverse, from to cupric oxide (CuO) to cuprous oxide (Cu_2O). It is the transition between copper oxide states that causes the problem. Stresses incurred during the transition cause the copper oxide to flake off.

This corrosion activity resulting from changes in the cooling water chemistry has a measurable electrochemical corrosion potential (ECP). Measuring this ECP potential provides real time monitoring of the oxidation state of the stator cooling water relative to the specific copper alloy used in the cooling strands. This measurement allows the operators to adjust the corrosion characteristics of the cooling water more accurately than by using dissolved oxygen monitors alone.

Monitoring dissolved oxygen levels alone does not provide an indication of the copper oxide state. Therefore, large swings in the corrosion potential of the copper tube can occur while the measured DO level maintains the appearance of a balanced system. Recent EPRI studies confirm that significantly higher rates of copper loss in the stator cooler occur at the intermediate dissolved oxygen concentrations of 100-1000 ppb. In addition, strainer clogging and strand plugging significantly increase during transitions from high to low or from low to high dissolved oxygen concentrations.

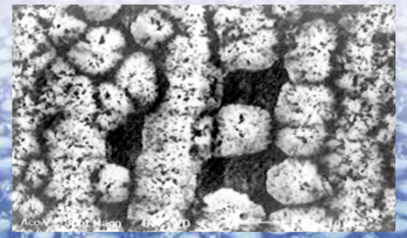
Intermediate levels of DO. Both cupric oxide CuO and cuprous oxide Cu_2O are present initiating corrosion activity.

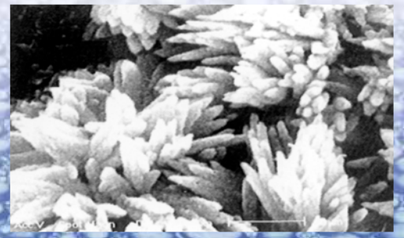
Low levels of DO. cuprous oxide Cu_2O.

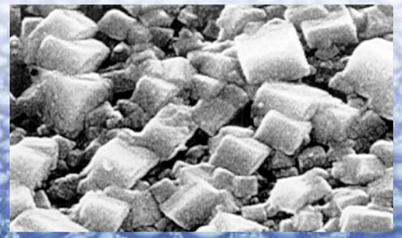
Cu_2O

High levels of DO. cupric oxide CuO.

CuO







Photos: EPRI