

COOLING TECHNOLOGY INSTITUTE

Guidelines for Evaluation of Cooling System Corrosion Control



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This guideline document summarizes the best current state of knowledge regarding the specific subject. This document represents a consensus of those individual members who have reviewed this document, its scope and provisions. It is intended to aid all users or potential users of cooling towers.



This document has been reviewed and approved as part of CTI's Five Year Review Cycle. This document is again subject to review in 2024.

Approved by the
CTI Executive Board

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Guidelines for Evaluation of Cooling System Corrosion Control

A. Scope

Monitoring corrosion is an essential part of any cooling system evaluation program. The gathering and interpretation of the various data can be compiled to determine the effectiveness of the corrosion control program. There are numerous methods that can be used to measure the effectiveness of a treatment program in cooling systems. This document will discuss some of the methods associated with practical control of corrosion in cooling systems.

B. Introduction

Monitoring can and should include simple inspections of any exposed and observable components, such as cooling tower supports and any opened equipment or piping that might be viewed during routine or non-routine unit shut-downs. Inspection monitoring mostly provides qualitative data, and does not yield quantitative data, such as might be more effective for trending analyses.

There are two other, common, and very useful quantitative methods used to monitor and rate corrosion. These include the use of a method where weight loss of coupon-type corrosion test specimens (corrosion coupons) are determined. An average corrosion rate is then calculated by dividing that weight loss over the exposed test time period; corrosion rate is commonly expressed as mils per year (mpy) or milligrams per square decimeter per day (mdd). Another method uses specific instruments to determine an electrical measurement of “instantaneous” corrosion rate. Instruments using linear polarization can measure the corrosion rate existing at the time of the test and are available as a portable unit or as a permanent installation with continuous measurement and recording. The use of instantaneous monitoring units is ideal for troubleshooting since the immediate effects of pH excursions, plant upsets, and a lack of a particular corrosion inhibitor, etc. can be shown.

There are many other sophisticated techniques that are used to monitor corrosion, typically under laboratory settings. As such, these will not be discussed here, as this document is limited to methods typically used in the field for evaluation of a cooling water treatment program on industrial or commercial cooling water systems.

C. Corrosion Monitoring

I. Visual Inspection

A visual inspection of exposed components of the cooling tower or other, open recirculating unit can start to indicate any corrosion that has occurred in the cooling system. A visual inspection of such equipment, however, is not a precise method. Corrosion products and/or microbiological accumulations may possibly be present, which can occlude the examination for corroded components. Under-deposit attack and crevice corrosion can occur in hard-to-see spots. One

should be mindful of the various metallurgies that can be affected. Carbon steel is quite common, but galvanized steel, stainless steel, copper alloy, and other, less frequently encountered metals might be used in cooling system equipment. Austenitic stainless steels might exhibit chloride stress corrosion cracking. Any joining of dissimilar metals can yield a galvanic corrosion mechanism, with the less noble metal becoming susceptible to metal loss and failure. Areas of the components that are intermittently wet and dried can exhibit patterns of deposition, metal loss, and cracking, so special note should be taken of such areas during the visual examination.

The installation and subsequent inspection of a test spool piece can be utilized to monitor corrosion in a cooling water system. Such a metal section can be plumbed as a side-stream section so that cooling water system conditions are replicated. Although a useful tool in visual examination, drawbacks to this method include design and installation time and costs, as well as the longer period required to allow for the effects of the cooling water on the spool piece and the time of extraction and inspection.

A visual inspection of the waterside surfaces of system piping and process heat exchangers is often possible during scheduled plant outages (turn-arounds) and/or during non-routine system outages (shut-downs). At such times, direct examination of actual plant equipment can provide information invaluable in the assessment of a cooling water treatment program on the plant infrastructure and process equipment. During a visual examination of plant equipment, photographs can be taken to record the condition of the metal surfaces. Waterside deposit and microbiological samples can be obtained for useful analyses. Specific measurements related to metal loss, such as from pitting, can be made and recorded for trending purposes. More sophisticated techniques employed during outages, such as with boroscope inspection, eddy current analyses, or use of other equipment, etc., can also greatly enhance the corrosion monitoring and trending data. A detailed discussion of the specific benefits and drawbacks of the various equipment techniques, however, is beyond the scope of this document.

II. Interpretation of Analytical Results

The proper treatment and service of a cooling water system often includes periodic sampling and analyses of water streams and/or any waterside deposition. Skilled interpretation of the results can be an effective form of monitoring the control, or lack of control, of corrosion in a cooling water system. For example, if a cooling system water analysis exhibits relatively high levels of metals, which are also found in the system equipment metallurgies, it might be inferred that those metals in the water have resulted from corrosion of the representative metal alloy equipment (high iron in cooling water might indicate a high steel corrosion rate; high copper in the water might indicate a high brass corrosion rate). Analyses