Understanding and Using Corrosion Coupons

Introduction

A common method of determining corrosion rates is by using corrosion coupons, which are uniform-sized, pre-weighed strips of metal. Corrosion coupons, representative of system metals, are inserted into a coupon rack installed on the system to be checked. Normally, system water is allowed to circulate over the corrosion coupons for about 30 - 90 days. The coupons are then removed and returned to a lab where they are cleaned and re-weighed. From this weight loss and the dimensions of the coupon, a corrosion rate in mils/year (mpy) is determined. 1.0 mil/year translates into 1/1000th of an inch of metal loss per year. To convert corrosion rates expressed in millimeter/year (mm/y), a common metric measurement, to mpy, multiply mm/y times 39.4.

Interpretation of Results

Whether a corrosion rate is good or bad is relative to the water used and operating conditions. No absolute interpretation is practical. However, Table One gives guidelines that have been published for assessing corrosion in cooling tower systems using fresh water make up. Keep in mind these rates and comments assume general system corrosion. Pitting corrosion can cause rapid metal failure even if the overall corrosion rate is low.

Metal	Corrosion Rate (mpy)	Comment
Mild Steel	< 1.0 1.0 - 3.0 3.0 - 5.0 5.0 - 10.0	Considered excellent corrosion rate. Generally acceptable corrosion rate. Fair corrosion rate. Acceptable with good iron fouling control. Unacceptable corrosion rate. Corrosion products may cause severe iron fouling.
Copper & Copper Alloys	< 0.2 0.2 - 0.5 0.5 - 1.0 1.0 - 1.5	Excellent for heat exchanger tubing and mild steel equipment. Generally acceptable corrosion rate. High corrosion rate. Corrosion products may aggravate mild steel corrosion. Unacceptable long term corrosion rate. Corrosion products will aggravate mild steel corrosion.

Table One - Guidelines for Evaluating Corrosion Rates

The following describes different forms of attack that can be observed on coupons.

Generalized Attack - Uniform corrosion over entire surface of coupon. Not usually a concern unless the mpy is high.

Pitting Attack - A general term given to any depression on the metal surface caused by corrosion. Pits can vary considerably in size and depth as well as density. Less than 10 pits per side is sometimes termed isolated pitting. Low inhibitor levels, high chlorides, pH excursions, under-deposit attack, or copper plating can all cause pitting.

Localized Areas of Attack - Usually the result of under-deposit corrosion. May indicate the need for better deposit control and/or low flow rates through the coupon rack. If the depression shows concentric rings with the deepest penetration in the center, it may be due to corrosive bacteria attack, such as can be caused by microbiologically induced corrosion (MIC).

Copper Plating - Results from the deposition of soluble copper on mild steel or other non-copper alloys. Copper plating can cause severe galvanic corrosion and metal failure due to pitting attack.

Edge Attack - Since the edges of coupons are highly stressed during fabrication, they tend to be preferential sites for corrosion. Edge attack does not generally indicate a major problem unless severe.

Attack Under the Coupon Holder - If metal loss is localized to the area under the coupon holder, this may merely represent the influence of the coupon holder to stimulate under-deposit or crevice attack and not reflect the characteristics of the recirculating water. Although these effects cannot be eliminated from corrosion rate calculations, they should be noted when interpreting the results. Insuring the coupon holder and bolts are fastened tightly helps minimize these effects.
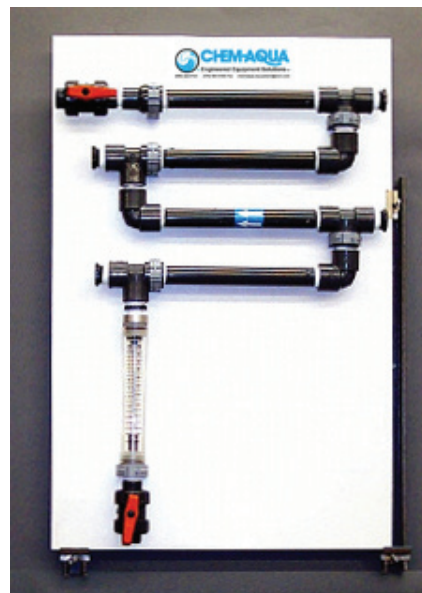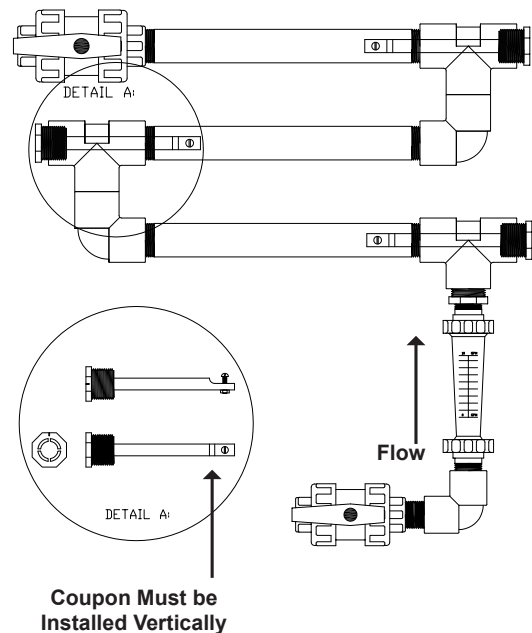
Installation Notes

1. The coupons have been cleaned and accurately weighed prior to shipping. They should not be handled any more than necessary when installed. Avoid fingerprints, oil, or grease contact. Use a paper towel or similar covering while handling the coupon prior to installation. The coupon should be attached to the Teflon®* rod with a nylon screw and nut. Metallic bolts and nuts will increase the probability of galvanic or contact corrosion at the secured end of the coupon.

2. Be sure the numbered corrosion coupons are recorded according to position and system for proper correlation. The dates of installation and removal from the system are critical.

3. Table Two gives the preferred order of installation for common metals.

4. To ensure that a representative sample of the bulk system water is directed over the coupons, the coupon rack should be installed on a line that is completely separate from any chemical injection points. Also, the flow rate that is preferred for coupon testing may not be ideal for the chemical injection line.

Position From Direction of Flow	Coupon Metallurgy
1	Aluminum & its Alloys
2	Galvanized
3	Mild Steel
4	Brass
5	Copper
6	Copper/Nickel Alloys
7	Stainless Steel

Table Two - Preferred Order of Coupon Installation

5. The flow should be adjusted so that there is no turbulence or air mixture. To avoid erosion of copper, a flow rate of three to five feet per second is desired. This translates into about eight to 14 gallons per minute in a one inch pipe. A flow meter or some other type of flow control device is recommended. Keep in mind that high flow rates can contribute to erosion while low flow rates (less than two feet per second) can accelerate corrosion and biological fouling.

6. Test periods are generally 90 days. Coupons may be observed at 30 days intervals for reference and signs of corrosive conditions. In observing the coupons, do not disturb the surface by scraping or removing material.

7. Typically coupons show some rapid corrosion indications initially, usually in the form of corrosion products forming on the surface, particularly at points where numbered stamps are made, edges of coupons, and around bolt heads. The rapid corrosion tapers off with time. This is more prevalent with steel than copper. Unless corrosion is significant, there should be no cause for alarm.

8. When the coupon is removed for lab evaluation, physical handling of it should be kept to a minimum. Unless microbial induced corrosion is suspected, removal of corrosion products should be minimized and the coupon thoroughly dried before returning to the lab for analysis in the paper envelope in which it was originally sent.

9. If microbial induced corrosion is suspected, the corrosion products should be scraped off with a dry plastic utensil into a bio-sample bottle containing system water. The coupon can then be dried and returned to the lab for analysis along with the bio-sample bottle.

Board Mounted Coupon Rack with Flow Meter

DETAIL A

DETAIL A

Flow

Coupon Must be Installed Vertically

Typical Corrosion Coupon Rack with Flow Meter

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