UNDERSTANDING & 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 1 gives guidelines that have been published for assessing corrosion in cooling tower systems using fresh water make up. Keep in mind that these rates and comments assume general system corrosion. Pitting can cause rapid metal failure even if the overall corrosion rate is low.

The appearance of the cleaned coupons can provide important information. 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 and the remainder of the coupon surface is not attacked, 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.

Metal	Corrosion Rate (mpy)	Comment
Mild Steel	< 1.0	Considered excellent corrosion rate.
	1.0 - 3.0	Generally acceptable corrosion rate.
	3.0 - 5.0	Fair corrosion rate. Acceptable with good iron fouling control.
	5.0 - 10.0	Unacceptable corrosion rate. Corrosion products may cause severe iron fouling.
Copper &	< 0.1	Generally safe for heat exchanger tubing & mild steel equipment.
Copper Alloys	0.1 – 0.5	High corrosion rate. Corrosion products may aggravate mild steel corrosion.
	> 0.5	Unacceptable long term corrosion rate. Corrosion products will aggravate mild steel corrosion.

Table 1 – Guidelines for Evaluating Corrosion Rates

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 2 gives the preferred order of installation for common metals:

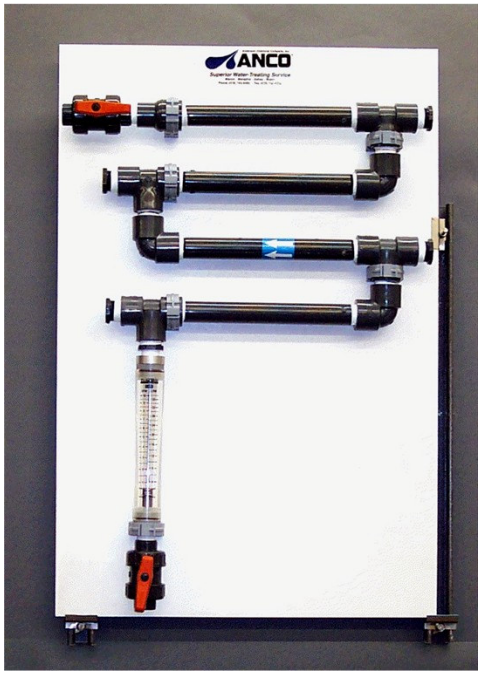
Position From Direction of Flow	Coupon Metallurgy
1	Aluminum & its Alloys
2	Galvanized
3	Mild Steel
4	Brass
5	Copper
6	Copper/Nickel Alloys
7	Stainless Steel

Table 2 – Preferred Order of Coupon Installation

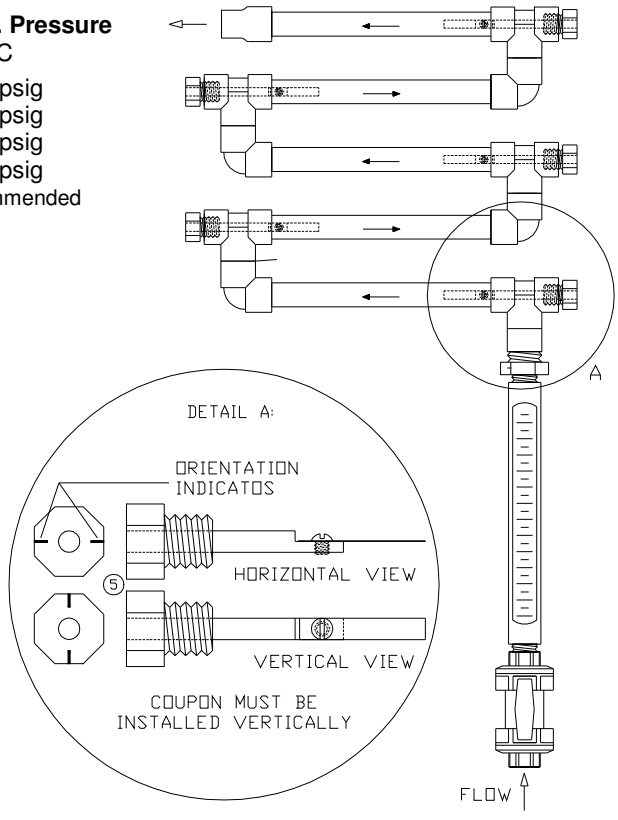
4. To ensure that a representative sample of the bulk system water is directed over the coupons, the coupon rack should be installed on a line that is completely separate from any chemical injection points. Also, the flow rate that is preferred for coupon testing may not be ideal for the chemical injection line.
5. The flow should be adjusted so that there is no turbulence or air mixture. To avoid erosion of copper, a flow rate of 3 - 5 feet per second is desired. This translates into about 8 to 14 gpm in a 1" 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 (< 2 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 gross, there should be no cause for alarm.
8. When the coupon is removed for lab evaluation, physical handling of the coupon 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 it was originally sent in.
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.

Max. Temperature vs Max. Pressure
1" Schedule 80 PVC

80 °F	280 psig
100 °F	198 psig
120 °F	128 psig
140 °F	70 psig
140 °F	Not Recommended



ANCO Board Mounted Corrosion Coupon Rack with Flow Meter



Typical Corrosion Coupon Rack with Flow Meter