Copper Corrosion Protection

PACE TECHNOLOGIES

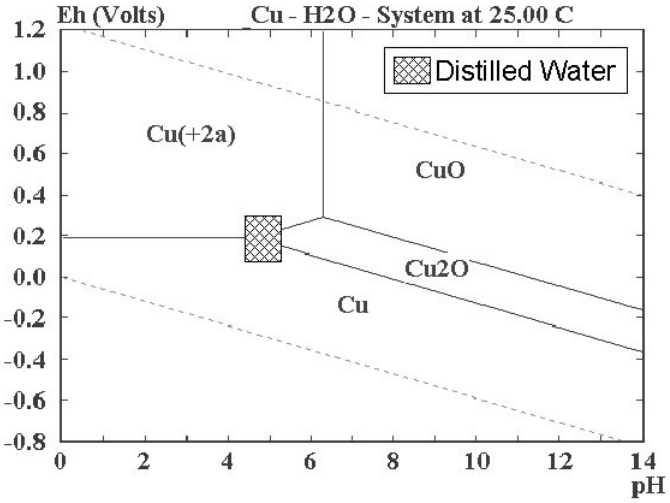
Copper Corrosion Protection

PCC 5500 Machining Corrosion Inhibitor

PCC 7500 Rinse and Cleaning Corrosion Inhibitor

Copper and copper alloys

Copper corrodes or dissolves anodically to form the divalent Cu++ ion in most aqueous environments when the pH of the solution is less then 6.5. At pH values greater then 6.5 copper oxides become more thermodynamically stable and thus forms a passivated layer which reduces corrosion susceptibility (see copper Pourbaix diagram below).



Copper corrosion also increases as the velocity of the aqeuous solution or water increases. The passivated oxide film can also be easily dissolved by carbonic acid or organic acids. Thus, distilled water has a tendency to accelerate the corrosive attack on copper because of the carbonic acid or dissolved CO_2 gas from the atmosphere. For example, sodium bicarbonate ($NaHCO_3$) was found to corrode copper pipes within 6 to 30 months (1).

Uhlig has summarized the following environments where copper is corrosive (2):

1. Oxidizing acids, e.g. HNO_3, hot concentrated H_2SO_4 and aerated nonoxidizng acids (including carbonic acid).
2. NH_4OH (plus O_2) and amines. A complex ion forms: $Cu(NH_3)^{4++}$
3. High velocity aerated waters and aqueous solutions
4. Oxidizing heavy metal salts, e.g. $FeCl_3$, $Fe_2(SO_4)_3$.
5. Hydrogen sulfide, sulfur, some sulfur compounds

Organic Corrosion Inhibitors

Corrosion inhibitors are an effective way to reduce metal corrosion. The inhibitors act by adsorbing onto the metal surface, thus providing an barrier to the corrosive environment.

1. M. Ovrecht and L. Quill, Heating, Piping and Air-Conditioning, January, pp. 165-169; March pp. 125-133 (1960); April, pp. 129-134 (1961). *Corrosion*, 18, 189t (1962).
2. Herbert Uhlig, Corrosion and Corrosion Control 2nd edition; John Wiley & Sons: New York (1971) pp. 325.

The advantages of organic corrosion inhibitors include:

- Presence of film prevents uniform corrosion attack
- Organic inhibitors increase the activation energy on the metal surface (passivation)
- Organic inhibitors have been shown to eliminate corrosion over wide range of pH values
- Inhibitors adsorb and form a thin polymeric layer

Corrosion Rates:

The Tafel plots below show that the addition of a corrosion inhibitor signifcantly reduces the corrosion rate of copper. The corrosion rates were decreased by 99% or from 1.76 angstroms/minute to 0.0026 Angstroms/minute.

The Table below also shows the corrosin rate for a number of other metals, as well as privides guildenines for the corrosion inhibitor concentrations.

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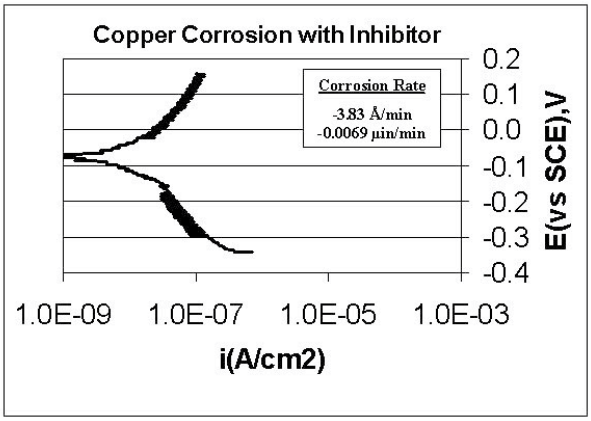

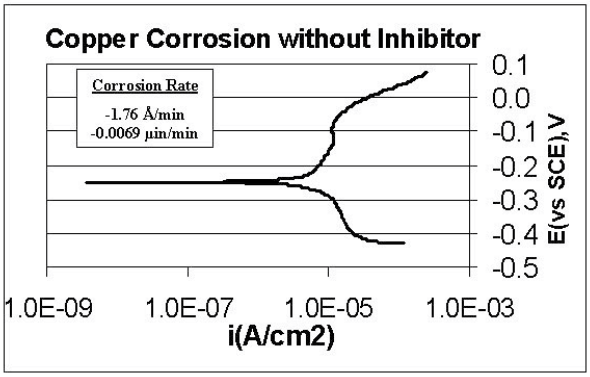

Metal	Corrosion Inhibitor Conc.	Corrosion rate reduction with Inhibitors
Copper	1-5%	99%
Iron	1-5%	92%
Manganese	5-10%	97%
Cobalt	2-10%	96%
Nickel	1-5%	99%
Zinc	1-5%	99%

Corrosion Inhibitors

Description	Part Number
IPA based corrosion inhibitor concentrate for addition into cleaning/D.I. rinse solutions	PCC-7500
Proplyene glycol concentrate for addition into lapping lubricant and diamond slurries	PCC-5000

Lapping Lubricants

Description	Part Number
Ethylene glycol lube, viscosity 20 cps	DIALUBE L7000
Higher viscosity lube, viscosity 25 cps	DIALUBE L7500
Anti-corrosion, non-ethylene glycol lube, viscosity 17.5 cps	DIALUBE 9G-A
Non-ethylene glycol lube for diamond lapping film swarf removal	DIALUBE 3000