Technical Application Bulletin

COPPER Cu^{+2}

Recognized treatment techniques for meeting the Primary Drinking Water Regulations for the reduction of copper using Point-of Use/Point-of Entry (POU/POE) devices and systems.

Copper is a metallic element that is essential to human health. Too little is unhealthy and too much can lead to copper poisoning. The body cannot synthesize copper so the human diet must supply regular amounts for absorption. The daily requirement is about 2 mg of copper intake per day to maintain a balance of 75-100mg in the adult body[1]. In the UK, it is now recommended that the daily intake should range from 0.4 mg/day for 1-3 year old children to 1.2 mg/day for adults[2]. Maximum intake of copper should not exceed 12 mg/day for adult males and 10 mg/day for adult females[2]. Recent surveys show only 25% of the US population consume the amount of copper per day estimated to be adequate by the US Food and Nutritional Board of the National Academy of Sciences. Ironically, the US Centers for Disease Control (CDC) has reported cases of copper poisoning.

Benefits from Copper: - Copper combines with certain proteins to produce enzymes that act as catalysts to help a number of body functions. Some help provide energy required by biochemical reactions. Others are involved in the transformation of melanin for pigmentation of the skin and still others help to form cross-links in collagen and elastin and thereby maintain and repair corrective tissue. This is especially important for the heart and arteries.

Copper Deficiency:- Children on diets deficient in copper have ineffective collagen synthesis, and may develop bone disease. Subclinical copper deficiency has been suggested as a risk factor for cardiovascular disease. People with Menkes disease, in which there is a failure of copper transport in the intestinal mucosa, show mental retardation, depigmentation, severe anemia and bone problems.

Copper Poisoning: - Acute copper poisoning can cause symptoms of nausea, vomiting, diarrhea, gastrointestinal illness, abdominal and muscle pain. Severe cases of copper poisoning have led to anemia, liver poisoning, and kidney failure. [2 & 5].

Copper in water exists as a divalent ion, Cu^{+2}. Levels over 0.05 mg/L are not naturally encountered in groundwater.[3] The presence of copper in water can be from industrial discharges or from copper salts used for algae control in reservoirs. Since copper is a common plumbing material, another source for copper is at the point of use due to corrosion.

The U.S. Department of Health & Human Services; Centers for Disease Control (CDC) reported two outbreaks of copper poisoning in Florida involving 37 people during 1997-1998. The first case involved two people becoming ill after consuming fruit drink made with tap water. Improper wiring and plumbing procedures caused leaching of copper from restaurant piping. Copper levels reached 3.6 mg/L in the tap water after leaching. The second case involved 35 persons in one community with gastrointestinal illness. A defective check valve and a power outage led to a malfunction at a water treatment facility. High levels of sulfuric acid corroded the pipes and leached copper into the system. Copper levels of 33 mg/L and 138 mg/L with pH<6 were found in two water samples collected on the day of the malfunction.[3] The CDC reported two cases in Wisconsin where elevated copper levels in tap water were associated with gastrointestinal illness. The first case in September 1995 involved 22 people; the second case in October 1995 involved 15 people. The homes in the community had recently been built or remodeled and new copper plumbing was thought to have contributed to the contamination of the water.[6]

The Wisconsin Department of Health and Social Services reported a case of methemoglobinemia in an infant during 1992 that was associated with ingestion of nitrate and copper-containing water. The symptoms described in the report appeared to have been induced by simultaneous exposure to copper and nitrates at levels close to federal drinking water standards. Copper is an effective emetic and gastrointestinal irritant, and concentrations in the 2.8-7.8 mg/L range have been associated with vomiting and diarrhea among adults and school age children. The dose required to cause acute symptoms in infants is unknown and children aged less than 1 year may be more sensitive to copper than older persons. Elevated copper levels in water used to prepare an infant's formula may cause loose stools and vomiting after eating. [3]

Copper levels may be reduced at the point of entry by water softening. If copper is present due to corrosion, the copper corrosion may be controlled at the point of entry with a neutralizing system or with polyphosphate feed. [4]

Since copper corrosion carries with it the possibility of lead dissolution, it is preferred to reduce copper from drinking water at the point of use with reverse osmosis (RO) or distillation.[4]

The treatment methods listed below are generally recognized as techniques that can effectively reduce the listed contaminants sufficiently to meet or exceed the relevant MCL. However, this list does not reflect the fact that POU/POE devices and systems currently on the market may differ widely in their effectiveness in treating specific contaminants, and performance may vary from application to application. Therefore, selection of a particular device or system for health contaminant reduction should be made only after careful investigation of its' performance capabilities based on results from competent equipment validation testing for the specific contaminant to be reduced.

As part of the installation procedure, system performance characteristics should be verified by tests conducted under established test procedures and water analysis.

Thereafter, the resulting water should be monitored periodically to verify continued performance. The application of the water treatment equipment must be controlled diligently to ensure that acceptable feed water conditions and equipment capacity are not exceeded.

Contaminant	Action Level mg/L	Treatment Methods
Cu^{+2}	1.3	RO, Distillation, & Cation Exchange

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[1] 1 – Committee on Dietary Allowances of the National Research Council
2- Web page – www.copper.org/environ/UK/UK96html
3- Web page- www.cdc.gov?mmwr/PDF/ss/ss4904.pdf
4- WQA Technical Application Bulletin on Copper, 1992
5-The National Academies News, 02 March 2000
6- www.cdc.gov/epo/mmwr/preview/mmwrhtml/00055820.htm