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CADMIUM

Contaminant	In Water As	Maximum Contaminant Level
Cadmium (Cd)	Cd^{2+}	MCL* = 0.005 mg/L MCLG** = 0.005 mg/L WHO† Guideline = 0.003 mg/L
Sources of Contaminant	Corrosion of galvanized pipes Erosion of natural deposits Discharge from metal refineries Runoff from waste batteries and paints	
Potential Health Effects	Short Term – nausea, Vomiting, diarrhea, muscle cramp, sensory disturbances, liver injury, convulsions, shock and renal failure. Long Term – kidney, liver, bone and blood damage.	
Treatment Methods **Point-of-Use (POU)**	Coagulation/Filtration, Ion Exchange, Lime softening, Reverse Osmosis, Distillation.	

*Maximum Contaminant Level (MCL) — The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards.

**Maximum Contaminant Level Goal (MCLG) - The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.

WHO† - World Health Organization

Cadmium occurs naturally in zinc, in lead and copper ores, in coal and other fossil fuels, in shales and is released during volcanic action. These deposits can serve as sources to ground and surface waters, especially when in contact with low total dissolved solids (TDS) and acidic waters. Major industrial releases of cadmium are due to waste streams and leaching of landfills, and from a variety of operations that involve cadmium and/or zinc. These may include many different types of industrial operations.

Cadmium is found in drinking water supplies as a result of deterioration of galvanized plumbing, along with industrial waste contamination, or surface water contamination by certain fertilizers...

Although it is possible for trace cadmium to be chelated or sequestered as with any metal, it will generally be found in the dissolved ionic form.

Food is the major source of cadmium in Humans. Leafy vegetables contain approximately 0.05 – 0.12 mg cadmium/kg.

HEALTH EFFECTS

The US EPA has established a Maximum Contaminant Level (MCL) of 0.005 milligrams per liter (mg/L) for cadmium in drinking water. The Agency has found cadmium to potentially cause a variety of effects from acute exposures, including: nausea, vomiting, diarrhea, muscle cramps, salivation, sensory disturbances, liver injury, convulsions, shock and renal failure. Drinking water levels which are considered "safe" for short-term exposures are: 0.04 mg/L for a 10-kg (22 lb.) child consuming 1 liter of water per day for one- to ten-day exposures, and 0.005 mg/L for a longer-term (up to 7 years) exposure.

EPA has established a reference dose (RfD0 for cadmium at – $5x10^{-4}$ mg/kg/day. The RfD is based upon chronic intake that will result in the kidney concentration of 200 µg/g. No-observed-adverse-effect level (NOAEL) for Cadmium for humans is 0.01 mg/kg/day.

Cadmium has the chronic potential to cause kidney, liver, bone and blood damage from long- term exposure at levels above the MCL. There is inadequate evidence to state whether or not cadmium has the potential to cause cancer from lifetime exposures in drinking water.

TREATMENT METHODS

Residential **Point-of-Entry** **Point-of-Use**	Strong Acid Cation Resin* Weak Acid Cation Resin Reverse Osmosis Distillation
Municipal	Strong Acid Cation Resin Precipitation/filtration Lime softening

Visit WQA.org or NSF.org to search for products certified to NSF/ANSI 58, 53, 62, WQAS-400, WQAS-200 for Cadmium reduction claims.

***May require customized application, design, and engineering to ensure the desired results as opposed to the other recognized off-the-shelf technologies more readily available for point-of-use and point-of-entry water treatment.**

In soluble ionic form, cadmium may be removed from water using standard, strong acid cation (SAC) resin regenerated with salt (NaCl or KCl). SAC resins have a higher selectivity for cadmium than hardness, so a whole house softener should perform well to remove cadmium as long as it is still removing hardness. Care should be taken to avoid operating past the hardness exhaustion by downgrading the operating capacity by 25%.

For cartridge applications, weak acid cation resins (WAC) in sodium (Na) form will exhibit higher capacity and selectivity than will SAC resins. WAC resins are effective well beyond the hardness capacity.

Cadmium can also be removed by coagulation, precipitation and filtration treatment when pH is raised. It can also be removed as a part of a lime softening process.

Reverse osmosis systems can effectively reduce all ionic species of cadmium by 92-98 percent of the influent concentration for influent water concentrations up to at least ten times greater than the MCL when operated at pressures greater than 50 psig and at temperatures between 40° and 85° F. There are several types of membrane materials in use. Acceptable operating conditions for each type are different. Care must be taken to insure that operating conditions for the specific membrane material are adhered to, especially feed water pH, particulates and oxidants, to maintain effectiveness. Periodic testing for percent rejection should be performed. Another effective means of reducing cadmium is distillation.

Precipitated and insoluble species of cadmium that may exist in some waters can be reduced with filtration that effectively removes particles of 0.5 microns in size.

Water sampling and analysis, using recognized analytical procedures to verify performance, are recommended to assure that the MCL of 0.005 mg/L can be met by the water treatment system at all operating conditions.

The treatment methods listed herein 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 point-of-use/point-of-entry (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 point-of-entry treatment system installation procedures, 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.

REGULATIONS

The US EPA has established a Maximum Contaminant Level (MCL) of 0.005 milligrams per liter (mg/L) for cadmium in drinking water. The Agency has found cadmium to potentially cause a variety of effects from acute exposures, including: nausea, vomiting, diarrhea, muscle cramps, salivation, sensory disturbances, liver injury, convulsions, shock and renal failure. Drinking water levels which are considered "safe" for short-term exposures are: 0.04 mg/L for a 10-kg (22 lb.) child consuming 1 liter of water per day for one- to ten-day exposures, and 0.005 mg/L for a longer-term (up to 7 years) exposure. WHO established a guideline of 0.003 mg/L for life time consumption. No Canadian guidelines exist.

REFERENCES/SOURCES

1) Basic information about Cadmium in Drinking Water.
   http://water.epa.gov/drink/contaminants/basicinformation/cadmium.cfm
2) Cadmium – Environmental Protection Agency.
   http://www.epa.gov/safewater/pdfs/factsheets/ioc/cadmium.pdf
3) Toxicological Profile for Cadmium –ATSDR
   http://www.atsdr.cdc.gov

World Health Organization. Cadmium in Drinking Water (2011).

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