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LEAD FACT SHEET

Contaminant	In Water As	Action Level
Lead (Pb)	$Pb(OH)_2$, $PbCO_3$ and Pb_2O	**US EPA:** Action Level* = 0.015 mg/L MCLG** = 0.00 mg/L (or ppm) **WHO† Guideline** = 0.01 mg/L
Sources of Contaminant	Mostly lead service lines, lead containing solder, and brass fittings of different types Industrial processes, mines, and smelting (not a direct source into water)	
Potential Health Effects	Children are more at risk than adults Reduced intelligence, impaired hearing and decreased growth in children Damage to the brain, kidneys, and bone marrow Damage nervous system and red blood cells	
Treatment Methods **Point-of-Entry** **Point-of-Use**	Reverse Osmosis Solid Block and Precoat Adsorption Filters (properly designed submicron filtration with adsorption media) Strong Acid Cation Exchange (Na^+ form) Distillation	

NOTE: Lead can exist in water in a broad array of forms, therefore, more than one type of technology may be needed for adequate removal. **Soluble** (or dissolved) lead may be removed by ion exchange, reverse osmosis, adsorption, or distillation. Insoluble (or **particulate**) lead may be removed by fine filtration and adsorption, reverse osmosis, or distillation.

*Action Level requires water utilities to sample specific number of samples in specific locations and verify that 90% of samples are below this level. If that is not met, an appropriate Action is required to be taken to remedy the situation.

**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

Lead has a tendency to be complexed and precipitated by a large number of substances. When released to land, lead binds to soils and does not migrate to ground water. In water, it binds to sediments, and it does not accumulate in fish. This is why it is seldom found in ground waters or natural waters in more than trace quantities, under 10 μg/L. However, source waters that contain lead are an indication that intrusions from industrial, mine, or smelter wastes may have occurred. Typically, the source water contains less lead than the water at the "point-of-use". Studies indicate that nearly all the lead in users' tap water does not come from the primary water source or from the municipal treatment plant, but is a result of corrosion of lead containing materials that contact water after leaving the treatment plant. Lead can enter the home drinking water by leaching from lead service connections, from lead solder used in copper piping, and from brass fixtures.

HEALTH EFFECTS

Lead is a metallic element, it tastes sweet and can enter the human body in different ways. Often times, lead poisoning shows no symptoms. However, signs such as irritability, weight loss, vomiting, constipation, or stomach pain could occur. The human body can be damaged by ingested lead and the most acute cases of lead poisoning can cause death. Damage to the brain, kidneys, and bone marrow can occur with lower exposures. Coma and convulsions can also be associated with lower exposures of lead. Lead can also damage a person's nervous system and red blood cells. Children are more at risk than adults when it comes to the dangers of ingesting lead. Children will absorb 30-75% of the lead they ingest while adults will absorb only 11%. Individuals with the greatest risk, even with short-term exposure, are young children and pregnant women. Estimates are, on average, lead in drinking water contributes between 10 and 20 percent of total lead exposure in young children. Reduced intelligence, impaired hearing and decreased growth, are associated with blood levels as low as 10 micrograms of lead per deciliter of blood (μg/dL). A 10 μg/dL increase in blood levels correlates to a loss of 2 IQ points. Individuals will adsorb more lead if they have poor nutrition than those that have better diets.

TREATMENT METHODS

Residential Point-of-Use	Reverse Osmosis Fine Filtration + Adsorption Distillation
Municipal	Corrosion Control Measures
Visit WQA.org or NSF.org to search for products certified to WQAS-200, NSF 53, 58, 62 for lead reduction.	

Lead is amphoteric, which means it is capable of functioning either as an acid or as a base. The chemistry of lead is complex since lead may be a soluble ion present in the monovalent or divalent form, a complex ion, a particulate, a hydroxide, carbonate, or oxide, depending upon the pH, alkalinity and other constituents present in the water. With this broad array of lead forms in water supplies, it is obvious that more than one type of technology may be needed for adequate removal of lead. Soluble lead levels, for example, may be reduced by ion exchange, reverse osmosis, adsorption, or distillation. Particulate lead may be removed by fine filtration and adsorption. Sodium cycle , strong-acid ion exchange water softening is a well-established technology for removing ionic forms of lead, but the process has its limitations. Typically, ion exchange softeners must be operated at no more than 2.0 to 3.0 gpm flow rate per cubic foot of ion exchange resin for best results. Removal of lead by reverse osmosis is effective because the membrane removes not only the soluble lead impurities by 90 to 95% typically, but also acts as a barrier to the particulate lead. Forty to sixty percent of the lead found in municipal supplies is present typically in the particulate or insoluble form. Although data is sparse, properly designed and operated distillation units are capable of reducing both suspended and dissolved lead levels.

Data verifies that solid block and precoat adsorption filters using a mixture of activated carbon and a lead adsorbent can remove insoluble lead by particulate filtration and adsorption, and soluble lead by adsorption. Contact time, type and size of activated carbon and the lead adsorbent material, flow rate per unit area, and the design of submicron filter void sizes to ensure effective filtration of precipitated and insoluble lead species are critical to the success of this treatment technology.

POU/POE products are considered to be the preferred method for lead removal, since most lead in drinking water is the result of corrosion in the water distribution and home plumbing system.

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.

Visit WQA.org to locate water professionals in your area. Note that Certified Water Specialists have passed the water treatment education program with the Water Quality Association and continue their education with recertification every 3 years.

REGULATIONS

In the United States the EPA, under the authority of the Safe Drinking Water Act (SDWA), has set the Maximum Contaminant Level Goal (MCLG) for lead at zero. This is the health-based goal at which no known or anticipated adverse effects on human health occur and for which an adequate margin of safety exists. It means that it would be desirable to have totally lead free water for consumption. But due to economic considerations USEPA has set an action level for lead in drinking water at 15 ppb (15 μg/L). This means that utilities must ensure that water from the customer's tap does not exceed this level in at least 90 percent of the homes sampled. The utility must take certain steps to correct the problem if the tap water exceeds the limit and they must notify citizens of all violations of the standard. In Canada, the regulated concentration of lead is set at 0.010 mg/L.

Amendments to the SDWA require the use of "lead-free" pipe, solder, and flux in the installation or repair of any public water system, or any plumbing in a residential or non-residential facility connected to a public water system. Solders and flux are considered "lead-free" when they contain not more than 0.2 percent lead. Solders used prior to 1986 typically contained about 50 percent lead. Pipes and fittings were considered "lead-free" when they contained no more than 8 percent lead until the end of 2013. A report shows that lead in drinking water can increase by more than 100 fold after 24 hrs of contact with lead-soldered copper piping. Current regulation that took effect in January 2014 in the US now requires all plumbing systems to be lead free, i.e. contain less than 0.25 % lead.

Revisions to the Lead & Copper rule proposed in December 2021 would allow public water systems serving fewer than 10,000 customers to use POU treatment as a long-term compliance solution (USEPA, 2020). The compliance date for the new rule is October 16, 2024.

Several public water systems have used POU treatment as temporary measures to address lead problems while they make necessary lead-line replacements or adjust their central treatment (City of Detroit, 2023; City of Evanston, n.d.; City of Newark, 2019; City of Pittsburgh, n.d.; Denver Water, 2023; USEPA, 2016; USEPA, 2022) . Systems tend to use pitcher filters or faucet mounted filters for this purpose. POU reverse osmosis is also an effective treatment method, however, the pitcher and faucet mounted filters are more attractive due to their lower cost, and the ease of implementation.

Due to variances in water chemistry around the country, carbon block filters can have limitations, even when certified to NSF/ANSI Standard 53 for lead concentration reduction. In 2019, with assistance from the USEPA, the city of Newark, New Jersey found that the addition of zinc othophosphate to their low hardness and low carbonate water produced lead particulates that were smaller than those used in product certification testing (Lytle et al., 2020).. Although the testing performed by the city and the EPA eventually proved "that the filters distributed by the City are reliable in reducing lead levels in tap water to below USEPA's action level of 15 ppb" (NJDEP, 2019) follow up testing on performance after installation is recommended when filters are used in this manner. The city also found that proper installation, maintenance, and certified replacement cartridges were critical in the filters' performance (Kutzing et al, 2022).

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