FLUORIDE

Fluoride is the ionic form of Fluorine. Some common forms compounds are hexafluoric acid, sodium fluoride, andcalcium fluoride.

Uses

Although fluoride naturally exists as calcium fluoride (CaF_2), other fluoride complexes derived from man-made resources increase environmental fluoride levels and our own exposure to fluoride. Fluoride is used often inPesticides, dentistry, and is added to municipal water supplies to prevent cavities in the community.

Current commercial toothpaste is fortified with sodium monofluorophosphate or sodium fluoride. Fluoride toothpaste and water fluoridation have been touted by some health organizations as major contributors to dental caries reduction in the United States and arguably a public health success.

Several fluoridation additives are used in treating drinking water in the United States, the most common of which are, in order, hexafluorosilicic acid (H_2SiF_6), sodium fluoride (NaF), and sodium hexafluorosilicic acid (Na_2SiF_6). Sources of fluoridating agents can be found naturally in volcanic ash and as fluorite and apatite in geological mineral deposits (#Urbansky, 2002). While small-scale water treatment utilities use NaF, larger ones operate with high quantities of fluorosilicates, whose lowered costs make up for its greater handling expenses (#Urbansky, 2002). The demand for fluoride additives benefits companies that can market their waste products as fluoridating agents to water utilities. Industries such as USSteel, DuPPont, Alcoa, Allied Chemical, and the Florida phosphate fertilizer industry all profit from selling fluoride byproducts they have generated (#Kauffman, 2005).

Various other forms of organic and inorganic fluoride complexes such as acetyl fluoride (CHCOF) and liquid hydrofluoric acid i.e. hydrogen fluoride gas (HF) can increase fluoride in water, too. Care should be taken when investigating potential fluoride sources, however, as not all chemical substances containing the element fluorine necessarily yield fluoride ions. Teflon polymer is composed of $-CF_2-$, whose chemical structure offers great stability and so does not readily produce fluoride ions (#Kauffman, 2005). Fluorine-containing chemical groups incorporated into drugs serve the purpose of slowing drug metabolization in the body

(#Kauffman, 2005). The likelihood of fluoride contribution from fluorine in drugs is debatable. Synthetic and natural substances with fluorine or fluoride display a variety of chemical structures, which affect the chemical properties of each substances and thus, the degree to which the substances act as fluoride-releasing agents.

Pharmacology and Metabolism

Fluoride ions convert to hydrofluoric acid in the gut. Around 50% of the fluoride is excreted in urine while a minute is excreted through saliva and sweat. The half life of these ions is short (1-5 hours).

Fluoride accumulates in people most often if they have impaired kidney function. The ions settle in the bones and teeth (#Limeback and Gingrich, 2007).

Health Effects

The health effects of fluoride is contentious. It has generally been thought that small levels of Fluoride (0.7 - 1.2 ppm in drinking water for example) increase bone density and increase calcium fluorapatite in teeth which is generally thought to lead to fewer cavities. Fluoride regulation in drinking water supplies at the .7 - 1.2 ppm level is recommended still by the American Dental Association and the World Health Organization. But, many are beginning to believe that chronic fluoride exposure can lead to liver damage, kidney damage, and Dental Fluorosis among other things. Amidst these negative findings, the American Academy of Allergy and Immunology, the American Academy of Diabetes, the American Cancer Society, the American Diabetes Association, the American Nurses Association, the American Psychiatric Association, the National Kidney Foundation, and the Society of Toxicology have discounted fluoride as a beneficial additive and no longer support its use (#Kauffman, 2005). Additionally there is an ethical argument surrounding city officials adding fluoride to drinking water supplies.

Fluoride is one of the most highly toxic substances present in our environment today. There are many different levels of toxicity:

Acute

In areas where fluoride compounds are naturally elevated in the drinking water, fluorosis are common (#Limeback and Gingerich, 2007).

Exposure levels of 1-5 mg/kg body weight can create acute fluoride toxicity symptoms such as nausea, vomiting, diarrhea, abdominal pain, and in rare cases cardiac arrhythmias and death (#Fallon, 2006). Acute ingestion of fluoride can be fatal. Skin or eye contact with gaseous fluoride results in irritation of the skin or eyes.

Chronic

Fluoride is everywhere. It is present as a mineral and is ubiquitously present in natural water sources throughout the world. It is also added to toothpaste to prevent cavities and decay. The most common problem associated with fluoride exposure is fluorosis.

Dental fluorosis occurs in areas with a fluoride exposure level higher than 1.0 ppm (#Fallon, 2006). Fluoride intake can cause mild symptoms such as white, opaque mottling of teeth and enamel wear. At higher levels of exposure, severe dental fluorosis occurs with pronounced brown or black discoloration and pitting of teeth. Staining only happens with developing teeth below the gum line. As such, any noticeable characteristic of dental fluorosis only indicates the fluoride exposure level an individual has had up to age 8-10 (#Meenakshi, 2006). Dental fluorosis symptoms, in effect, are more of a time capsule rather than a present indicator of fluoride exposure and may fail to determine alone whether adults currently suffer from excessive fluoride intake. Additionally, although fluoride fosters bone formation, the new bones develop abnormally (#Fallon, 2006).

Skeletal fluorosis happens at the advanced stage of fluorosis. Fluoride deposits in the joints of the neck, knees, pelvic and shoulder bones and hinders movement. In the early stages, back stiffness, burning sensations, tingling or prickling, and muscle weakness arise and irregular calcium deposits show up in ligaments and bones. Advanced skeletal fluorosis creates osteoporosis, growth of bony spikes at the joint, vertebral fusion, and even osteosarcoma (bone cancer). Damage to the entire musculoskeletal and nervous systems marks the end stage of advanced fluorosis (#Meenakshi, 2006).

Overexposure to fluoride affects more than just bone and teeth. It can cause physical damage to human physiology by lowering hemoglobin count, distorting red blood cell shape, suppressing immunity, destroying enzymes and disrupting the normal mechanisms of the excretory, digestive, and respiratory systems (#Meenakshi, 2006). Children who drank water with fluoride levels exceeding 2.0 mg/L had kidney and liver function damage, the latter independent of dental fluorosis (#Xiong et al., 2007). Excessive fluoride intake can also cause mental harm in

the forms of depression, nervousness and symptoms similar to those of Alzheimer's disease as well as reproductive harm such as male sterility, still birth, and abortion (#Meenakshi, 2006).

Precautions

Several possible options are available for the removal of fluoride from water including cartridges with an activated alumina adsorbent, reverse osmosis, and distillation. Of the three, distillation is the best micro-scale method of fluoride removal based on affordability (#Kauffman, 2005).

For some tips on how to reduce your daily fluoride intake, visit 10 Steps to Cutting Back on Fluoride

Regulation

Within the United States, drinking water regulation of fluoride levels is set by the Environmental Protection Agency (EPA) at 4 mg/L as the maximum contaminant level (MCL), established after review of a report from the National Research Council (#EPA, #Urbansky, 2002). The Safe Drinking Water Act, requiring the EPA to set drinking water standards, includes the Maximum Contaminant Level Goal of permitting no carcinogens in the U.S. water supply. Although some studies point to fluoride as a possible carcinogen (find sources here), the conclusion from a 1990 National Toxicology Program sodium fluoride study that once proved fluoride's carcinogenicity was revised to suggests only that the study yielded arguable evidence, effectively allowing fluoride to remain a legitimate water additive (#Kauffman, 2005).

The FDA oversees the fluoride levels in bottled water and beverages and sets the acceptable range at 1.4-2.4 ppm (determined by the annual average maximum daily air temperature) (#US FDA, 2006). Alongside FDA regulation, the Secretary of Health and Human Services is responsible for creating another bottled water standard that echoes EPA drinking water regulation (#Urbansky, 2002).

No federal agency exists to control drinking water additives. Instead, the National Sanitation Foundation certifies chemicals that add less than 10% of the MCL of any drinking water substance under EPA regulation as an acceptable water additive. State and local authorities enforce either NSF-certification or their own certification standards to all drinking water additives

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