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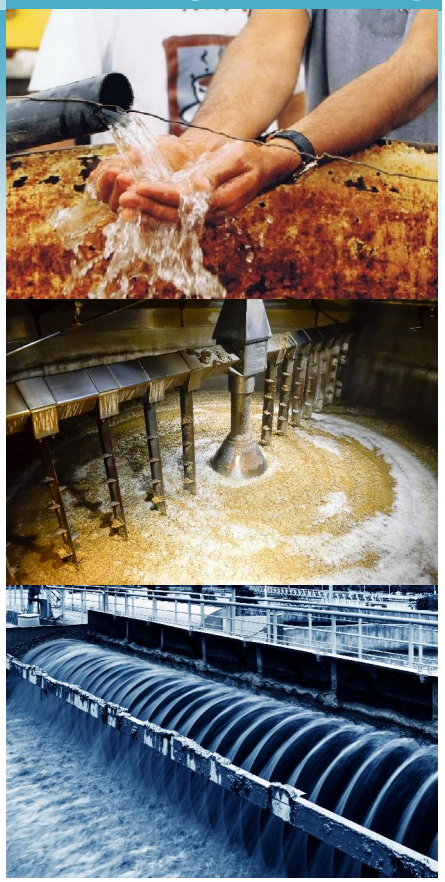
Process, Air & Water



Flint Water Crisis

Potable water or drinking water, is water that is safe enough for drinking and food preparation. Water is designated as potable if it does not exceed the maximum contaminant levels (MCLs) for different regulated substances. The contaminants found within water is dependent on the water source. Some waters are sourced from surface waters both freshwater and saltwater. Examples of freshwater sources are lakes, rivers and streams. The use of reverse osmosis has made the use of saltwater from the sea or mangroves a feasible option for the production of drinking water. Drinking water is also sourced from groundwater or aquifers. The contaminants that can get into the source is very dependent on the geographic location of the source, the surrounding ecosystem and the surrounding runoff from the watershed which can be heavily influenced by human activity from agriculture, industrial and domestic use. This dependency of the water quality in geographic location leads us to understand that it is not possible to regard all water as being the same. Thus, although the general process steps in the treatment of water are the same, specifics can vary tremendously. Water treatment can be as much art as it is science.

For largely economic reasons, Flint, MI decided to process drinking water for its citizens itself, rather than continuing to obtain water from Detroit Water and Sewerage Department, which sources its water from Lake Huron. In making this switch, the city decided to temporarily source its water from the Flint river until it can be supplied with Lake Huron source water by the Karegnondi Water Authority at the end of 2016. This switch occurred in May 2014.[1] Almost immediately, the populace reported foul-smelling and foul-tasting water. Visually, the water also showed high turbidity and coloration at the end user. The City of Flint later reported that the water had lead and iron contamination and contained levels of total trihalomethanes (TTHMs), that exceeded maximum contaminant levels (MCLs). TTHMs are byproducts of disinfection and are produced in amounts that can exceed the MCLs if chlorination rather than chloramination is used as the disinfection technology.

Lead and discoloration. It has been said that the lead in the water was attributed to the high corrosiveness of the Flint river water.[2] What exactly is causing the water to be more "corrosive"? It is the high level of chloride ions.[3] Chloride ions have an affinity to iron in the cast iron pipes, and which leads to stress corrosion cracking.[3,4] These cracks are entryways for lead and iron in the distribution system to mix with water. Another possible source of lead can arise from the use of chloramines to treat drinking water, that is, if chloramination was used for disinfection.[5] The lead leaching caused by chloramines is especially pronounced in older homes with older plumbing systems.

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Introductions

Hello! Thank you for reading the inaugural publication of Process, Air & Water. The goal of this newsletter is to bring awareness and provoke thought of current, relevant issues in the chemical and environmental arenas. In the spirit of provoking thought, this newsletter will also serve as a forum to expound on hypothetical solutions which may not yet have been proved out. I would be happy to hear from you! - *Keisha Antoine, PhD, PE*

About Antoine Technical Consulting LLC

Antoine Technical Consulting LLC offers solutions to help clients improve their primary and auxiliary processes using chemical process simulation to perform process design, energy assessments, troubleshooting and scale-up.

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"Each component added to the water to make it drinkable brings its own set of potential issues."

References

[1]City of Flint 2014 Annual Water Quality Report, https://www.cityofflint.com/wp-content/uploads/CCR-2014.pdf
[2]"How tap water became toxic in Flint, Michigan", S. Ganim and L. Tran, CNN, January 13, 2016, http://www.cnn.com/2016/01/11/health/toxic-tap-water-flint-michigan/
[3]"The science behind the Flint water crisis: corrosion of pipes, erosion of trust", T. Olson, http://theconversation.com/the-science-behind-the-flint-water-crisis-corrosion-of-pipes-erosion-of-trust-53776
[4]https://en.wikipedia.org/wiki/Stress_corrosion_cracking
[5]"Changes in blood lead levels associated with the use of chloramines in water treatment systems", M.L. Miranda, D. Kim, A.P. Hull, C.J. Paul, M. A. Overstreet Galeano, Environmental Health Perspectives, v. 115(2), February 2007, p. 221-225, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1817676/
[6]"Effects of silver in water", G.D. Jennings, Water Technology, October 2010, http://www.watertechonline.com/effects-of-silver-in-water/

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The Water Quality Summary Report, dated January 2015 and published by the City of Flint, shows that Flint had no value assigned for a maximum concentration level (MCL) for chloride, although the average level was 86 ppm with a range of 78 – 92 ppm. What is now known is that the corrosion inhibitors were not used as part of the water treatment plan.[2,3] The use of corrosion inhibitors (phosphates) would have mitigated either mechanism of lead leaching. Water treated by the Detroit Water & Sewerage Authority, the previous supplier of drinking water, is treated with anti-corrosion agents.

A look at TTHMs. Flint received violations from the Michigan Department of Environmental Quality (MDEQ) for total coliform and E. coli in August and September of 2014.[1] To combat the bacteria, the city used chlorination (where free chlorine is used) rather than chloramination (where compounds of chlorine and ammonia are used) to disinfect the water and bring the MCLs within specification. Free chlorine is faster acting than chloramines. The result of chlorination, however, was an uptick in the TTHMs levels.

Proposed methods for managing water "corrosivity". In lieu of using corrosion inhibitors are there other ways in which chloride ions could be removed? A possible means of removing the chloride ions is to oxidize them to the chlorine gas using ozonation. Ozonation is a well-accepted practice for disinfection at public water utilities, and optimizing the dosage according to source water properties could be a management practice. An effective management practice would also include a consideration of where ozone is used in the process as well as frequency of use. Another method of removing chloride ions could be to precipitate it out. The treatment of water with silver ions or colloidal silver nanoparticles on a ceramic filter substrate can remove these chloride ions. Additionally, the use of silver for disinfection of drinking water can also be leveraged.[6] These alternatives cost money and must go through extensive evaluation as it is seen that each component added to the water to make it drinkable brings its own set of potential issues.