Why is Chloramine used for Water Treatment?

Disinfection is an essential step in the water treatment process because it can destroy microorganisms that may cause diseases in humans. Public water systems utilize various disinfection practices, some of which may potentially lead to undesired, harmful chemical byproducts. Following the regulations for disinfection treatments and byproducts is an important measure to ensure water is safe to drink.

Use of chloramine

Chloramine is a chemical formed by the reaction of chlorine and ammonia (chloramination) and may be used as primary or secondary disinfection for drinking water. According to the US EPA, more than one in five Americans use drinking water treated with chloramines (1). Chlorine is still considered the most effective disinfectant used in water treatment plants to disinfect the water for distribution and consumption of drinking water (2). Ammonia is either present at some concentration in the source water or is added for purposes of disinfection as chloramine. Chloramine is often used as a secondary disinfectant and is increasingly used based on its effectiveness as a disinfectant and its longer residence time in distribution systems (3). Increased regulation of disinfection byproducts (chemicals formed from the use chlorine disinfection) has caused water utilities to seek more cost effective approaches to disinfection — such as chloramination — and is the primary reason for the increase of chloramination treatment in recent years (4, 5) because it can significantly reduce the formation of regulated disinfection byproducts (DBPs).

Advantages and disadvantages of chloramination

Mono-chloramine has been used in water treatment for more than 90 years (3). Even though chlorine is more efficient to eliminate microorganisms, the benefits of using chloramine are less production of regulated DBPs than chlorine, cost and longer residence time in the distribution system resulting in better overall disinfection. Since the enactment of the Disinfectants/DBP Stage 1 and Stage 2 rules by EPA (1), the cost to water treatment facilities has increased due to the requirement to reduce DBPs. Chloramination has be identified as the most cost-effective approach to reduce regulated DBPs in the drinking water. Some source waters (particularly ground waters) have a residual amount of free ammonia, which reduces the amount of ammonia to be added and also reduces the overall cost.

A disadvantage to using chloramine is the complexity of balancing the water chemistry to assure the maximum amount of monochloramine while minimizing dichloramine and trichloramine. Monochloramine is the active disinfectant. Dichloramine and trichloramine lead to taste and odor issues. In addition, the potential for nitrification in the distribution system can cause nitrite and nitrate levels to exceed the maximum contaminant level, and therefore become a potential public health hazard (4). Nitrification occurs when the free ammonia is oxidized by nitrifying bacteria in the distribution system to form nitrite and nitrate (6). Another major disadvantage in using chloramine is the formation of highly toxic iodinated DBPs when iodide is present in source waters (7). In addition, increased releases of lead in the distribution system also can occur (8).

Environmental health effects of chloramine

Normal levels of chloramine found in drinking water range from 0 – 4 mg//L, and are considered safe to drink (1). The maximum contaminant level for chloramine is 4 mg/L (9). Higher levels of chloramine are not associated with significant health outcomes below 200 ppm or 9.5 mg/Kg/Day (10). The careful monitoring and control of chloramine, chlorine and the formation of DBPs in drinking water are important to reduce potential health problems with drinking water. DBPs are associated with increased risk for adverse health outcomes (11); however, it is difficult to assess which DBPs are most toxic and how mixtures affect overall toxicity (12). Toxic effects from nitrogenous DBP's formed from chloramination of wastewater effluents have been observed, although the complex mixture of DBP's that can be formed make it difficult to determine which compounds exhibit toxic effects (13).

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