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DISINFECTION OF DRINKING WATERS WITH OZONE BROMAT CREATION

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ABSTRACT

Introduction

Ozone gas, in nature, occurs as ultraviolet rays from the sun break down the oxygen in the atmosphere into ozone molecules. Technologically, it is obtained from the air we breathe with the help of electron discharge or pure oxygen. Ozone is used extensively in recent years for the purpose of disinfection, due to its high oxidation potential. Ozone gas, which is a raw material oxygen, is the only natural disinfectant.

Aim of the study

Bromata, formed in the disinfection of drinking water with ozone, emphasizes the importance of process control.

Results

It is possible to provide safe disinfection by ensuring the use of online monitored technologies.
The formation of a natural disinfectant has led to the rapid spread of usage areas and their safe use. In the field of aquaculture, interest in the use of ozone for disinfection has increased rapidly in recent years. In the disinfection of waters, in the food industry, in cold air depots, in eliminating odor, in swimming pools, in color removal, in waste water treatment, in nitrite, ammonia, iron, manganese removal; Ozone gas is used in the disinfection of living environment air. Ozone is a gas with very high oxidation power and the most powerful disinfectant known. The high oxidation force plays an important role in eliminating situations that would cause ozone fish diseases. The effect of disinfection of ozone gas is 3125 times higher than that of chlorine under the same conditions. It is more effective against chord and cysts and viruses. In addition, after ozone is obtained by disintegration of the oxygen in the air, and after completing the disinfection task due to its unstable structure, it is always converted to raw material oxygen.

Key Words: Water,Ozone,Bromate,Toxicity

INTRODUCTION

Ozone was discovered in 1840 by German chemist Christian Frederick Schonbein at the University of Basel in Switzerland. However, ozone was not scientifically investigated until 1932 (1). Ozone during World War II; After trauma in German military units, gas gangrene has been used for the treatment of infected injuries, mustard gas burns and fistulas. In America, ozone was accepted as an alternative medicine between 1880-1932. n 1930, the dentist Dr. E.A. Fisch is the first physician to use it in his algebra (fluid state) work. He introduced Ozon to his friend Dr. Erwin Pyre. Erwin Pyre used ozone surgery and presented the results at the 59th German Surgical Union Meeting. Today, ozone treatments are among the accepted treatment methods in 16 countries. t is being investigated for use in eye diseases, acute or chronic viral, bacterial and fungal infections, ischemic diseases, age related macular degeneration, orthopedic diseases, skin, lung, kidney, blood diseases and neurodegenerative diseases. Biological Effects The ozone has antimicrobial, immune stimulating, blood circulation enhancing, biosynthetic, analgesic, detoxication and bioenergetic effects on the human body. Antimikrobiyal etki: t has a cytotoxic effect on ozone, bacteria, fungi and viruses. Antimicrobial effect of ozone; Due to secondary oxidative effects, bi-directional bonds damage the cytoplasmic membrane of the ozonolysis-causing cell (2). Ozone disinfection tears the cell membrane and comes into the water. Chlorine, a common disinfectant, enters the cell membrane and inactivates microbial enzymes. Bactericidal effect of ozone; Water pollution, amount of dissolved substance in water, pH, water temperature and duration of contact. Approximately 4-10 minutes of water with ozone provides disinfection. Approximately 0.1-0.5 mg / L ozone will kill almost all the bacteria.
Kroll is more effective against sports, cysts and viruses.Bacterial waters always contain dissolved organic materials, which also consume some ozone. When ozone is given to the water containing organic matter, ozone first reacts with inanimate organic substances in the water. In the meantime, only some of the bacteria will kill. The rate of bacterial killing increases rapidly after the reaction with organic substances. Therefore, the amount of ozone required for disinfection in filtered and granular-activated carbon-treated waters is less than in untreated waters (3). Ozone, the oxidation power is very high and the most powerful disinfector known. The high oxidation power is very effective in the destruction of bacteria. It was first discovered in 1873 to have ozone disinfectant properties and was used in the Oudshoom region of the Netherlands in 1893 for water disinfection (4). The use of drinking water in the field of disinfection has received considerable attention and has been around for many years. In the 1940s, this interest was lost during the construction of chemical weapons, with a suitable method for treating chlorine gas (5). In Industry; Ozone (O3) is a disinfectant used especially in spring water to protect freshness and extend the shelf life of the ozone (O3), which has many applications such as drinking water treatment, wastewater management, pure water, fishery, agriculture, paper, food and paint industry (6).

Ozone And Chemıcal Structure

Ozone is a molecule that contains three oxygen atoms that can exist naturally in nature. It is formed by the chemical combination of an oxygen atom and an oxygen molecule containing two oxygen atoms. Oxygen and ozone are constantly converting into each other. The chemical reactions leading to this transformation are catalyzed by high-fre- quency UV rays from sunlight (7). Ozone in the atmosphere, gaseous; Troposphere and stratosphere. The stratosphere plate contains natural ozone at a concentration of 1-10 ppm. B and C type ultraviolet radiation coming from outside the atmosphere is absorbed by ozone in the stratosphere layer. The ozone found in the stratosphere; The thermal structure of the stratosphere and the ecological balance of the world. Ozone found in the troposphere has been reported to have toxic effects on the respiratory tract. Ozone; In the troposphere, including cars' exhaust gases, oxygen and sunlight It occurs with a wide variety of reactions.

Uses of Ozone

InFood Industry;

It is used as a disinfectant agent for food preservation, shelf life extension, equipment sterilization, evaluation of vegetable food waste, food for cold storage rooms, to prevent mold and yeast growth in fruit storage,

In Chemical Industry;

As an oxidant in the organic chemical industry, in the disinfection of drinking water and air, in the bleaching of flour, paper clay, starch and sugar, in the processing of some perfumes, vanillins, in the rapid drying of varnishes and printing inks, in the removal of chlorine from nitric acid, in the oxidation of cyanide and phenol, As a disinfectant agent, it is used in the treatment of industrial wastes, in the elimination of odor of volatiles, air and sewage gas, in the killing of bacteria, in the production of steroid hormones One of the most widely used sites of ozone is the disinfection of second-hand or biologically treated wastewater. Ozone is used extensively in the cleaning of wastewaters flowing into large reservoirs or where there may be living organisms. Advantages of ozone disinfection compared to chlorine in such waters; Ozone is the protection of the natural equilibrium of the waters, as ozone removes all the viruses more effectively than chlorosis, as opposed to the great damage of the living beings living in the water, by ozonation and enrichment of oxygen on the one hand. Ozone provides effective disinfection for this type of water while reducing color and blurring on the other side, reducing the need for chemical oxygen.

Bromate Formation

When the concentration of organic matter in the water is high in water treatment processes, chlorine dioxide, chloramines or ozone can be used as a disinfectant instead of chlorine. In addition to being a good disinfectant, ozone is also beneficial in processes such as coagulation of suspended solids and filtration. Another advantage is that it does not smell and taste in waterBesides, ozone also produces various oxidation products due to its high reactive effect. When bromide is present in the environment, some bromine compounds are reported to be carcinogenic during the ozonation. Bromide salts resulting from bromine, which may be present with free chlorine, are bromate pollution when converted to bromate in a suitable environment. Some studies in the water show that some byproducts can occur during various disinfection processes. The amounts of by-products vary with the given doses of ozone and chlorine in the samples obtained from different temperatures and different regions. Different methods were used to study the changes in the amounts of by-products. The resulting by-products often reach critical levels. For this reason, follow-up is important for public Health (8-16).

The disinfection effect of the ozone is due to its oxidizing properties and high reactivity. The mechanism of action of ozone in the water depends on pH. The ozone, which acts in the molten state in the acidic medium, suppresses hydroxyl radical forms at higher pH valuesThese two mechanisms are different from each other by-products formed as a result. Organic acids and aldehydes, which are ozone side products, can easily be converted into organic carbon or biodegradable carbon derivatives. For this reason it is possible to remove biodegradable by-products by accompanying the biologically active process to the ozonation process. In Figure 1, the mechanisms of formation of brominated by-products, which are released by ozone and hydroxyl ions in the water containing the bromide ion, have been shown (17).

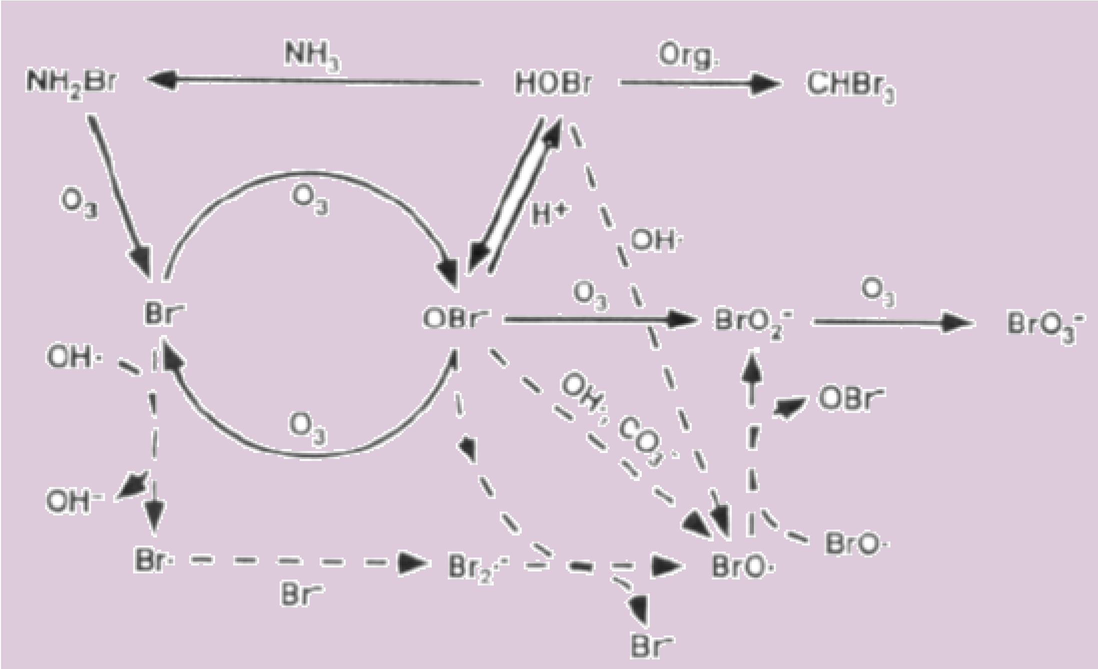

Figure 1

Ozonation alternatives for water and wastewater disinfection are becoming increasingly widespread. However, bromide is a good source of ozone that can be readily oxidized and leads to the formation of organic and inorganic disinfection by-products (18). The byproduct formation proceeds through the oxidation of the bromide, the reactive intermediates termed bromine aqueous solution. Bromine is found in the form of hypobromite ion in water and its combination of hypobromic acid, a weak acid. The following reactions lead to the formation of inorganic (e.g. bromate, BrO3-) and organic brominated compounds (e.g. bromoform, CBr3), respectively, formed by hydroxyl radicals (19) or natural organic material formed by molecular ozone or ozone decomposition of bromine aqueous solution.

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$O3 + Br^{-}$ -------> OBr^{-}

$OBr^{-} + H^{+}$ <-------> $HOBr^{-}$

HOBr + NOM -------> TOBr

OBr^{-} + {HO ve/veya O3} -------> $BrO3^{-}$

By products such as ozone and ozone depletion, such as HO radicals, act as oxidation forces for bromate and TOBr formation. However, the formation of these disinfection byproducts depends on the formation of reactive, brominated intermediates. Studies have shown that bromate has a potentially carcinogenic effect and the formation of bromate in the oxidative treatment of bromide-containing drinking water has become very important.

Today, the ozonation of bromine-containing waters results in the conversion of bromine to bromate or TOBr in the region of the region depending on the water quality parameters (the composition and concentration of the organic material in the water, the amount of ammonia, the alkalinity, the pH and the temperature) and the treatment conditions (ozone dosing, reaction duration etc.) (19). Bromate and TOBr species are almost non-reactive, irreversible end products. The choice of the ozonation treatment system depends primarily on the potential for water bromate formation. Two important factors are present in the formation of bromate and organic brominated compounds. These are bromine and natural organic matter. These two factors play an important role in determining the distribution and degree of brominated by-products formed by ozonation, along with water quality variables. The presence of natural organic matter improves TOBr formation while reducing bromate formation (20).

Bromate Removal / Control Methods

Alternatives to reducing bromatte formation include ammonia (NH3) or acid addition. Hydrogen peroxide addition has a mixed (+/-) effect. A full-scale controlled bromate control can be regarded as the most effective method of reducing pH (21). As a result of the work done, the following conclusions were reached in terms of bromate control.

- Two methods for controlling bromate formation are pH adjustment and ammonia addition. Despite the pH conversion of HOBr from the bromine species to OBr, the concentration of OH radicals in the system also decreases. The addition of ammonia leads to the consumption of bromide by the formation of monobromine and consequently the reduction of bromate formation.
- The addition of ammonia leads to the consumption of bromide by the formation of monobromine and consequently the reduction of bromate formation. For this reason, selection of bromate control strategies that affect the concentration of OH radicals may be more appropriate than methods that affect the level of HOBr / OBr. Bromate formation during ozonation can be reduced by lowering the pH. It has been observed that the amount of bromate has been reduced by 50% by decreasing the pH to 8.0 dL 6,0Ammonia depletion was also found to be the reducing effect of bromate formation, but it was found that ammonia addition in excess amounts lost the benefit of reducing bromate formation. According to von Gunten and Pinkernell (2000) there are two main control methods to reduce bromate formation: Lowering the pH and adding ammonia. Decreasing the pH shifts the HOBr / OBr - balance with molecular ozone to the protonated species which is the oxime and is unable to form bromate. Decreasing the pH also slows the rate of formation of the OH radical from the decomposition of the ozone, thereby reducing bromate formation through the radical pathway. Ammonia depletion reduces HOBr to form masks and bromate by forming monobromamine (NH_2Br).

CONCLUSIONS

The chemical disinfection process in drinking water treatment causes the formation of unwanted disinfection by-products due to potential chronic toxicity. Chlorination results in the formation of many chloroorganic compounds such as chlorophenols, trihalomethanes (THMs) and haloacetic acids (HAAs), as well as organic compounds such as aldehydes, ketones and carboxylic acids by ozonation and bromate as the basic inorganic byproduct. In North America and Europe, the quality standards for THM, HAA and bromate are very low, and even in some cases the disinfection process has a good disinfection and optimization of disinfection byproducts is difficult to achieve. However, for many cases the formation of disinfection byproducts is much lower than standards and there is no need to take any control measures. However, these parameters must be routinely measured to ensure reliable process control.

In toxicological studies, it was observed that guinea pigs fed with bromate aqueous solution had tumors in kidney cells (22). This is why it is known to be an animal carcinogen. USEPA; Conducted a risk assessment study on a 70 kg adult per day 2 liters of water with a bromate concentration of 5 µg / l: Life-time risk was calculated to e 10-4. This value means that every 10,000 people will get cancer due to bromate intake (23).

Bromate is in the group of 2B cancer (weak effect) and has mutagenic effect. Depending on the duration of exposure and ozone concentration, the toxic effect changes. In short-term exposures, nausea, vomiting, abdominal pain, anuria, diarrhea, central nervous system depression, hemolytic anemia, pulmonary edema may lead to renal failure and deafness in long-term exposures (23).

Although the formation of disinfection by-products is very low in most cases and does not require any control measures, these parameters should be routinely measured to ensure reliable process control. Today, there are technologies that can monitor online. With these methods it is possible to eliminate the risks posed by the ozonation process to ensure safe disinfection.

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