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Research Article

AN OVERVIEW: OZONATION A TECHNIQUE FOR WATER PURIFICATION AND SIMHASTHA 2016

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ABSTRACT

Water disinfection means the removal, deactivation or killing of pathogenic microorganisms. Contaminated water is estimated to result in more than half a million deaths per year. Reduction of waterborne diseases and development of safe water resources is a major public health goal in developing countries. Ozone was first used in water treatment in the late 1800s. Ozone has a greater disinfection effectiveness against bacteria and viruses compared to chlorination. In present research paper we will discuss advantages of ozonation over chlorination. This technique has been successfully applied for the first time during a festive congregation, Ujjain Simhastha 2016, in India. With this technique Kshipra's water is cleaned in a Natural process.

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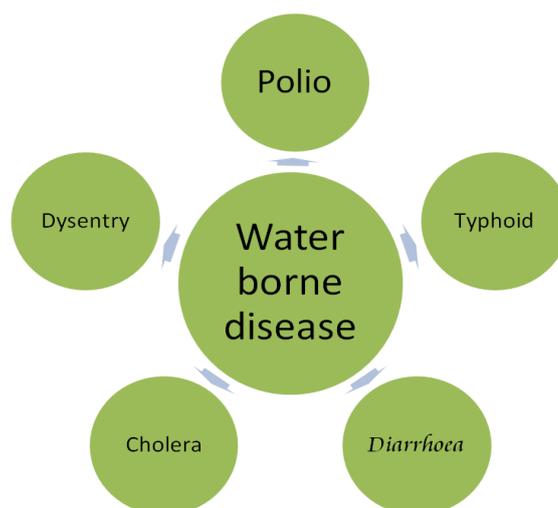
INTRODUCTION

Water is essential for life. The amount of drinking water required is variable. It depends on physical activity, age, health issues, and environmental conditions. Water makes up about 60% of weight in men and 55% of weight in women. Infants are about 70% to 80% water while the elderly are around 45%. Typically in developed countries, tap water meets drinking water quality standards, even though only a small proportion is actually consumed or used in food preparation. Other typical uses include washing, toilets, and irrigation. Reduction of waterborne diseases and development of safe water resources is a major public health goal in developing countries. Bottled water is sold for public consumption in most parts of the world. Water covers some 70% of the Earth's surface. Approximately 97.2% of it is saline, just 2.8% fresh. Contaminated water is estimated to result in more than half a million deaths per year Fig.1.

Water disinfection means the removal, deactivation or killing of pathogenic microorganisms. Microorganisms are destroyed or deactivated, resulting in termination of growth and reproduction. When microorganisms are not removed from drinking water, drinking water usage will cause people to fall ill.

Ozone was first used in water treatment in the late 1800s and ozone is more widely used in Europe and Asia than the United States. Ozone is an unstable, colorless gas comprising of three oxygen atoms and it is a product smelled near an electric spark

or lightning strike similar to smell of the air after a major thunderstorm. The gas will readily degrade back to oxygen, and during this transition a free oxygen atom, or free radical is formed. The free oxygen radical is highly reactive and short lived, under normal conditions it will only survive for milliseconds.



With the 1996 reauthorization of the Safe Drinking Water Act, Ozone was named as among a best available technology (BAT) for small system compliance to National Primary Drinking water Regulations as overseen by the US Environmental Protection Agency. Disinfection treatment tech

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The word cancers cares people, and chlorination does produce chemicals that are more carcinogenic than the organic compounds initially present. Such compounds accumulate in fatty structures such as the membranes of cells, so concentrations tend to be higher in organisms than in the water in which they grow.

Ozone is extremely active as a disinfectant. The benefits are the strength of the disinfection and the lack of potentially harmful by-products like trihalomethanes (THMs). A wider range of organisms is killed by ozonation than by chlorination. Infusion of ozone gas into water, thus removal of effluents from waste water treatment plants in process called ozonation. Ozone water purification system is one of the most advanced and superior water Treatment Technology in the water Industry. It also achieves excellent removal of taste and odors. In fact, ozone is 1.5 times stronger than chlorine and many times faster acting. The reactions, in general, are more rapid than that of chlorination processes

Ozone, being a strong oxidizing agent reacts directly with constituents found in solution and is also capable of forming highly reactive chemical agents that can contribute to additional oxidizing reactions. The most common of these reactive agents is the hydroxyl free radical. Conditions that contribute to the formation of these reagents vary with water quality. The actual disinfection occurs as the oxidation reactions damage and destroys critical components of microorganisms. Like chlorination, ozonation also forms a residual, however due to its short life span it is negligible for preventive measures in distribution systems.

Ozone has a greater disinfection effectiveness against bacteria and viruses compared to chlorination. Ozone can be used as a disinfectant, decolorizer, deodorizer, detoxifier, precipitant, coagulant and for removing tastes. In addition, the oxidizing properties can also reduce the concentration of iron, manganese, sulfur in the water to form insoluble metal oxides or elemental sulfur and reduce or eliminate taste and odor problems. These insoluble particles are then removed by post-filtration. Organic particles and chemicals will be eliminated through either coagulation or chemical oxidation. Ozone is unstable, and it will degrade over a time frame ranging from a few seconds to 30 minutes. The rate of degradation is a function of water chemistry, pH and water temperature. Ozone can eliminate a wide variety of inorganic, organic and microbiological agents including bacteria, viruses, and protozoans (such as: Giardia and Cryptosporidium) Fig.2.

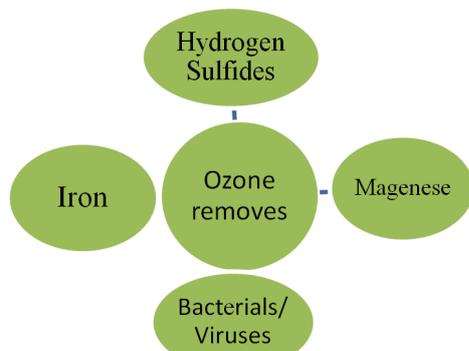


Fig.2

Ozone is used in the same manner as chlorine. The major difference is that ozone is unstable so cannot be produced and transported to the point of use. It must be generated at the point of use.

Preparation of Ozone

1. Ultraviolet light
2. Cold plasma and
3. Corona discharge (hot spark).

Ultraviolet and cold plasma are commonly used in therapeutic applications. Ultraviolet is useful when we want to produce a slow, steady stream of ozone, while cold plasma can produce greater quantities within a shorter period of time.

Corona discharge was originally designed for industrial use, but has been made available for home or personal use. Corona discharge generators are considered the best for producing medical-grade ozone water. Ozone production on site, via normal corona discharge, eliminates the problems of transporting, storing and handling of hazardous and dangerous materials. Medical-grade ozone generators cost \$3,000 or more. However, home-grade ozonators begin around \$300. For water treatment, ozone is produced by an electrical corona discharge or ultraviolet irradiation of dry air or oxygen. Ozone can be injected or diffused into the water supply stream.

Mechanism of action

1. Direct oxidation
2. Indirect oxidation by the hydrogen peroxy and hydroxyl free radicals.
3. Ozonolysis

Ozone reacts in water, or any aqueous solution, in two ways:

Direct Action as molecular ozone via three mechanisms; (slow and very selective), forming aldehydes, ketones and carboxylic acids,

- **Cyclo addition** (+ & -); on unsaturated bonds, as a dipole.
- ozonide > carbonyl > hydroxy-hydro peroxide > carbonyl & hydrogen peroxide
- **Electrophilic** (+); on molecular sites with strong electronic density.
- aromatics (phenol & aniline)
- **Nucleophilic** (-); on molecular sites with an electronic deficit, usually on carbons carrying electron withdrawing groups.

Indirect Action via radicals formed as it decomposes in water;

A few such radicals are as follows;

- Hydroxyl radical, OH^\cdot , a main reactive ingredient
- Hydroperoxide radical, HO_2^\cdot
- Superoxide radical ion, $\text{O}_2^{\cdot-}$
- Ozonide radical O_3^\cdot

Comparison of ozonation over chlorination

- 1 High oxidation potential
- 2 Powerful bactericide, virucide

- 3 Reacts thousand time faster than chlorine
- 4 Does not produce carcinogenic THM's (halogenated compounds)
- 5 No residual of chlorinated compound
- 6 Excess ozone gets decomposes automatically into beneficial oxygen residual as a product
- 7 Generated electrically does not need addition of any chemicals into treated water
- 8 Ozonated effluents are less toxic
- 9 Short contact time (app 10 to 30 min)
- 10 Generated on site so eliminate handling, transportation, storage

Ozone has been used to disinfect water in the US and France for several decades Ozone has been employed in over 3,000 large scale municipal plants worldwide. Since world war II, Ozonation has become the primary method to assure clean water in Switzerland, West Germany and France. More recently, major fresh water and waste water treatment facilities using ozone water treatment methods have been constructed throughout the world.

In our country first time a major initiative in this direction was taken by M.P. Government in Ujjain to clean Kshipra for Simhastha pilgrams. The estimated cost of project was about Rs. 9 Crore .Ozone gas was used to disinfect and purify water in Kshipra River for pilgrims taking a holy dip during Simhasth 2016.

Ujjain Municipal Corporation and administration released bubbles of ozone from the bottom of the river through pipelines so as to clean water during the festival. Five spots had been identified in Kshipra River where the pipelines were laid. These ozone gas plants were installed by Poorab logistics Gurgoan at Ram Ghat, Gaughat, Lalpul, Mangalnath and Narsingh Gaht. The pipeline was connected to ozone gas plants generating ozone continuously by corona discharge method to treat the river water. About 600 gm/hr ozone dosing was practiced in the river water at each of the five locations. Ozone was pumped into the pipelines, which would have released points attached to it. Soon after the ozone gas was released it disinfected the water. During one month of Kunbh mela, every day about 100 oxygen cylinders were used in five units. These five units had been continuously used during 24 hours and very well controlled by Supervisory Control and Data Acquisition (SCADA) software. The observed values of parameters viz. Dissolved oxygen, Biochemical oxygen demand, pH and Temperature during the Simhastha festival. The real time monitoring results helped the administration to take immediate measures like aeration, ozonation, addition of fresh waters etc to maintain the water quality. The Paddle wheel aerators, fountains and surface aerators were installed by Urban Administration and Development (UAD) Department/ local administration in the river bed. The best part was that an LED installed at the Ghat displayed the purity level of kshipra round the clock basis. It was informed by Water Resources Department that the pilgrims took bath in the flow of 2 cubic Meter water in kshipra on the day of Royal dip, it was noticed that the water appeared clear even after the bath. For the first time in the country water of any river was being cleaned through this method. In this way ozonation technique again proved to be a very powerful and effective water purification

and disinfection technique during Simhasth 2016 where one crore pilgrims took holy dip for one month.

CONCLUSION

When comparing the economics cost of an ozonation system with other treatment system there are some key factors to consider, There is no need to purchase , ship or store chemical or disinfectants, no labor for handling as well as many health and safety concerns are reduced or eliminated. Ozone is superior to any other disinfection method because of its high oxidation state .It is not typically associated with by-products, and naturally reverts to oxygen, so no taste or odor is associated after its use. This approach is being considered as a means to avoid using chlorine as the primary disinfectant. Purification of water with ozone is the superior treatment technology. Ozone water treatment is in keeping with the true environment.

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