University of Belgrade
Technical Faculty in Bor and
Mining and Metallurgy Institute Bor

43rd International October Conference on Mining and Metallurgy

IOC 2011

PROCEEDINGS

Editors:
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Dragana Živković
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October 12 - 15, 2011
Kladovo, Serbia

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Publisher: University of Belgrade - **Technical Faculty in Bor**
For the publisher: Dean Prof. dr Milan Antonijević
Circulation: 250 copies

Printed in Serbia by „Grafomed-trade" Bor

ISBN 978-86-80987-87-3

Kladovo, Serbia, October 12-15, 2011

ELECTROCHEMICAL WATER TREATMENT DEVICES

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Abstract

Drinking water treatment plays an important role in maintaining public health. Chlorine is the most often disinfectant used for microbiological protection of water. Required residual chlorine concentration must be in treated water. The chlorine residual must be 0.5 mg/L at the entrance into the distribution system and 0.25 mg/l at consumers, according to the law. Any less and there is no guarantee that the water has adequate quality. The characterization of chlorinated by-products, particularly THMs (three-halo-methane's). The risks related to THMs formation force the community to look for alternative water sources, treatment methods or disinfectants. As an alternative disinfectant, ultraviolet germicidal irradiation (UV) commonly used in preoxidation. This study presents the results of combination UV and chlorine disinfection.

Key Words: water disinfection, water chlorination, UV disinfection

1. OVERVIEW OF THE EXISTING TECHNOLOGIES FOR WATER DISINFECTION IN THE WORLD

Four different technologies for water disinfection are used nowadays in the world:

- disinfection with gaseous or liquid chlorine;
- disinfection with ozone;
- disinfection with hypochlorite solution produced by the electrolysis of 3% solution of sodium chloride;
- disinfection with chlorine-dioxide (ClO_2).

The oldest and the most exploited one, which is known as conventional, is the disinfection with gaseous or liquid chlorine. During the last two decades ozonization has also been used, while only recently the other two technologies were used. The biggest producers of the equipment for the water treatment in the world (CAPITAL CONTROLS, WALLACE & TIERNAN, PROMINENT, TRAILIGAZ, etc.) mainly possess all mentioned technologies for water disinfection. The basic characteristics, i.e. the advantages and disadvantages of all technologies are given in Table 1.

The possible solution of the above given problem is removal of organic mater (formation of three-halo-methane's during the chlorinating) by strong and unstable oxidants in pre- treatment, and than application of oxidants with longer residual effect in main treatment. (1,2,3) Raw water firstly enters into device for magnetic treatment distorting the solvate shells of magnesium and calcium ions. After magnetic treatment, water enters photo- catalytical reactor in witch several meta stabile compounds are formed.

The ultraviolet (UV) oxidation process is designed to destroy dissolved organic contaminants (4,5) through an advanced chemical oxidation process using ultraviolet radiation and hydrogen peroxide. Hydrogen peroxide is added to the contaminated water, and the mixture is fed into the treatment system. The treatment system contains one or more oxidation chambers. Each chamber contains one high-intensity UV lamp,. mounted in a quartz tube. The contaminated water flows in the space between the chamber wall and the quartz tube in which each UV lamp is mounted. UV light catalyzes chemical oxidation of organic contaminants in water by its combined effect upon the organic substances and reaction with hydrogen peroxide. First, many organic contaminants that absorb UV light may undergo a change in their chemical structure or may become more reactive with chemical oxidants. Second and more importantly, UV light catalyzes the breakdown of hydrogen peroxide to produce hydroxyl radicals, which are powerful chemical oxidants. Hydroxyl radicals react with organic contaminants destroying them and producing harmless carbon dioxide, halides, and water byproducts. The process produces no hazardous by-products or air emissions. The hydrogen peroxide oxidation equipment includes circular wipers attached to the quartz tubes. These wipers periodically remove solids that may accumulate on the tubes; a feature designed to maintain treatment efficiency.

Table 1. Advantagees and disadvantagees of the existing technologies for water disinfection

TECHNOLOGY	ADVANTAGES	DISADVANTAGES
Gaseous, or liquid chlorine	Very successful disinfection Relatively low cost of exploitation Medium investment expenses Removal of ammonia compounds from water	Risk of chlorine leaking during the transport and storage of gaseous chlorine (ecological catastrophe) Necessity of trained workers for hand ing Impossibility of storage of higher amount of gaseous chlorine Chlorinating plants must be located out of the towns Formation of three-halo-methane's during the chlorinating
Ozone	Very successful disinfection Production of ozone on the site of the ozonization Absence of three-halo-methane's in treated water Ecological technology	Very high investment expenses Very high cost of exploitation Necessity of trained workers for handling Short time of activity of ozone as a disinfectant (about 1h - it is usually combined with some other technology of disinfection, e.g. chlorinating)
Hypohlorite * (HIPOGEN®)	*Very successful disinfection* *Production of hypochlorite on the site of the chlorinating* *Ecological technology* *Removal of ammonia compounds from water* *Low cost of exploitation* *Medium investment expenses* *Possibility of storage of salt for a long time of exploitation* *(0.5 to 1 year)* *Unnecessity of trained workers for handling* *Completely automatized operation*	*Formation of three-halo-methane's during the chlorinating*

	Possibility of remote control	
chlorine-dioxide ClO_2	Very successful disinfection Production of ClO_2 on the site of the chlorinating There is no formation of three-halo-methane's	Very high investment expenses Very high cost of exploitation Necessity of import of the row materials for ClO_2 production Impossibility of storage of higher amount of row materials It does not remove ammonia compounds from water

'*Characteristics are mainly given for the system HIPOGEN®.*

The chemical oxidation process in the hydrogen peroxide oxidation system is dependent upon a number of reaction conditions that can affect both performance and cost. The process variables that are related to the contaminated water condition are:

- Type and concentration of organic contaminant
- Total organic substances present
- Light transmittance of the water (turbidity or color)
- Type and concentration of dissolved inorganic substances (e.g., carbonates and iron)
- pH.

The process variables that are related to the treatment process design and operation are:

- UV and hydrogen peroxide dosage
- pH and temperature conditions
- Use of supplementary catalysts treatment mode (batch, recycle, or continuous).

After UV treatment and separation column, water is subjected to further treatment in two electrochemical reactors. One reactor serves for production of noble metal ions, while other produces ions of active chlorine (6).

Hipogen provides on site production of sodium hypochlorite, on demand from brine, which is safer to store than chlorine gas. Additionally when bulk salts in used the process requires no chemical handling. Up to 1kg capacity of equivalent chlorine per hour. Efficient operation giving 1kg of equivalent chlorine from as little as 2,5-3kg of salt (NaCl). Comprehensive alarm specification combined with a mimic control panel offering easy identification of system faults. Minimal maintanance requivements.

HIPOGEN presents a real alternative to gaseous chlorine, enabling completely safe disinfection with lower expenses. It can be used for drinking water disinfection, for waste textile and food industry waters treatments and also for swimming poll water disinfection.

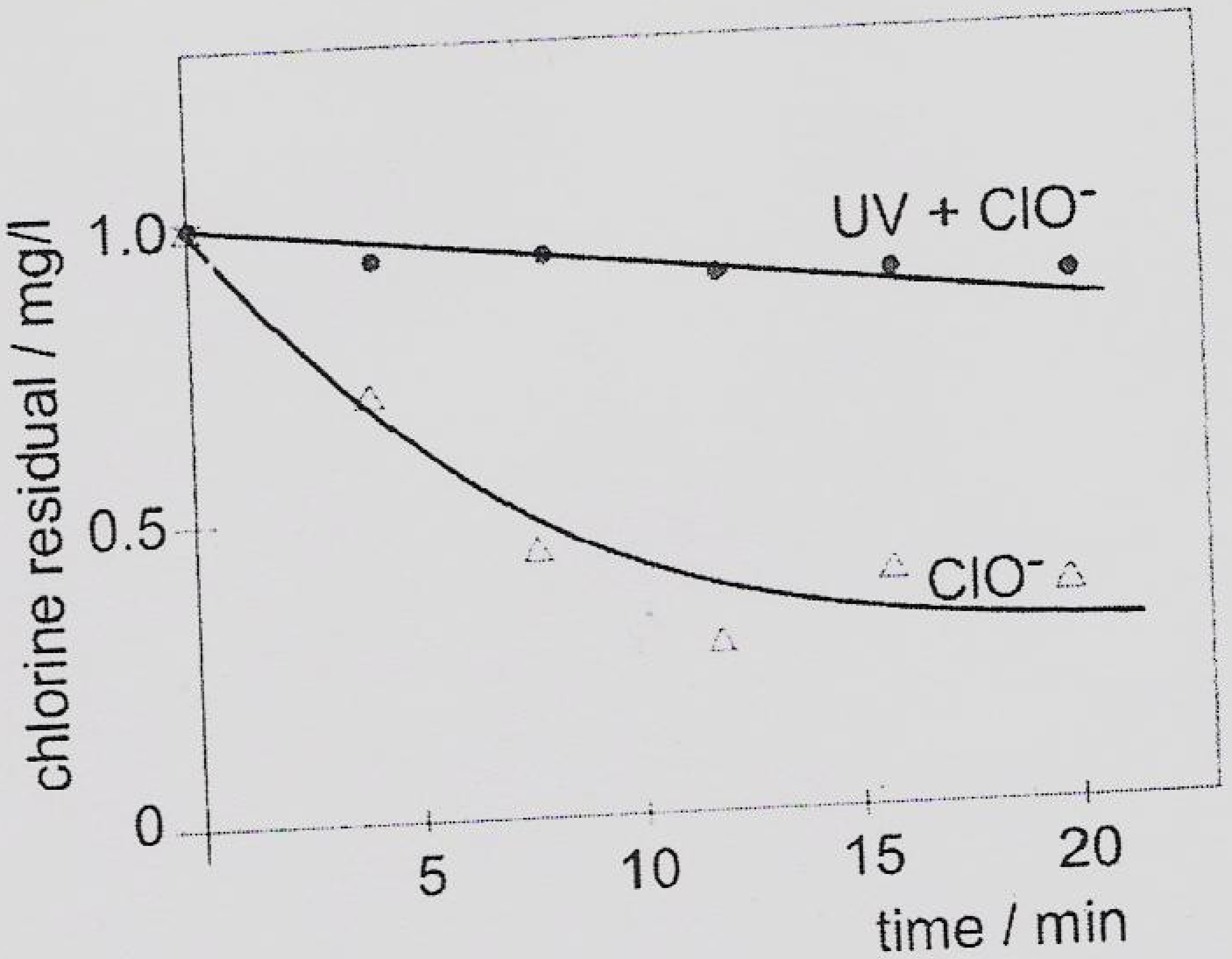

Figure 1. Experimental results for chlorine residual distribution in drinking water mains of "Obrenovic tim" Dobanovci a) UV irradiation (preoxidation) after that chlorination ClO^- b) only chlorination ClO^-

CONCLUSION

From the characteristics presented in this work it could be concluded that on site water chlorination combination with UV ray, has several advantages over the other technologies, with the most important one being ecological aspect of this technology.

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