International Journal of Mathematics and Physical Sciences Research ISSN 2348-5736 (Online)
Vol. 5, Issue 1, pp: (68-72), Month: April - September 2017, Available at: www.researchpublish.com

Assessment of Free Residual Chlorine - Elobeied Town – North Kordofan State -Sudan

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Abstract: **This analytical study was conducted at Elobeied Town – North Kordofan State – Sudan to assess free residual chlorine. 165 samples (55 per season) were collected for analysis of free residual chlorine from surface treated water and distributed , before treatment , after treatment ,Areas near to treatment plant , middle area , Far area from water treatment plant , and samples from local storage inside houses (Pottery) .At the interval from 2009 – 2011. The calculation of samples according to(1) samples per (10000) population, plus 10 additional samples (W.H.O 1993). Chlorine residual declined to non or less than 0.2mg/l specially in rainy season . and 0.10 mg/l free residual chlorine after treatment in winter season and 0.00 mg/l in far area from water treatment plant.**
Time and Place Limitation: This study was carried out during June 2009 to December 2011 at Elobeied Town North Kordofan State - Sudan.
Constrains: The natural constrains (Winds, rains and floods which affect in samples reading).

Keywords: (Free– Residual– Chlorine – Dose – Hypochlorous – Hypochlorite - Prechlorination).

I. INTRODUCTION

Chlorination of public water supplies has been practiced for almost 100 years in the United States. Although the pros and cons of disinfection with chlorine have been extensively debated, it remains the most widely used chemical for disinfection of water in the U.S. Comprehensive information explaining chlorine chemistry in water treatment is available in several excellent references describing chlorination and disinfection practices. An overview emphasizing general chemistry of chlorine disinfection will be presented here. Chlorine usually is added to water as the gaseous form or as sodium or calcium hypochlorite. Chlorine gas rapidly hydrolyzes to hypochlorous acid according to the following equation.

$Cl_2 + H_2O \rightarrow HOCl + H^+ + Cl^-$

Similarly, aqueous solutions of sodium or calcium hypochlorite will hydrolyze according to

$Ca(OCl)_2 + 2H_2O \rightarrow Ca^{2+} + 2HOCl + 2OH^-$

$NaOCl + H_2O \rightarrow Na^+ + HOCl + OH^-$

The two chemical species formed by chlorine in water, hypochlorous acid (HOCl) and hypochlorite ion (OCl^-), are commonly referred to as “free available” chlorine. Hypochlorous acid is a weak acid and will disassociate according to: $HOCl \rightarrow H^+ + OCl^-$.(1). Chlorination has virtually eliminated serious waterborne outbreaks such as dysentery, cholera and typhoid fever.(8).

1.1 Definition:

1.1.1 Free available residual chlorine: Is that residual chlorine that exists in water as hypochlorous acid and hypochlorite ion.

1.1.2 Chlorine demand: Is the difference between the amount of chlorine applied to water and amount of free , combined or total available chlorine remaining at the end of specified contact period.

1.1.3 Prechlorination : Is the application of chlorine to water prior to any other unit treatment process.

1.1.4 Free residual chlorination: Is the application of chlorine in water to produce , either directly or through the destruction of ammonia , a free available chlorine residual and to maintain that residual through part or all of water treatment plant or distribution system. (Break point chlorination is encompassed by this practice).(2).

1.2 Water Security:

Disinfection itself is crucial to water system security, providing immediate and lasting protection against biological contamination. Conventional filtration and disinfection processes will remove or reduce the threats posed by numerous potential bioterrorism agents. However, even multiple conventional treatment barriers cannot ensure safety from all biological attacks.(3)

1.3 Effects on Human:

Exposure to chlorine, hypochlorous acid, and hypochlorite ion through ingestion of household bleach occurs most commonly in children. Intake of a small quantity of bleach generally results in irritation of the oesophagus, a burning sensation in the mouth and throat, and spontaneous vomiting. In these cases, it is not clear whether it is the sodium hypochlorite or the extremely caustic nature of the bleach that causes the tissue injury.

The effects of heavily chlorinated water on human populations exposed for varying periods were summarized in a report that was essentially anecdotal in character and did not describe in detail the health effects observed . In a study on the effects of progressively increasing chlorine doses (0, 0.001, 0.014, 0.071, 0.14, 0.26, or 0.34 mg/kg of body weight) on healthy male volunteers (10 per dose), there was an absence of adverse, physiologically significant toxicological effects in all of the study groups . It has been reported that asthma can be triggered by exposure to chlorinated water Episodes of dermatitis have also been associated with exposure to chlorine and hypochlorite.(4), Chlorination is employed primarily for microbial disinfection. However, chlorine also acts as an oxidant and can remove or assist in the removal or chemical conversion of some chemicals—for example, decomposition of easily oxidized pesticides, such as oxidation of dissolved species (e.g. manganese(II)) to form insoluble products that can be removed by subsequent filtration and oxidation of dissolved species .(6) to more easily removable forms (e.g. arsenite to arsenate). Although historically chlorine dioxide was not widely used for drinking-water disinfection, it has been used in recent years because of concerns about THM production associated with chlorine disinfection.(7)

1.4 Chlorination and intermittent supplies:

There is no point in chlorinating pipe networks if the water supply is intermittent. All pipe systems leak and when the water supply is switched off, the pressure will drop and contaminated water will enter the system through the breaks in the pipe wall. No level of residual chlorine acceptable to consumers will be able to deal with such high levels of contamination. All intermittent water supplies should be assumed to be contaminated and measures taken to disinfect water at the point of use.(5).

1.5 Critical factors for controlling the replication of bacteria in finished drinking water are:

• Maintenance of a disinfectant residual

• Limitation of biodegradable organic material

• Control of corrosion.(9).

2. STUDY METHODS AND MATERIAL

2.1Testing for chlorine residual:

The quickest and simplest method for testing for chlorine residual is the dpd (diethyl paraphenylene diamine) indicator test, using a comparator. A tablet of dpd is added to a sample of water, colouring it red. The strength of colour is measured against standard colours on a chart to determine the chlorine concentration. The stronger the colour, the higher the concentration of chlorine in the water. Several kits for analysing thechlorine residual in water, are available commercially. The kits are small and portable.(5).

2.2 When and where to test water:

Continuous chlorination is most commonly used in piped water supplies. Regular chlorination of other water supplies is difficult and usually reserved for disinfection after repair and maintenance. It is common to test for chlorine residual at the following points:

• Just after the chlorine has been added to the water to check that the chlorination process is working.

•At the outlet of the consumer nearest to the chlorination point to check that residual chlorine levels are within acceptable levels.

• At the furthest points in the network where residual chlorine levels are likely to be at their lowest. If chlorine levels are found to be below minimum levels it might be necessary to add more chlorine at an intermediate point in the network.(5).

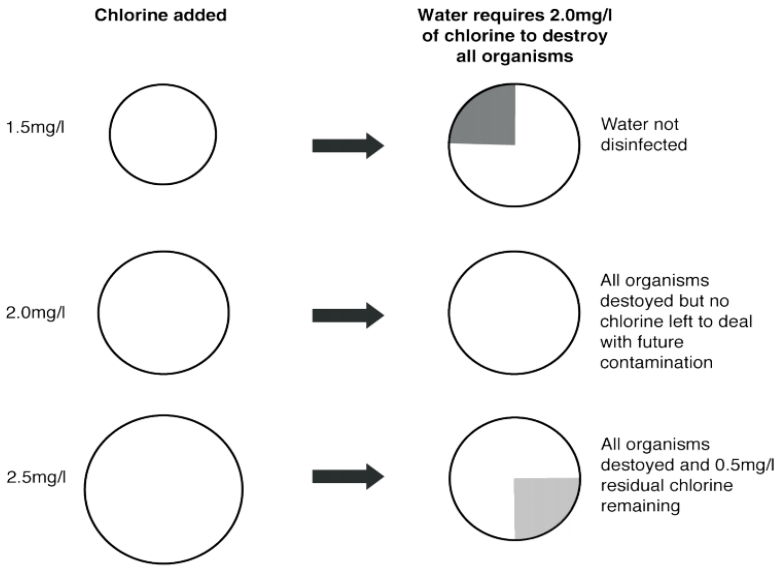

Figure 2-1: The effect of chlorine residual (5)

2.3 Sample size:

Water samples were selected according to WHO guidelines (1993). is 55 sample , every season , summer , winter , and rainy season.

(The total sample for the three seasons is165 samples).

-Note:- The calculation of samples according to(1) samples per (10000) population, plus 10 additional samples (W.H.O 1993).

3. RESULTS

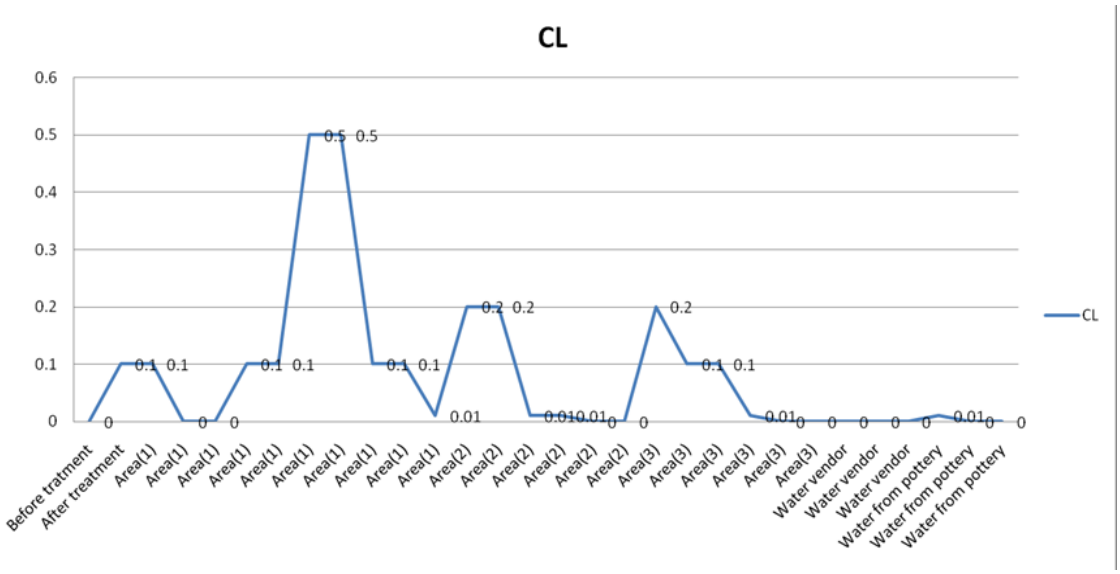

Figure 3.1: The Free residual chlorine of surface water January (Winter)- Elobeid Town

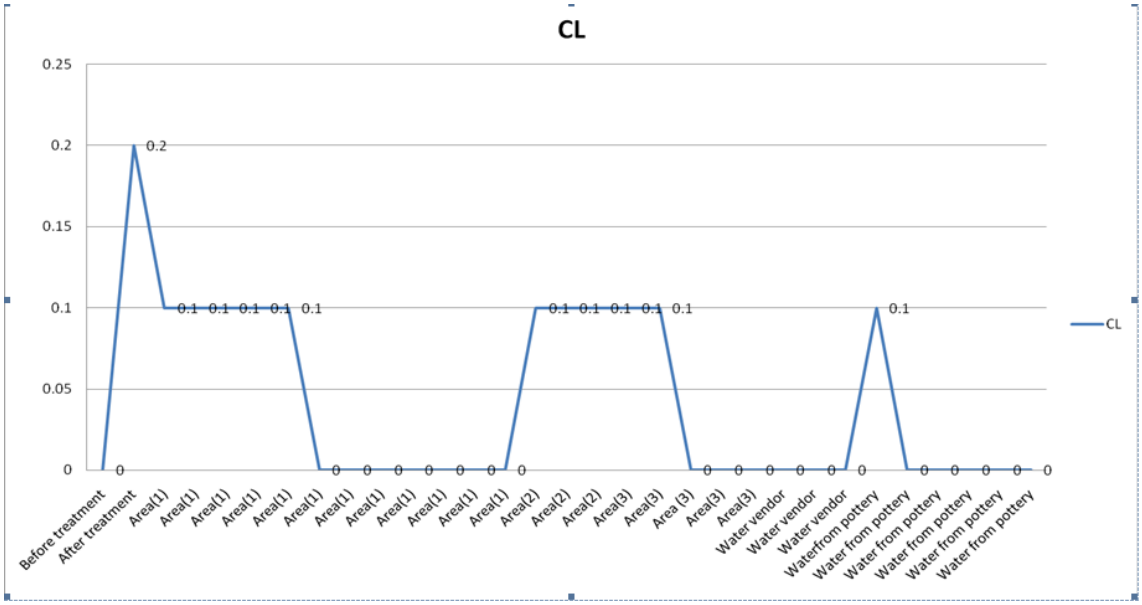

Figure 3.2: The residual Chlorine of surface water April (Summer)- Elobeid Town

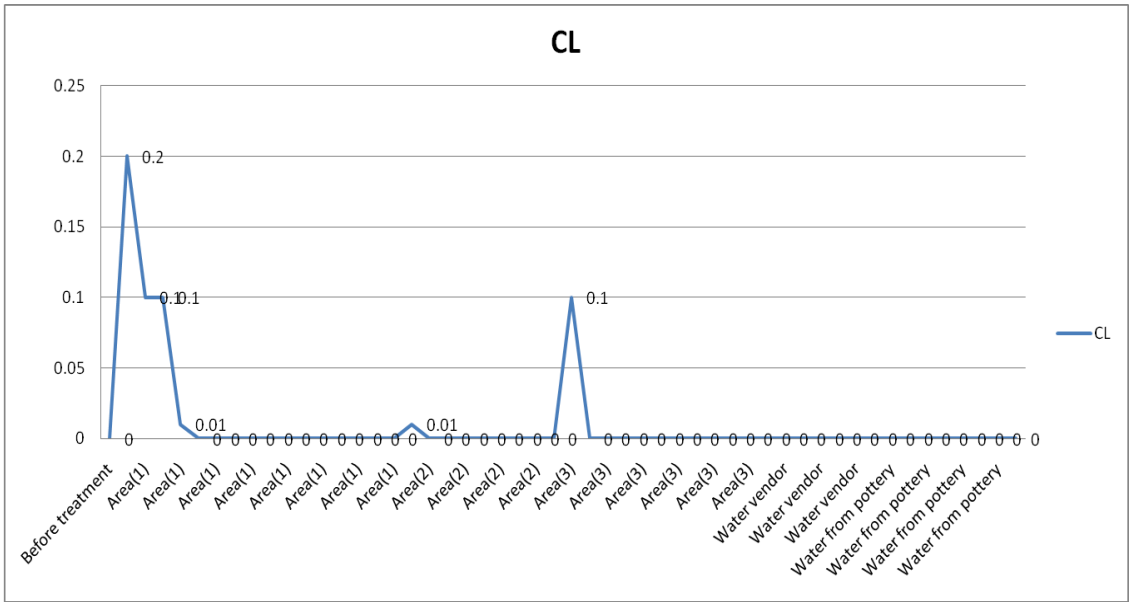

Figure 3.3: The residual Chlorine of surface water July (Rainy season)- Elobeid Town

4. DISCUSSION

The free residual chlorine of surface water in winter in the treatment plant, after treatment was (0.1mg/lit) , this value is lower than W.H.O guidelines and SSMO standards (2007) recommended value , (Where concentration of free residual chlorine must be 0.5mg/lit after a contact 30min)

The study reveals that the residual chlorine of surface water in winter in area (1) , adjacent area to Elobeid treatment plant, was (0.1mg/lit - 0.00mg/lit - 0.1mg/lit - 0.5mg/lit - 0.1mg/lit) . This results of free residual chlorine do not comply with W.H.O guidelines and SSMO (2007) which advocate that , the free residual chlorine after a contact time of 30min in network must be not less than 0.2mg/lit , except for two samples where the residual chlorine was 0.5mg/lit , this high residual chlorine may be due to in - house disinfection of water tanks or that the contact time in the treatment plant was not enough since this , was recorded in areas near the treatment plant .

The free residual chlorine in area(2) middle of surface water network in winter was (0.1 mg/lit - 0.2 mg/lit - 0.01 mg/lit - 0.00 mg/lit) . This result means there is no free residual chlorine in the network which is very dangerous if there is any leakage in the distribution system which may cause contamination to water supply

The free residual chlorine in the farthest area(3) from the treatment plant was (0.00mg/lit - 0.2mg/lit - 0.1mg/lit - 0.01mg/lit) , these results reflect the low residual chlorine concentration and the absence of free residual chlorine in the distribution system ,

The free residual chlorine (after storage in treatment plant) in summer was 0.2mg/lit This is not in agrees with the W.H.O and SSMO (2007) guidelines (which recommend the concentration in treatment plant after contact 30min must be 0.5mg/lit)

The free residual chlorine in water samples (in the treatment plant in the rainy season) , was 0.2mg/lit . This is very low according to SSMO (2007) guidelines which recommends 0.5 mg/lit .

5. CONCLUSION

Water treatment is inadequate in terms of the quality, and the free residual chlorine of treated water ranged between 0.00mg/lit to 0.2 mg/lit across all seasons of the year, In rainy season the poor water quality in terms of absence of chlorine in different areas in water supply systems in the town. I recommend Free Residual chlorine should be maintained in the distribution system at 0.2mg/L in normal conditions and 0.5mg/L after storage and contact time of 30min in treatment plant , and up to 0.5mg/lit during outbreaks. 3. Chlorine and other coagulants must be available all the time in the treatment plant.

ACKNOWLEDGEMENT

I would like to thank the Dr. Bashir Mohammed Elhassan, Head department of chemical engineering faculty of Engineering , University of Khartoum , and the former Dean of Faculty of Public and Environmental Health - University of Khartoum who provide valuable advices guidance through the study .

I would like to thank Dr. Mohammed Elhaj Elkheder

I wish to gratefully acknowledge the help of Administration of Environmental Health / ministry of Health Khartoum state, and also for public health laboratory staff.

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