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Transit Monitoring of Residual Chlorine in Awe-Oyo Area of Nigeria Water Township Supply

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Abstract—**This research work is a study of transit dechlorination of public water supply through underground lead pipe to different destinations taking samples at an interval of 0.5km and the microbial analysis of the transported water. The amount of residual chlorine was determined using DPD lovibond method which is effective, accurate and less cumbersome. The pour plate method was used to detect the growth of Salmonellae Shigellae, total coliforms and other microbes that could be present in the water. With time, the transported water dechlorinates. After some covered distance, the residual chlorine of the water had completely diminished thereby supporting massive microbial growth. The study proposes the likely causes of the transit dechlorination of water and prescribes measures to make the source safe to the end users.**

Index Terms—**Dechlorination, DPD Lovibond method, Pour plate method, Salmonellae shigellae, Total coliforms.**

I. Introduction

Chlorinated drinking water's chief benefit is the protection of public health through the control of waterborne diseases [1]. It plays a paramount role in controlling pathogens in water that cause human illness.

Untreated or inadequately treated drinking water supplies remain the greatest threat to public health [2] especially in developing countries, where nearly half the population drink contaminated water. In these countries, diseases such as cholera, typhoid and chronic dysentery are endemic and kill young and old alike. Unfortunately, the availability of safe drinking water in many areas of developing countries is practically nonexistent, due to poverty, poor understanding of water contamination, and lack of a treatment and delivery infrastructure.

Disease-causing bacteria can infect humans and animals in several ways. Fecal waste from an infected host frequently carries organisms which cause diseases such as typhoid fever, paratyphoid fever, bacillary dysentery, infectious hepatitis and others [3]

According to the World Health Organization (WHO) "3.4 million people in developing countries, most of them children, die every year from diseases associated with lack of safe drinking water, inadequate sanitation and poor hygiene [4].

Chlorine is a highly efficient disinfectant, and it is added to public water supplies to kill disease-causing bacteria that the water or its transport pipes might contain [5]. Awe-Oyo is on latitude 7.37750 and longitude 3.75806 with population of about 500,000 people. The people living in certain axis of Awe-Oyo of Nigeria and neighborhood still rely on surface and subsurface water as primary source of water. This may be due to the weakness of the water authorities to extend their tentacles to such area. Even in metropolis where reasonably regular supply of water is being enjoyed, it is still very important to install water storage tanks for future use of water to take care of the irregularities of water supply [6]. Chlorine in the treated water is not stable and decreases rapidly [7]. Exposure to sunlight or other strong light or agitation will accelerate the reduction of chlorine [8] With time, the chlorine contents of water diminish until it disappear completely and drastically to an insignificant level. Chlorine as a biocide gets depleted consequently creating an ecosystem for microbes to thrive giving needs for their ecological studies. This research work however explains the chlorine profile of treated water for public consumption as it is transported to various destination through pipes within the Awe-Oyo locality.

II. Kinetics of Chlorination

Chlorine reacts with water to produce chlorine water which is a mixture of hydrochloric acid and hypochlorous acid.

$$Cl_2 + H_20 \longrightarrow HCl + HOCl$$

$$HOCl \longrightarrow H^+ + OCl^-$$

If ammonia is present in water either naturally or because it has been added, Chloramines will be formed as follows

$$NH_4^+ + HOCl \longrightarrow NH_2Cl + H^+ + H_20$$

$$NH_2Cl + HOCl \longrightarrow NH_4CL_2 + H_2O$$

$$NH_4CL_2 + HOCL \longrightarrow NCl_3 + H_2O$$

III. Mathematics of Microbial (Bacteria) Growth in Water

Bacteria reproduce by binary fission. One cell divides, producing two cells. Thus, if we start with a single bacterium, their multiplication therefore corresponds to a geometric progression

$$2^0 \longrightarrow 2^1 \longrightarrow 2^2 \longrightarrow 2^3 \longrightarrow 2^4$$

2^5 -------------- 2^n.

Taking a unit volume of a growing batch culture containing N_0 cells, then the number of cells after n

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divisions will be $N = N_0 \times 2^n$.

Therefore, $\log_{10} N = \log_{10} N_0 + n\log_{10} 2$

$n = 3.3(\log_{10} N - \log_{10} N_0)$

The generation time (g) is therefore t/n.

The rate of change in the microbial mass(x) during any time interval is proportional to the initial value of x Thus, during exponential growth, $\partial x/\partial t = \mu x$. Therefore, $\int dx/x = \mu\int dt$.

Integrating from x_0 to x and 0 to t, $x = x_0 .e^{\mu t}$

For doubling of x, $2 = e^{\mu td}$

Therefore, $\mu = \ln 2/t_d$

IV. Materials and Method

A. Sampling

Water is supplied on a weekly basis. Samples of water were collected from ten different points starting shortly after the supply from the water treatment plant at an interval of 0.5 km.

B. Free residual chlorine

The DPD lovibond method was used to determine the amount of free residual chlorine. The lovibond was manufactured by Tintometer Limited, Waterloo road, Salisbury; U.S.A. A comparator cell was rinsed and filled with water sample from one of the tanks up to the mark on the cell. The cell was placed in the carrier of the comparator which is in line with the colour standard. A second cell was rinsed and filled with the same water sample. A period of about 60-120 seconds was allowed for natural dissolution of the DPD tablet. The cell was shaken to ensure even mixing and later placed in the comparator. While holding the comparator facing natural light, the disc was rotated until the colour of the standard is the same as that developed by the DPD tablet. The value of the free residual chlorine was read in mg/L immediately and the same procedure was repeated for other water samples.

C. Microbiological analysis

The method used by [9-10] was adopted. The total colony count of bacteria was done by the pour plate method using nutrient agar (Oxoid).The samples were serially diluted and 0.2ml of an appropriate dilution was used to inoculate the plate. The plates were incubated at 37^0c for 24-48 hours, after which the colony count was determined Analysis of Salmonellae shigellae and Total coliforms were done using Selenite cystine agar and Eosine methylene blue agar respectively.

V. Results And Discussions

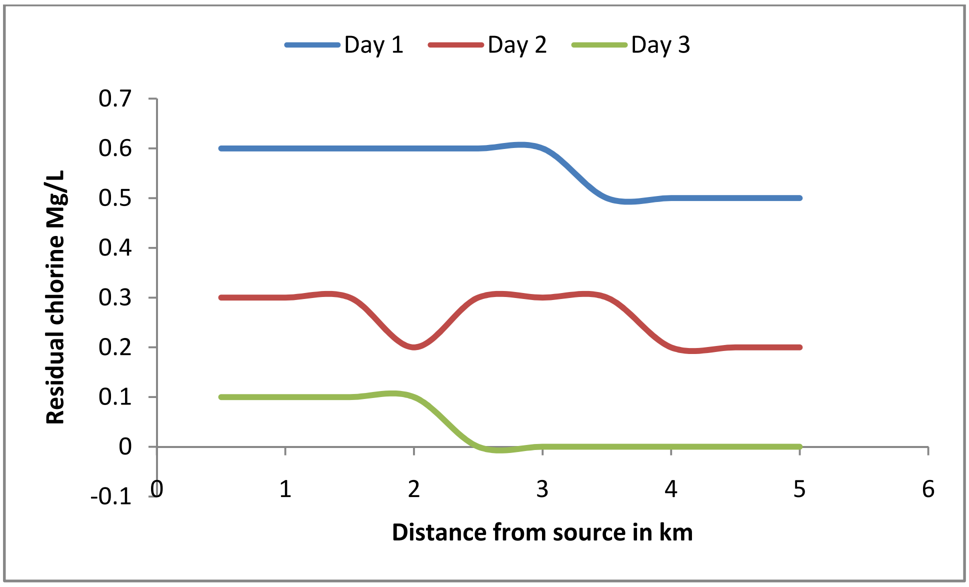

Fig. 1. Profile of Residual Chlorine with distance.

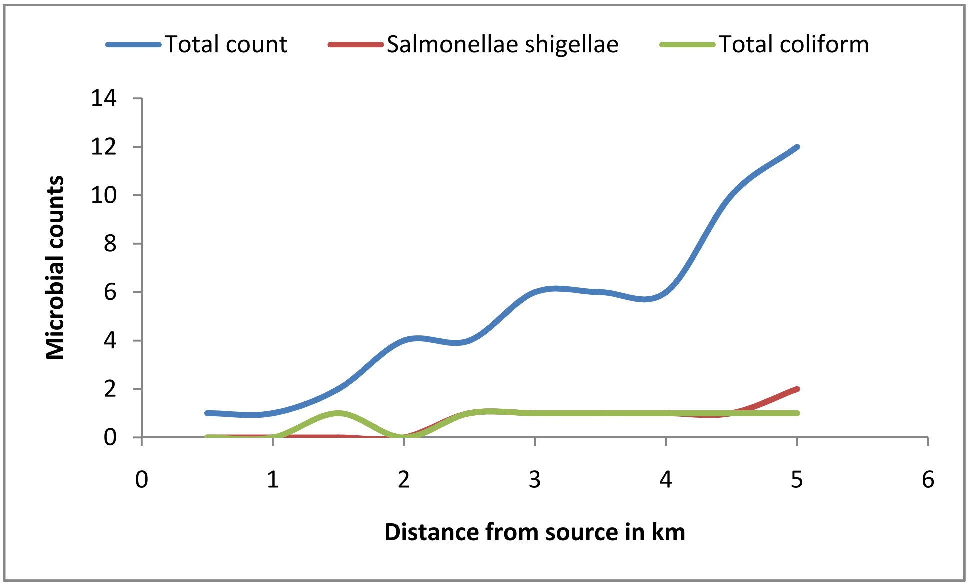

Fig. 2. Profile OF.Microbial Counts with Respect To Distance For Day 1

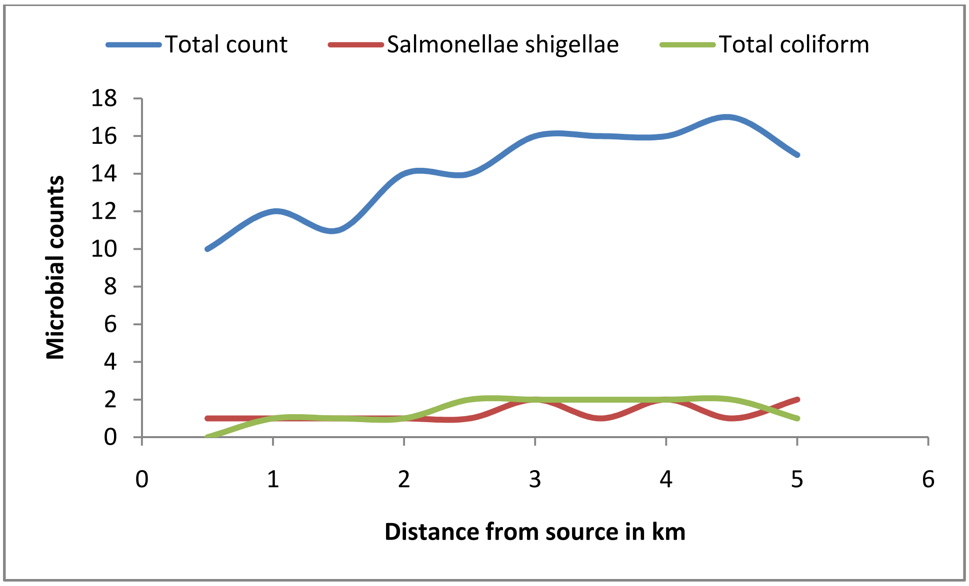

Fig. 3. Profile of.Microbial Counts With Respect to Distance for Day 2

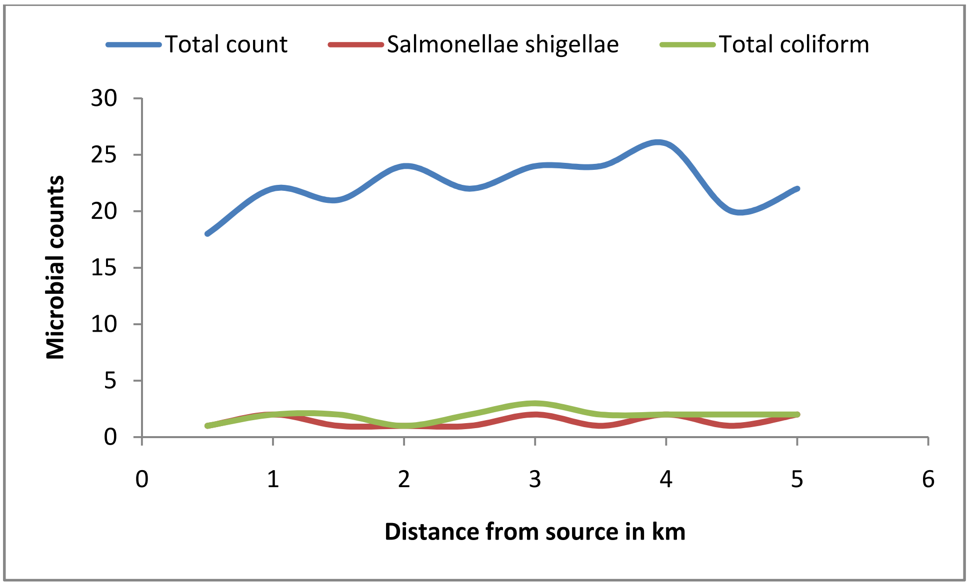

Fig. 4. Profile of Microbial Counts with Respect to Distance for Day 3

A. Discussion of Results and Conclusion

In FIG1, practically, it was shown that with increase in distance, the chlorine content diminishes. This could be as a result of chemical instability of the chlorinated water or efforts committed in combating impurities as the water flows .More residual chlorine was witnessed in samples collected on day 1.More microbial load appeared in samples collected on day 3.The residual chlorine of samples collected on day 3 greatly diminished, thereby supporting massive microbial growth.

FIG. 2, 3 & 4 describe the microbial load profile (total count, total coli form & salmonellae shigellae) with respect to distance. As samples were collected further, the chlorine content reduces, thereby also supporting massive microbial growth.

VI. Conclusion

The study therefore reveals that the chlorine level of the water supply for public use decreases with distance. Though the elaborate reason for the decrease could be sourced for elsewhere, it can still be concluded that some constituents of the chlorine water is unstable, and photo-sensitive. The combat with impurities of the lead pipe may account for the decline of the residual chlorine.

The appearance of salmonellae shigellae and total coliforms in some water samples render such samples unfit for drinking.

It can be concluded that treatment applied to water plants in the locality are not enough to absolutely eradicate microorganisms.

The higher the accuracy of calculated level of chlorine vended or dosed in stored water, the lesser the microbial growth.

Moreover, the microbial population rises when the degree of contamination of water increases. The contamination is attributable to reduced chlorine content, improper conditioning of pipes such as exposure of pipes to dusty environment and leakages of the pipes.

References

[1] Dolf, V.W, 2002, protecting public health: water chlorination, Euro chlor, Belgium
[2] Geldreich, EE, and M LeChevallier. 1999. Microbiological quality control in distribution Systems, Chapter pp. 18.1-18.49. In: Water Quality and Treatment (5th Ed.). Letterman, RD (Ed.). McGraw-Hill, Inc. New York,NY.
[3] Steel, E.W., 1989, Water supply and Sewage, McGraw-Hill Book Company, N.Y, 249- 250.
[4] AWWA, American Water Works Association. 1999. 20 City Survey.
[5] AWWA. American Water Works Association. 1995. Problem organisms in water: Identification and treatment. M7. Denver, CO.
[6] Choudhary, S.G, 1998,´ Emerging microbial control issues in cooling water systems. Hydrocarbon process journal` 77, 5, 91-102.
[7] Owolabi, R.U., Kareem, S.A., (2010) Dechlorination/On set of microbial growth in water storage tank, Journal of Applied Sciences Research, 6(6): 589-593.
[8] Cooper, W.J, Roscher, N.M and Slifer, R.A, 1982, ´Determining free available chlorine by DPD Colorimetric`, American water works association journal, 74, pp362.
[9] Adewoye, S.O. and Lateef, A., 2003,´Evaluattion of the microbiological characteristics of Oyun River –a polluted river in north central Nigeria. Pollution research.22, 457-461
[10] Bakare, A.A., Lateef, A., Amuda, O.S. and Afolabi, R.O., 2003,´The aquatic toxicity and Characterization of chemical and microbiological constituents of water samples from Oba river, Odo-oba, Nigeria`, Asian journal of microbiology, biotechnology and Environmental sciences 5, 11-17.
[11] Fawole, M.O and Oso, B.A, 1998, ´Laboratory manual of microbiology ,2nd Ed, Ibadan, spectrum.
[12] Federal ministry of water resources and rural development, 1990, ´Training guide for water Quality testing and control`, 2nd, Kaduna.
[13] Geldreich, EE. 1996. Microbial quality of water supply in distribution systems. Lewis Publishers, Boca Raton, FL.
[14] George, S., 1979, ´Basic water treatment`, 2nd Ed London.
[15] Hans, G.S., 1986, ´General microbiology` 7th ed, New York, Cambridge.
[16] Stander, G.J., Van, L.R., 1969,The reclamation of potable water from waste water, Water pollution Journal, 41,3,355
[17] Slechta and Culp, R.L., 1998, Advance waste water treatment, Van Nostrand Reinhold Company, N.Y, 136,241,246.