

# THEME 3

## WATER & WASTEWATER TREATMENT

# Dosing of Proper Oxidizing Agent as Pre-treatment to Kalatuwawa Water to Reduce the Trihalomethane (THM) Formation in Drinking Water

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## INTRODUCTION

Metals and other inorganic toxic substances management of reservoirs is aimed at the protection of human health and aquatic life from impacts caused by the release of toxic substances to surface waters. These reservoirs and lakes hold important fresh water ecosystems of the globe, in which a great number of species, including human beings interact with each other. Therefore special care must be taken when releasing substances in to the reservoir because of the unique physical and chemical characteristics of confined water. Metal and other inorganic substances are retained longer in both water and sediments than in flowing surface water which increases the risk of exposure of toxicants in terms of concentration and duration to both aquatic organisms and humans who depend on drinking water and food from reservoir.

The presence of metals and other inorganic substances in reservoir is attributable to both natural processes and human activities. Metals enter the reservoir as a result of natural physical and chemical processes such as weathering and leaching of soil and rocks. Ammonia and other inorganic toxic substances are released due to decomposition of organic matters. Therefore pre-treatment has to be introduced vigilantly minimizing disinfection byproducts (DBPs) effects.

Kalatuwawa water treatment plant was commissioned in 1960 to provide 68,000 m<sup>3</sup>/day drinking water to Colombo and suburbs - Kaduwela, Dehiwala, Maharagama. Kalatuwawa reservoir dam is 980 ft. in length and 80 ft. in height to retain the water and with the maximum 370 ft. MSL water level. This reservoir has its own catchment with native flora.

Kalatuwawa raw water contains high concentration of ammonia ( $0.578 \pm 0.469$  mg/dm<sup>3</sup>) and the highest concentration of ammonia of 1.92 mg/dm<sup>3</sup> was reported at the bottom of the reservoir. High concentration of iron ( $0.751 \pm 0.643$  mg/dm<sup>3</sup>) and the highest concentration of iron 12 mg/dm<sup>3</sup> was reported at the bottom of the reservoir. Colour levels were  $1.571 \pm 7.271$  Hz and the highest level of colour 90 Hz was reported at the bottom of the reservoir.

Kalatuwawa water treatment plant consists of an intake well with four valves, aeration, coagulation, flocculation, sedimentation with two units, filtration with ten numbers of filters and disinfection. Two turbines were installed to generate electricity. Existing aeration is not adequate to oxidize the inorganic and organic impurities in Kalatuwawa raw water and therefore pre-chlorine is used as oxidizing agent. PolyAluminum Chloride (PAC) is the coagulant and hydrated lime is used for the pH correction.

Pre-chlorination where chlorine is utilized not only to oxidize the iron, manganese, ammonia and organic compounds but also reacts with naturally occurring organic matter present in water to produce a group of organic compounds as by-product arising from chlorination which was classified as trihalomethane (THM). THMs are often used as indicator compounds for other DBPs. The four main THM compounds found in abundance are chloroform (CHCl<sub>3</sub>), bromodichloromethane (CHCl<sub>2</sub>Br), dibromochloromethane (CHClBr<sub>2</sub>) and bromoform (CHBr<sub>3</sub>). Many factors which will affect the THM formation are concentration and type of precursors, type of disinfectant and concentration and the

dosing point, temperature, pH, contact time and the length of the distribution network.

## METHOD

This study is carried out during a period of seventeen months starting from May 2013 to Oct 2014 to investigate THMs formation without pre chlorination where Potassium permanganate ( $\text{KMnO}_4$ ) is used as pretreatment to remove the organic and inorganic impurities. Apart from THMs, colour, turbidity, pH, total iron, manganese, ammonia and RCl levels were analyzed in treated water collected at sampling locations, treatment plant and after the jar tester. Raw water collected at the water treatment plant was also tested for the above parameters except RCl and THMs.

Different concentrations of  $\text{KMnO}_4$  ( $0.2 - 1.0 \text{ mgdm}^{-3}$ ) were used in laboratory level to find out the optimum dosage of  $\text{KMnO}_4$  to the Kalatuwawa water.

Analysis of free ammonia was carried out by a spectroscopic method which used Nessler's reagent with colorimeter (HACH DR 4000). Measurement of pH, RCl and turbidity were analyzed using pH meter (HACH), field colorimeter (HACH) with DPD No 1 tablet for the RCl and turbidity meter (HACH 2100P) for the turbidity.

In this investigation water samples were collected in cleaned acid-washed plastic bottles for analysis of Manganese (as Mn) and Iron (as Fe) where Flame Atomic absorption spectrometer (Varian 240 FSAAS) was used to measure the Manganese (as Mn) and Iron (as Fe) levels. Determination of THMs were done by the Industrial Technology Institute (ITI) laboratory using purge and trap (Tekmar, Dohrmann 3100) coupled with capillary column (DB 624 column) gas chromatograph (Agilent 6890 series) with electron capture detector (ECD).

## RESULTS AND DISCUSSION

Analytical results revealed that the 90% of iron was removed with  $0.3-0.6 \text{ mgdm}^{-3}$  dosage of potassium permanganate and the same time manganese level is within SLS 614:2013. THM levels were monitored at the clear water sump and distribution system with pre and post chlorination at the same time. THM level were monitored with  $\text{KMnO}_4$  as pretreatment and post chlorination just after 30 minutes contact time and the after 24 hrs time period in laboratory level.

The analysis showed that there is a significant effect of the water treatment plant (WTP) on the THM. It was observed that the TTHM levels at the storage tanks of the Kalatuwawa WTP are below the acceptable levels for TTHMs in WHO and USEPA. Analytical results were summarized in table 1.

It was observed that the TTHM levels in the distribution system are higher than in the sump. The levels were below the acceptable levels for the TTHMs established by the WHO, but exceeding USEPA guideline value for drinking water which is  $80 \text{ ugdm}^{-3}$ .

Analytical results revealed that TTHM levels reduce by 67% with the  $\text{KMnO}_4$  as pretreatment and at the same time operational cost will be lower than that of the existing pre-chlorination system.

Table 1

Average THMs level at clear water sump (ug/l)	Average THMs level at distribution system (ug/l)	Average THM level with $\text{KMnO}_4$ pretreatment & post chlorination (ug/l)
68.0	72.5	34.0

## **CONCLUSIONS**

In the chlorination of raw water containing ammonia, virtually no free residual chlorine is obtained until the ammonia has been oxidized. Rather the chlorine reacts with ammonia to form monochloramine, dichloramine and trichloramine - combine chlorine. Therefore high chlorine dosage is required for disinfection process.

Considering the above facts following recommendation can be given;

- Sediment removal is proposed to reduce the release of accumulated metals - Mn, Fe - and ammonia and other contaminant to the water column. This method may be quite effective as a means of reducing the reservoir toxic substances.
- Catchment protection and management to minimize the loading of organic matter to the reservoir - Control an adequate buffer zone around the reservoir, remove leaves dropping trees, shrubs and weeds from the buffer zone, maintain short grass in the immediate runoff area, replace shoreline silt with gravel, steepen the shoreline for aquatic weed control and control the pollution sources such as agriculture, timber cutting, industry and accidental.
- TTHM levels were reduced up to 70% with  $\text{KMnO}_4$  as pre-treatment and the same time operational cost will be lower than that of the existing pre-chlorination system in Kalatuwawa WTP.

## **REFERENCES**

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