Investigation of Trihalomethanes formation in Greater Kandy Water Treatment Plant and its distribution

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Introduction

No doubt that chlorination has been successfully used for the control of water borne infections diseases for more than a century. Halogenated trihalomethanes (THMs) and haloacetic acids (HAAs) are two major classes of disinfection byproducts (DBPs) commonly found in waters disinfected with chlorine (Rook, 1974). The formation of the Trihalomethanes (THMs) was investigated in Greater Kandy Water Treatment Plant (GKWTP) and distribution system which serve drinking water to Kandy region, located in the middle province of Sri Lanka. Water samples were taken from storage tank of GKWTP of the National Water Supply and Drainage Board (NWS & DB), covering selected water quality and operational parameters that have direct influence on THM formation. In addition THM formation at the distribution extremities were also studied.

Methodology

Water samples were taken from storage tanks of GKWTP after the chlorination of initial dosage of 2 ppm chlorine. Water samples of 32 taken from selected distributed within six Divisional Secretariat Divisions for the analysis. Primary Trihalomethanes were analyzed using Gas Chromatography – ECD (Kuivinen, 1999). Formation of Trihalomethanes were analyzed in storage tanks for 64 hours by doubling time and level of Trihalomethanes in distribution system. Apart from THMs, pH, temperature, turbidity, were analyzed in raw water and treated water collected at sampling points by pH meter, thermometer and turbidity meter respectively. Treated water was also tested for free chlorine level and total chlorine level to observe impact on THM formation by those parameters by colorimeter.

Result and Discussion

Measured THMs and other parameters for storage tanks in GKWTP summarized in Table 1 and indicate in figure 1. This indicate that the trihalomethanes increase with the time in storage tanks. Initially mean TTHMs was 17.09 µg/L when the initial dose of chlorine of 1.85 mg/L. When doubling the reaction time formation of THMs were increased and finally it became 40.72 µg/L when reaction time become 64 hours. Table 1 indicates that the free chlorine and total chlorine decaying with time. Temperature is constant for the whole analysis as 25 C, as it highly depend

on temperature. Concentrations of $CHCl_3$, $CHCl_2Br$ and TTHM of sampling locations indicate in Table 2 in 32 sampling points. Table 2 summaries descriptive statistics for individual and total THMs (TTHMs) with free chlorine in the water samples of distribution system. Highly variable range of TTHMs concentrations were found (11.275 to 22.976 µg/L) in distribution system. Chloroform ($CHCl_3$) concentrations contribute a significant portion to the TTHMs (76%) while Bromodichloromethane ($CHCl_2Br$) contribute 24%.

Regression model for GKWTP. The regression equation is:

TTHM (µg/L) = 19.5 + 0.00580 Time (min) R-Square (adjusted) value = 95.9%; $p < 0.05$

Conclusions

When considering storage tanks conclude that the formation of trihalomethanes depend on reaction time and free chlorine while temperature, pH, turbidity remains constant. CHCl3, CHCl2Br and TTHMs levels at all locations were found lower than the guideline values regulated in WHO and USEPA which is lower than 25 µg/L. Due to the free chlorine ranges to 0.2 to 0.7 mg/L in distribution system, conclude that residual chlorine exceeding its standard value of 0.2 mg/L for drinking water. Variation of trihalomethanes and free chlorine values of storage tanks and distribution system, assume that chlorine reactions take place and evaporation of free chlorine during analysis. Other two compounds of trihalomethanes such as Dibromochloromethane (CHClBr2), and Bromoform (CHBr3) could not be detected in GKWTP.

Table 1:- Mean values of THM formation in drinking water (GKWTP)

Time (min)	CHCl3 µg/L	CHCl2Br µg/L	TTHM µg/L	pH	Temp .C	Turbidity NTU	Free chlorine mg/L	Total Chlorine mg/L
0	13.8797	3.20567	17.0853	7.35	25	0.13	1.65000	1.84667
15	15.0257	3.66033	18.6860	7.35	25	0.13	1.64667	1.83000
30	16.2490	3.64800	19.8970	7.35	25	0.13	1.57667	1.99333
60	16.0750	3.76000	19.8350	7.35	25	0.13	1.59667	1.72667
120	16.2653	3.86500	20.1303	7.35	25	0.13	1.58333	1.72333
240	17.0267	4.30367	21.3303	7.35	25	0.13	1.51667	1.68333
480	18.3473	4.22367	22.5710	7.35	25	0.13	1.44000	1.59000
960	22.8537	5.27133	28.1250	7.35	25	0.13	1.21000	1.36000
1920	25.5840	5.50600	31.0900	7.35	25	0.13	1.20667	1.34000
3840	34.4920	6.22700	40.7190	7.35	25	0.13	0.85667	1.00333

Table 2:- Minimum (Min), Maximum (Max), Mean, Median and Standard Deviation (SD) levels of THM formation in drinking water (distribution)

	CHCl3 (µg/L)	CHCl2Br (µg/L)	TTHM (µg/L)	Free chlorine (mg/L)
Min	6.706	2.481	11.275	0.200
Max	19.481	6.168	22.976	0.700
Mean	13.885	4.274	18.159	0.560
Median	14.185	4.243	18.058	0.550
SD	3.038	1.060	2.871	0.107

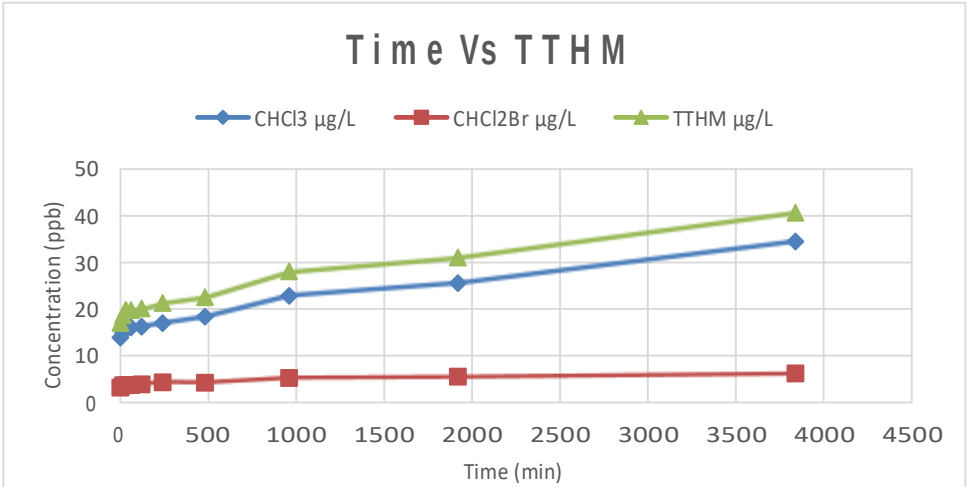

Figure 4:-CHCl3, CHClBr2 and THM formation in storage tanks of GKWTP

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