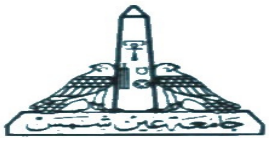
Control of Trihalomethanes (THMs) Formation by Proper Prechlorination System in Water Treatment Plants

By

Eng.Mohamed Ahmed Reda Hamed
BSc. of Civil Engineering, Cairo University,1994

A thesis Submitted to
Faculty of Engineering ,Ain Shams University
In partial fulfillment of the
Requirement for the Degree of
Master of Science
In
Civil Engineering- Public Works Department

Faculty of Engineering, Ain Shams University
Cairo, Egypt
2013



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Under Supervision of

Prof. Dr. Mohammed Hassan Abdel-Razik

Professor of Sanitary & Environmental Engineering, Ain Shams University
Faculty of Engineering, Ain Shams University

Dr. Nany Ali Hassan

Associate Professor of Sanitary& Environmental Engineering
Faculty of Engineering, Ain Shams University

Dr. Sherien Ali Elagroudy

Assistant Professor of Sanitary& Environmental Engineering
Faculty of Engineering, Ain Shams University

Faculty of Engineering, Ain Shams University
Cairo, Egypt
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A Thesis For
The M.Sc. Degree in Civil Engineering
(Sanitary Engineering)

BY

Eng. Mohamed Ahmed Reda Hamed

B.Sc. in Civil Engineering, June 1994

Faculty of Engineering, Cairo University

Thesis Approval

Examiners Committee
Signature

Prof. Dr. Hazem Ibrahim Saleh
Professor of Sanitary & Environmental Engineering
Faculty of Engineering, Monofeia University
.....

Prof. Dr. Fekry Halim Ghobrial
Professor of Sanitary & Environmental Engineering
Faculty of Engineering, Ain Shams University
……

Prof. Dr. Mohamed Hassan Abdel -Razik
Professor of Sanitary & Environmental Engineering
Faculty of Engineering, Ain Shams University
……

Date: 23/03/2013

Statement

This dissertation is submitted to Ain Shams University, Faculty of Engineering for the degree of M.Sc. in Civil Engineering.

The work included in this thesis was carried out by the author in the department of Public Works, Faculty of Engineering, Ain Shams University, from November 2010 to December 2012.

No part of the thesis has been submitted for a degree or a qualification at any other University or Institution.

The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others

Date: 23/03/2013

Signature: ……..

Name: *Mohamed Ahmed Reda Hamed*

Acknowledgement

First and for most thanks are due to ALLAH WHO helped me to accomplish this work.

I would like to thank all members of sanitary engineering Section at Faculty of Engineering, Ain Shams University for their continuous support throughout my educational career.

I would especially like to thank my advisors, Prof. Dr. Mohammed Hassan Abdel-Razik, Dr. Nany Ali Hassan, and Dr. Sherien Ali Elagroudy for their support, valuable advice and excellent supervision.

Finally, I would like to thank all members of the Holding Company for water and wastewater who helped me with their technical expertise.

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Abbreviations	Referent
ACS	American Chemical Society
ATSDR	Agency for Toxic Substances and Disease Registry
APHA	American Public Health Association
AWWA	American Water Work Association
AWWARF	American Water Works Association Research Foundation
BDCM	Bromodichloromethane
CT	Disinfection Contact Time
DBD	N,N- diethy1-P- phynylenediamine
DOC	Dissolved Organic Carbon
DHS	California Department of Health Services,
DBCM	Dibromochloromethane
CDPH	California Department of Public Health
DNA	Deoxyribonucleic Acid
DPP	Disinfection By- Product
ECD	Electron Capture Detector
EOSQ	Egyptian Organization for Standardization and Quality
EPA	Environmental Protection Agency
HSDB	Hazardous Substances Data Bank
GAC	Granular Activated Carbon
GC	Gas Chromatography
GCWC	Greater Cairo Water Company
GCWTP	Greater Cairo Water Treatment Plant
IARC	International Agency for Research on Cancer
MCL	Maximum Contamination Level
NDIR	Nondispersive Infrared
NOM	Natural Organic Matter
COEHHA	California Office of Environmental Health Hazard Assessment
SDWA	Safe Drinking Water Act
RNA	Ribonucleic Acid
SUVA	Specific ultraviolet light Adsorption
TOC	Total Organic Carbon
THMs	Trihalomethanes
TTHMs	Total Summation of Trihalomethanes Compounds
U.S.EPA	United States Environmental Protection Agency

U.S. FDA	United States Food and Drug Administration
UV	Ultraviolet light
UVA	Ultraviolet light Adsorption
WHO	World Health Organization

ABSTRACT

River Nile contains significant concentrations of algae with an average annual value of 6189±296 unit/ml. Pre-chlorination doses ranging from 4 to 7 mg/L are applied to Greater Cairo WTPs leading to the formation of annual average total trihalomethanes (THMs) of 35 to 126μg/L. Five of these WTPs, namely Obour, Shubra El-Kheima, Amerea, Fostat and North Helwan, where the maximum total THMs concentration exceeds the allowable limit (100μg/L), were studied for 10 consecutive months. This study aims at identifying optimum pre-chlorination doses for these WTPs that keeps THMs compounds below permissible limits which satisfying residual chlorine requirements.

The highest values for raw water algae count (6900±486and 5754±583unit/mL) and total organic carbon (TOC) (4.51±0.399and 4.19±0.512mg/L) were recorded at Shubra El-Kheima and Obour WTPs, respectively. Optimum pre-chlorination dose was determined using jar test. Concentrations of THMs compounds (Chloroform, Bromodichloromethane, Dibromochloromethane and Bromoform) as well as TTHMs concentration were used as indicators to determine optimum pre-chlorination dose for each WTP. The optimum pre-chlorination dose for Obour and Shoubra El-Kheima WTPs as identified by conducting jar test for ten consecutive months was 5 mg/L, while for the other three WTPs was 4 mg/L. Applying the optimum pre-chlorination dose, and a 1 mg/L post-chlorination dose, to full-scale stream in each of the five WTPs for ten consecutive months led to reduction in THMs concentration of 29%, 26.2%, 25.5%, 27.99% and 24.4% for Obour, Shubra El-Kheima, Amerea, Fostat and North Helwan WTPs, respectively. Concentrations of THMs compounds as well as total THMs, in each of the five WTPs, after applying optimum pre-chlorination dose fell within permissible limits. The mean residual chlorine concentration in the final effluent also was within the allowable limit.