DEPARTMENT OF MINING AND WATER RESOURCES ENGINEERING

WAR 4201: ENGINEERING PROJECT II

FINAL PROJECT REPORT

OPTIMIZATION OF SOLAR WATER DISINFECTION TECHNOLOGY FOR EFFICIENT PATHOGEN REMOVAL

CASE STUDY: KIKONI, KAMPALA

BY

SANYA FILEX……BU/UP/2013/308

felixsanya@gmail.com

Submitted in Partial Fulfillment of the Requirements for the Award of a Degree of Bachelor of Science in Water Resources Engineering

MAY 2018

DECLARATION

I SANYA FILEX, hereby declare to the best of my knowledge that this report is my original work. It was done through my own efforts and practical experience during the course of my study. All literature and material that was consulted in the preparation of this report is fully acknowledged and referenced herein.

This report has never been submitted to any university or institution for any academic awards.

Signature: ………………………………

Date: ………../……….. /………….

APPROVAL

This research project was conducted under my supervision and has been submitted with my approval for examination and award of B.Sc. Water Resources Engineering at Busitema University.

MAIN SUPERVISOR

SIGNATURE: ……………………..…………

DATE: …………/…………. /……………

Mr. JOSEPH DDUMBA LWANYAGA

ACKNOWLEDGEMENT

I thank the Almighty God for the knowledge, health, protection and guidance he accorded me during the course of preparing this project report.

My special and heartfelt gratitude goes to my supervisor Mr.Ddumba Joseph Lwanyaga for his wholehearted effort in advising me, reading the manuscript and providing me with valuable information, comments as well as continuous follow up of the research. I really appreciate his critical evaluation of the project draft and immediate feedback with valuable comments as well as for his immediate response for any problem i faced. my sincere appreciation is also extends to the public health laboratory management for providing the conducive environment to carry out my tests and analysis of results. I would also like to thank Madam Rita Nakazibwe for her outstanding technical assistance, support and guidance during the practical sessions of the study.

Special Thanks to my parents Mr Ouma Gabriel and Nafula Roseline for the financial, moral and spiritual support and timeless effort given to me in my education journey.

I extend my thanks to my fellow students with whom i have studied with and have supported me in the course of my project. Iam also grateful to residents of Kikoni for providing the relevant information and also ensuring my safety and security of my property while i conducted the fieldwork, i acknowledge the general administration of Busitema University, faculty of Engineering under the Department of Mining and Water Resources Engineering, especially my lecturers for their priceless contribution in the course of pursuing this Water Resources Engineering degree.

DEDICATION

I dedicate this report to my parents, friends and colleagues for their financial and social support. Above all, to God for the opportunity, good health, and competence that enabled me reach this great achievement.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMES

DNA…………………………Deoxyribo Nucleic Acid

DO …………………………Dissolved Oxygen

EC ………………………… Electrical Conductivity

E. coli …………………………Escherichia coli

INRESA ……………………Integrated Rural Energy Systems Association

MWLE …………………… Ministry of Water Lands and Environment

NTU ……………………… Nephelometric Turbidity Unit

PET…………………………Polyethylene Terephthalate

pH ………………………… Potential Hydrogen

SANDEC ………………… Sanitation in Developing Countries

SODIS …………………… Solar Water Disinfection

TDS ……………………… Total Dissolved Solids

TSS ……………………… Total suspended solids

TTCs…………………… Thermo tolerant Coliforms

TVS ……………………… Total Volatile Solids

UN ………………………… United Nations

UV ...……………………….Ultraviolet

UV-A ……………………….Ultraviolet light in with wavelength in the range of 320 to 400 nm

UV-B………………………... Ultraviolet light in with wavelength in the range of 290 to 320 nm

UV-C ………………………...Ultraviolet light in with wavelength in the range of 190 to 290 nm

ABSTRACT

SODIS technology has been used for many years as a Household Water Treatment System (HWTS). However, due to the high density of houses in slums, a slight movement of the sun results in to the houses casting a shadow on to the bottles. This implies that the contact time required for disinfection of the pathogens in the water while using the SODIS technology may not be attained in slums.

This study sought to optimize the Solar water technology by reducing the contact time for pathogen disinfection by black wrapping PET bottles using polythene bags of gauge 30 microns. Black wrapping increases thermal inactivation of the pathogens in the water thereby reducing the contact time required for deactivation. This study investigated the effect of black wrapping on the solar disinfection rate of pathogens in drinking water from springs in slums. Results of raw water samples from the study area have showed the need for treatment of water before it is used for drinking as 80% of the springs had their water contaminated with faecal matter.

The rate of disinfection in the first run for black wrapped was obtained as 1.833 per hour and 1.363 per hour for the unwrapped bottles and the rate of disinfection in the second run for black wrapped was obtained as 2.657 per hour and 1.689 per hour for the unwrapped bottles

100% disinfection of pathogens was attained by the fifth and fourth hour of exposure for the black wrapped bottles and by the eight and sixth hour for the unwrapped bottles for the first and second run respectively. This shows that the black wrapping makes the disinfection faster and thus this solves the problem of envisaged inadequate contact time for disinfection encountered in slums due to the casting of the shadows from the closely spaced houses.

CHAPTER ONE:

I.0 NTRODUCTION

1.1 Background

Water is the most widely distributed substance on the planet and plays a vital role in both the environment and human life (Shiklomanov, 1998). The various water sources in the world include lakes, rivers, seas, oceans, streams, springs, swamps among others. The quality of water is threatened by both point and non-point source pollution from agriculture and runoff (Herman, 2000). Access to water is recognized as a precondition of the fulfillment of universal human rights and indispensable for leading a life with dignity (de Albuquerque, 2009).

Most of the water sources are becoming highly contaminated due to the poor disposal of municipal and untreated industrial waste discharge in water bodies (Ritter et al., 2002; Hossain, 2009). This is due to the development of the various cities and industries in the world that discharge untreated water into the water bodies. Public water supplies in developing countries often fail to produce and distribute safe water for consumption (Meierhofer, et al., 2009). 663 million people worldwide still rely on unimproved drinking water sources, including unprotected wells and springs and surface water (United Nations, 2015). The lack of access to safe drinking water makes water borne diseases one of the major public health problems in developing countries. It is estimated that 1.5 million people die each year worldwide because of the consumption of untreated or contaminated water (Kalt et al., 2014). In Uganda, there are many slums with poor solid waste and faecal sludge management practices. Access to improved sanitation in urban poor areas of developing countries is low. Slums are heavily populated areas, characterized by substandard and unplanned infrastructure, poverty, and lack of basic services like water and sanitation (UN-HABITAT, 2009). Poor waste management leads to deterioration in water quality for various water sources, which pose risks to the human health. Slum dwellers resort to using the low-quality water available from the water sources such as springs, swamps, wells among others (Meierhofer & Wegelin 2007). This leads to the increased prevalence of the water borne diseases like diarrhea, cholera, and dysentery, which claim the lives of many people (Borts, 1949).

REFERENCES

Acra, A., Raffoul, Z. &Karahagopian, Y. (1984) Solar Disinfection of Drinking Water and Oral Rehydration Solutions.Guidelines for Household Application in Developing Countries.UNICEF, Amman, Hashemite Kingdom of Jordan. Retrieved from http://hetv.org/resources/solar-disinfection-guidelines

Agency, E. P., & Estate, J. C. (2014). Drinking Water Parameters Microbiological , Chemical and Indicator Parameters in the 2014 Drinking Water.

Binns, J. A., Maconachie, R. A., &Tanko, A. I. (2003). Water, land and health in urban and peri-urban food production: the case of Kano, Nigeria. Land Degradation & Development, 14(5), 431-444.

Borts.I. H, (1949), Water-borne Diseases, American Journal Of Public Health, Vol.39, 974-978.

Demena M, Workie A, Tadesse E, Mohammed S, Gebru T, (2003), Water Borne Disease for the Ethiopian Health Center Team, Haramaya University

EAWAG/SANDEC 2002 Solar Water Disinfection- A Guide for the Application of SODIS.SANDEC Report No.06/02, Swiss Federal Institute of Environmental Science and Technology (EAWAG), Department of Water and Sanitation in Developing Countries (SANDEC), Switzerland.

Hankins, M. 1995 Solar Electric Systems for Africa.A Guide for Planning and Installing Solar Electric Systems in Rural Africa.Commonwealth Science Council, London, and AGROTECH, Harare 27Kaggwa, R.C., Mulalelo, C.I., Denny, P., Okurut, T.O., 2001. The impact of alum discharges on a natural tropical wetland in Uganda. Water Resource. 35, 795–807.

Kulabako, R. (2005). Analysis of the impact of anthropogenic pollution on shallow groundwater in peri-urban Kampala.

Meierhofer, R. &Wegelin, M, 2007 Solar Water Disinfection: A Guide for the Application of SODIS. Retrieved from http://www.sodis.ch/files/SODISManual-english.pdf

New Vision. (2012, October 31st). Retrieved from www.newvision.co.ug: Retrieved from www.newvision.co.ug:

MWLE (Ministry of Water Lands and Environment). 2005. Water and Sanitation Sector Performance Report 2005. Kampala, Uganda.