A STUDY OF ELECTROCHEMICAL TREATMENT OF WASTEWATER FROM A SELECTED GOLD MINNING SITE AT ITAGUNMODI, OSUN STATE

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DEDICATION

This research work is dedicated to the memory of my late sister, BolatitoBolorunduro, my parents, Chief and Mrs MorakinyoBolorunduro whose love and integrity prepared me for these challenges of life. To my wife, MrsAdebimpeBolorunduro and my children, Gbolahan and AkindunmadeBolorunduro whose tolerance and perseverance brought me thus far.

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ABSTRACT

The study investigated the treatment of wastewaters from selected gold mining sites at Itagunmodi in Osun State electrochemically, with a view to developing a system that would remove selected contaminants from wastewaters effectively without losing much of the electrodes.

Wastewater samples were collected twice in a month from four main ponds in October, 2015 (rainy season) and February, 2016 (dry season). The samples were collected twice during the rainy season and twice during the dry seasons making a total of sixteen (16) wastewater samples. The wastewaters collected were characterized (turbidity, solids, chloride, pH, zinc and lead) using standard procedures; the electrolysing equipment was calibrated and the electrodes used were selected based on previous studies;electrochemical treatment of the wastewater at laboratory scales and effects of selected factors (operating time, stirring speed, contact area to volume ratio and pH value) on the performance of the electrochemical treatment were evaluated using orthogonal array factorial experiment (4^4). Performance of the electrochemical treatment of the wastewater was based on the ability to reduce selected parameters. The results of 4^4orthogonal array factorial experiments were analysed using analysis of variance (ANOVA) to ascertain the effects and identify significant factors. The factors were optimized statistically using methods stated in literature.

The results revealed that there was no significant difference between the outputs (expected and obtained currents; expected voltages and obtained voltages) at 95 % confidence level ($f_{1,10}$ =4.96; p=0.99, p > 0.05 for current and $f_{1,8}$ =0.00; p=0.98, p > 0.05 for voltages). Turbidity of the wastewater samples at the different locations were between 92.51 and 95.42 NTU, pH values ranging between 7.6 and 7.8 and concentration of zinc in the wastewater was between 0.01 and

0.04 mg/l. The treatment showed that the process was capable of removing 20.42 % of the zinc, removed 99.69% of suspended solid and removed 62.02% of lead concentration. The study revealed that pH, operating time, volume to surface area ratio and stirring speed had effects on turbidity removal from the wastewater. The effect of stirring speed was significant (F = 23.22) at 95 % confidence level.

The study concluded that the treatment method was able to remove the contaminants in the wastewater (turbidity, solids, pH, zinc and lead) and stirring speed, operating time, pH and surface area to volume ratio are significant factors in removing these pollutants.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

A prerequisite for sustainable development must be to ensure uncontaminated water bodies (streams, rivers, lakes and oceans). There are growing environmental and public concerns about the condition of freshwater in Nigeria especially areas where mining activities take place. It is well known that mining affects fresh water through the heavy use of water in processing ore. It also affects it through water pollution from discharged mine effluent and seepage from tailings and waste rock impoundments. Water bodies are among the most vulnerable water bodies to contamination. It is necessary to prevent and control contamination of these water resources and to have reliable information on the quality of the water (Singh *et al.*, 2005). It has been documented that human activities such as mining operations threaten to the potable water sources on which man, plants and animals depend. Water has been called "mining's most common casualty because the most pressing environmental problems associated with abandoned hard rock mine sites relate to water pollution.

Adequate drinking water (quality and quantity) is essential for the well-being of man and animal. In many developing countries around the world, drinking water supplies have become contaminated, which has impacted on the health and economic status of most people (Akoto and Adiyah, 2007). There is a growing awareness of the environmental legacy of mining activities with little concern for the environment. Mining activity by its nature consumes, diverts and can seriously pollute water resources. Although there are improvements in mining practices and activities in the recent years, but the issues on environmental risks and pollutions remain. The issues of negative impacts of mining activities can vary from the sedimentation of sludge caused

by poorly built roads during exploration to the sediment of clay in water, and disturbance of water quality during mine construction. Polluted water from mine waste rock and tailings need to be controlled for a longer period after the closure of the site. These impacts of mining activities depend on a variety of factors (nature of the local terrain, mineral composition of the soil at the site, the type of technology in use, the skill acquired and applied, knowledge and environmental commitment of the company, and ability to enforce and compliance with environmental regulations). The major problem is that mining activities have become more mechanized (able to handle more rock and ore material than ever before) and mining waste has multiplied enormously. It has been highlighted that new mining technologies have been developed to make the action more profitable, but these technologies produce newer and more wastes (solid and liquid wastes), which are complex and treatment resistance.

1.2 Statement of Research Problem

Recent reports of lead poisoning from gold mining sites in Nigeria call for urgent solutions, such as its removal from wastewater. The effect of lead on living things have been documented, but its removal from wastewater generated from wet process gold from mining sites are rare, hence this study.

1.3 Justification for the Study

Frequent report of lead poisoning from gold mining sites in Nigeria calls for the urgent removal of lead and other pollutants from wastewater. Lead in water affects man, plant and animals. Effects of lead on man have been documented, but its removals from wastewater generated from gold mining sites (using artisan methods of mining) are rare. In Itagunmodi (Atakunmosa West), surface gold mining operations generate substantial revenue for the Osun

State Government. The surface gold mining activity involves extraction and exploitation of gold as minerals from the ore in the earth's crust by the surface (strip) mining operation. Surface gold mining operations basically involve the clearing of vegetation cover from the area to be mined, striping off topsoil, creating pit with ramps, waste rock dumps and stockpiles and haul roads. Gold extraction process depends on the ore mineralogy of the area being mined. However, if its activities are not well monitored and proper measures put in place, it will be a major cause of environmental degradation (e.g. loss of farmland, air pollution, water resource contamination, etc.). It is therefore essential to identify the water sources within the gold mining area and determine the actual sources of impact on the water quality in relation to the geochemistry and mining activity. The study seeks to assess and compare the physicochemical qualities of water sources in Itagunmodi and its environs in order to attempt removing the contaminants. Previous researchers attempted to remove these toxic contaminants from wastewater using chemical methods, but the current cost of chemicals and availability of the required chemicals makes the method cumbersome, hence the need to remove these toxic contaminants through electrochemical method.

1.4 Objectives of the Study

The objectives of the research are to

(a.) determine the quality of wastewater from a selected gold mining site in Itagunmodi in Osun State,

(b.) subject the collected wastewater to electrochemical treatment using orthogonal array factorial experiment, and