UNIVERSITI TEKNOLOGI MARA

ANOXIC OXIDATION OF SULPHIDE IN BULK WATER AND BIOFILM PHASES OF MUNICIPAL SEWER

SALIHA BINTI MOHAMAD

Thesis submitted in fulfillment of the requirements
for the degree of
Master of Science

Faculty of Civil Engineering

October 2011

Candidate's Declaration

I declare that the work in this disserta was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledge as referenced work. This topic has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

In the event that my thesis be found to violate the conditions mentioned above, I voluntarily waive the right of conferment of my degree and agree be subjected to the disciplinary rules and regulations of Universiti Teknologi MARA.

Name of Candidate	Saliha binti Mohamad
Candidate's ID No.	2007131279
Programme	Master of Science in Civil Engineering
Faculty	Civil Engineering
Dissertation Title	Anoxic Oxidation of Sulphide in Bulk Water and Biofilm Phases of Municipal Sewer.

Signature of Candidate .....

Date 25th October 2011

ABSTRACT

Anaerobic decomposition of wastewater in sewer systems generates sulphur compounds which leading to the formation of hydrogen sulphide (H_2S) has been identified as a major cause of problems related to foul odors, corrodibility and toxicity. Therefore, it is necessary to investigate appropriate techniques and/or technologies for removing H_2S. Various studies on the use of nitrate in suppressing sulphide production in sewer systems have been documented. However, limited reports are available on transformation rates of sulphur compounds in sewer systems under anoxic conditions. Lack of this knowledge will prevent estimations of nitrate dosing rates into sewer systems to maintain anoxic condition for sulphide oxidation. Three phases of experiments utilizing anoxic batch reactors were conducted. In phase I, sterilized and active wastewater were used to establish the rates and relative importance of chemical and biological oxidation of sulphide. For Phase II, batch reactors containing bulk water were used to determine the transformation rates of selected sulphur and nitrogen compounds in bulk water phases of municipal sewer. And in phase III, the transformation rates in the biofilm phase were determined using two different batch reactors. One reactor contains both bulk water and biofilm while the other reactor contains only bulk water. Ion Chromatograph (Metrohm 790 IC) was used to analyze concentrations of selected sulphur and nitrogen compounds. Results showed that chemical sulphide oxidation with nitrate were found to be insignificant compared to biological sulphide oxidation process. The median of anoxic biological transformation rates for NO_3-N and NO_2-N were 0.645 and 0.312 mg/L h respectively. The corresponding rates for SO_4-S, SO_3-S and S_2O_3-S were determined to be 0.071, 0.000 and 0.049 mg/L h respectively. In bulk water and biofilm phases, sulphate was the end product of anoxic oxidation of sulphide. In bulk water, sulphate being formed at a median rates of 0.103 mg SO_4-S/ (L h) during the 5^{th} to 6^{th} hour and 0.091 mg SO_4-S/(L h) during the 8^{th} to 9^{th} hour. Nitrate, on the other hand was reduced at a median rates of 3.804mg NO_3-N/ (L h) during the 5^{th} to 6^{th} hour and 7.149 NO_3-N/ (L h) during the 8^{th} to 9^{th} hour to nitrogen, with nitrite accumulating at a median rates of 0.856mg NO_2-N/ (L h) during the 5^{th} to 6^{th} hour and 0.934 NO_2-N/ (L h) during the 8^{th} to 9^{th} hour. Based on median value, in biofilm phase sulphate was found to be 0.050 mg SO_4-S/ (L h) during the 5^{th} to 6^{th} hour and 0.056mg SO_4-S/ (L h) during the 8^{th} to 9^{th} hour. As for nitrate reduction were 3.582mg NO_3-N/ (L h) during the 5^{th} to 6^{th} hour and 5.198 mg NO_3-N/ (L h) during the 8^{th} to 9^{th} hour. Nitrite accumulation were found to be 0.024 mg NO_2-N/ (L h) during the 5^{th} to 6^{th} hour and 0.088mg NO_2-N/ (L h) during the 8^{th} to 9^{th} hour. Statistical analysis on the relationship between nitrate, nitrite and sulphate in bulk water and biofilm phases under anoxic condition was performed using Pearson correlation analysis. Based on the results, in bulk water phase, insignificant correlations were obtained while in biofilm phase, the significant correlation was obtained for the analysis. Results from this study found that the nitrate compounds can be a good electron acceptor during the anoxic oxidation of sulphide thus removes H_2S in sewer systems.

Keywords: anoxic oxidation, bulk water phase, biofilm phase, microbial transformation, municipal sewer.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.1 Background of study

In Malaysia, separate sewer systems are adopted due to heavy rainfall. The sewer systems only cater for municipal wastewater which is conveyed through closed underground conduit, whereas rainwater is discharged through open drain channel (Ujang *et al.,* 2002).

Sewer system has conventionally been designed to perform as a conduit to collect and transport wastewater and sewage from various sources to wastewater treatment plants (WWTPs). A new paradigm has now emerged where the sewer not only functions as a transport conduit but also as a biochemical reactor where changes in chemical components are initiated by living organisms in the wastewater (Hvitved-Jacobsen *et al.*, 2000 and Franke et al., 2010). The wastewater in sewer pipes consists relatively high concentration of organic constituents that makes the sewer systems biologically active. Sewer systems are very complex where hydrodynamics, mass transfer and microbial processes occur during transportation of wastewater (Hvitved-Jacobsen, 2002). Heterotrophic microorganisms are dominant in sewer systems. They will degrade and transform the wastewater components as it flows to WWTPs (Bjerre, 1996; Huisman, 2001). Green *et al.* (1985) reported that microbial processes causing changes in organic matter occurs in sewer systems. Findings by Tanaka and Hvitved-Jacobsen (1998), Vollertsen (1998), Almeida (1999), Huisman (2001), Abdul-Talib (2002) and Yang *et al.* (2005) support observations that during transportation of wastewater in the sewer