

DYNAMIC MODELING AND SIMULATION OF THE IMPACT OF MICRO-AERATION ON ANAEROBIC TREATMENT OF SULFATE-RICH WASTEWATER

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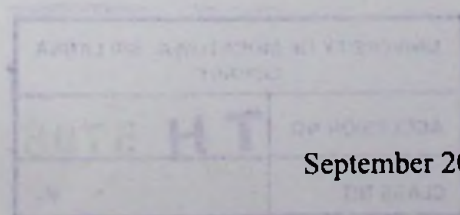
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DEDICATION

Dedicated with gratitude to my loving **MOTHER** for being the greatest plier of my life.

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Completing this research work has been the most significant challenge I have ever faced throughout my academic path. It would not be successful without the support, guidance and patience of several people and I owe my greatest sense of gratitude towards them.

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ABSTRACT

This study investigates the application of micro-aeration to remove dissolved sulfide produced during the anaerobic treatment of wastewater containing sulfate. A completely mixed batch reactor was used to develop a dynamic model of batch anaerobic digestion with micro-aeration of the liquid phase using BioWin (version 6.2) software to simulate the performance of sulfate reduction and sulfide oxidation in a single reactor unit. When calibrating the micro-aerated model, maximum specific growth rate for sulfur-reducing acetotrophic bacteria was set to 0.38 d^{-1} , switching function of sulfur reducing pathway DO half saturation concentration was set to $0.0001\text{ mgO}_2/\text{L}$ and air was introduced to the system at two stages; for 12 hours at a rate of $0.018\text{ m}^3/\text{hr}$ and another 12 hours at a rate of $0.015\text{ m}^3/\text{hr}$. When comparing the calibrated micro-aerated model and the strictly anaerobic model, rate of sulfate reduction reduced with micro-aeration, but complete removal could be expected. Although methane production improved over the first half of the time period in calibrated micro-aerated model, a negative impact of the presence of oxygen on methanogens could evident when the oxygen presents in the system beyond 13 hours. The calibrated micro-aerated model showed a significant decrease in dissolved sulfides when compared to the anaerobic model. Moreover, an average of 80% H_2S removal could be achieved with micro-aeration. It indicates the possibility of adapting micro-aeration in liquid phase of anaerobic reactors to reduce formation of gaseous H_2S by oxidizing dissolved sulfides to elemental sulfur, alongside the simultaneous removal of sulfate.

Keywords: Micro-aeration, Sulfate reduction, Anaerobic, BioWin, Dynamic simulation

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LIST OF ABBREVIATIONS

Abbreviation	Description
AD	Anaerobic digestion
ADM1	Anaerobic Digestion Model No. 1
COD	Chemical oxygen demand
DO	Dissolved oxygen
IWA	International Water Association
LCFA	Long-Chain Fatty Acids
MABR	Membrane aerated biofilm reactor
MPO	Methane-producing organisms
ORP	Oxidation-reduction potential
SOB	Sulfur-oxidizing bacteria
SRB	Sulfate-reducing bacteria
UASB	Up-flow anaerobic sludge blanket
VFA	Volatile fatty acids
Fbs	Readily biodegradable (including Acetate) (gCOD/ g of total COD)
Fac	Acetate (gCOD/ g of readily biodegradable COD)
Fus	Un-biodegradable soluble (gCOD/g of total COD)
Fup	Un-biodegradable particulate (gCOD/ g of total COD)
Fna	Ammonia (gNH ₃ -N/ gTKN)
Fnus	Soluble un-biodegradable TKN (gN/gTKN)
Fpo4	Phosphate (gPO ₄ -P/ gTP)
Fsr	Reduced sulfur [H ₂ S] (gS/ gS)
μ _{max}	Sulfur-reducing acetotrophic maximum specific growth rate (d ⁻¹)
K _{m_ac}	Acetic acid half saturation constant for sulfur-reducing acetotrophic bacteria (mgCOD/L)

K_{m_s}

Sulfate half saturation constant for sulfur-reducing
acetotrophic bacteria (mgS/L)

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