



**BUSITEMA
UNIVERSITY**
Pursuing Excellence

FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF WATER RESOURCES ENGINEERING

FINAL YEAR PROJECT REPORT

**EXPERIMENTAL EVALUATION AND PROCESS OPTIMIZATION
FOR MINIMIZING HYDROGEN SULFIDE EMISSIONS IN
WASTEWATER**

BY

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Abstract

Hydrogen sulfide (H₂S) is a toxic, corrosive, and malodorous gas generated in wastewater treatment systems, especially under anaerobic conditions. Its emission contributes to sewer infrastructure degradation, air quality deterioration, and public health hazards. Conventional approaches to managing H₂S emissions are mostly reactive and do not account for predictive control based on critical operational parameters. This study addresses this challenge by applying statistical modeling using Minitab to investigate and optimize the influence of key wastewater quality parameters temperature, pH, total suspended solids (TSS), chemical oxygen demand (COD), and hydraulic retention time on H₂S emissions. A Box-Behnken experimental design was employed to develop a response surface model, with the following parameter ranges; temperature (20–35 °C), pH (6.0–8.0), total suspended solids (TSS) (165–250 mg/L), chemical oxygen demand (COD) (445–900 mg/L), and retention time (1.0–4.0 days). Hydrogen sulfide concentration (ppm) was the response variable. Analysis of variance (ANOVA) and regression modeling revealed that pH, temperature and retention time were the most influential parameters, while TSS and COD showed minimal impact. Among the studied parameters, pH (26.52%) and temperature (32.82%) and retention time (21.09%) showed the highest contribution to the model, followed by while TSS (0.91%) and COD (0.13%) that had minimal influence on hydrogen sulfide emissions. The final model achieved a coefficient of determination (R^2) of 89.32%, indicating strong predictive reliability. The study provides a data-driven decision support framework for wastewater operators to identify operational conditions that minimize H₂S emissions, reduce odor and corrosion risks.

Keywords: wastewater, hydrogen sulfide, toxicity, odor, concrete corrosion, statistical analysis, Minitab.

Declaration

I Ayebare Jenifer, hereby declare that this research report is my original work except where due acknowledgement has been made. I declare that this work was written by me and it has not been utilized for academic award by any individual in any learning institution.

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May the Almighty God bless you all.

Dedication

I dedicate this report to my mother whose endless love and encouragement have been my foundation. Thank you, my biggest cheerleader.

Approval

This research proposal submitted as a partial fulfilment for the award of Bachelor degree of science and water resources engineering at Busitema University, with my approval as her academic supervisor

MR. KUSEMERERWA JOSEPH



Signature.....

Date/...../.....

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LIST OF ABBREVIATIONS

H₂S – Hydrogen Sulfide

RSM – Response Surface Methodology

BBD – Box-Behnken Design

COD – Chemical Oxygen Demand

TSS – Total Suspended Solids

ANOVA – Analysis of Variance

R² – Coefficient of Determination

PRESS – Prediction Error Sum of Squares

WWTP – Wastewater Treatment Plant

ATC – Automatic Temperature Compensation

ppm – Parts Per Million

MSE – Mean Squared Error

RMSE – Root Mean Square Error

pH – Power of Hydrogen

HS - Bisulfide

S⁰ - Elemental Sulfur H Humidity

MICC - Microbial Induced Concrete Corrosion

ORP - Oxidation-Reduction Potential

SO₄²⁻ - Sulfate Ion

S²⁻ - Sulfide Ion

H₂SO₄ - Sulfuric Acid

SOB - Sulfur Oxidizing Bacteria

SRB - Sulfur Reducing Bacteria

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