

BIOLOGICAL REMOVAL OF SULFUROUS POLLUTANTS OF SKIM LATEX
WASTEWATER



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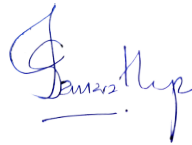
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DECLARATION OF THE CANDIDATE AND THE SUPERVISOR

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ABSTRACT

Skim Latex Wastewater (SLW) contains high concentrations of sulfate, together with organic matter and nitrogenous compounds such as Ammonia and protein. High concentrated sulfuric acid is added in coagulation process to recover rubber particles and ammonia is used for preservation of rubber latex. Under anaerobic digestion, sulfate breakdown into hydrogen sulfide which is one of the highly toxic, corrosive and odorous gas which causes severe threat to the environment and health. Nevertheless, it degrades the commercial value of biogas as a renewable energy source causing severe corrosion in connected components of equipment. Conventional biological process to treat sulfate rich wastewater consists of two processes, sulfate reduction to sulfide by Sulfate Reducing Bacteria (SRB) and Sulfide oxidation to elemental sulfur by Sulfide Oxidation Bacteria (SOB) in separate reactors. Major objectives of this research study are to investigate the effect of ammonia rich SLW on sulfate reduction and Hydrogen sulfide emission reduction under anaerobic condition and develop strategies for enhancement of sulfate reduction for subsequent elementary sulfur formation under different micro-aeration techniques. Optimum conditions for both sulfate reduction as well as elementary sulfur formation are also investigated.

In previous studies, various reactor configurations have been developed by integrating both the SRB and SOB into a single reactor. In this study SRB and SOB integrated suspended growth reactor for SLW which is not only rich in sulfate, but also ammonia and protein which ultimately breakdown to produce more ammonia is introduced. This new reactor is termed as Single-stage Sulfate-removal Micro-aerated Anaerobic Digester (SSMAD). It is hypothesized that this SRB and SOB integrated micro-aerated anaerobic reactor approach can be applied to enhance removal of sulfurous pollutants from SLW.

To achieve the research objectives, seven experiments were conducted. All experiments were conducted semi batch wise using 3 litres airtight completely mixed anaerobic reactors which were maintained at 35 ± 1 °C. From the results, it can be concluded that, Single-stage Sulfate-removal Micro-aerated Anaerobic Digester (SSMAD) simultaneously reduced high concentrated influent sulfate of SLW, while hydrogen sulfide been transformed to reusable elemental sulfur. To achieve the optimum sulfate reduction as well as maximum elemental sulfur yield, bulk liquid of the SSMAD was micro-aerated with air at rate of 1.6 ml/hr for two hours following half an hour of feeding SLW. It was found that yield and the stability of the generated elemental sulfur improved at O_2/S ratio 1.0-1.2, after 18-24 hours of feeding. At this range, specific H_2S formation was less than 0.2 mmol/mmol while the sulfate reduction was 95.8%. The COD/SO_4^{2-} ratio of SLW was nearly 3 and it was increased to 5 adding an external electron donor for efficient sulfate reduction but further increased up to 10, reduced the sulfate reduction as Methanogens dominate than SRB. Although ethanol enhances the sulfate reduction than acetate, excess ethanol adversely affected on the micro-aerobic systems degrading generated elemental sulfur back to gaseous H_2S faster. Thus, the elemental sulfur yield reduced by 69% when the COD/SO_4^{2-} ratio was increased from 5 to 10. However, sufficient precautions were taken to increase the C/N ratio from 3.8 to 6.9, by maintaining pH of the reactor at 7.5-8.0 and volumetric loading at 50 $l/m^3.d$ to minimize ammonia inhibition in the reactor. Developed novel approach through Single-stage Sulfate-removal Micro-aerated Anaerobic Digester (SSMAD) can be successively used to recover sulfurous pollutants from SLW.

Key words: Skim latex wastewater, Sulfate reduction, sulfide oxidation, Ammonia inhibition, Micro aeration

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LIST OF ABBREVIATIONS

Abbreviation	Description
AD	Anaerobic Digestion
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
sCOD	Soluble Chemical Oxygen Demand
tCOD	Total Chemical Oxygen Demand
DO	Dissolved Oxygen
DRC	Dry Rubber Content
EDX	Energy Dispersive X-ray
FAN	Free Ammoniacal Nitrogen
GC	Gas Chromatograph
HRT	Hydraulic Retention Time
MB	Methanogenic Bacteria
ORP	Oxidation Reduction Potential
SME	Scanning Electron Microscope
SRB	Sulfur Reducing Bacteria
SOB	Sulfur Oxidizing Bacteria
SLW	Skim Latex Wastewater
SSMAD	Single-stage Sulfate-removal Micro-aerobic Anaerobic Digester
TDS	Total Dissolved Sulfide
TAN	Total Ammoniacal Nitrogen
TKN	Total Kjeldahl Nitrogen
TMTD	Tetra Methyl Thiuram Disulfide
TS	Total Solid
TSS	Total Suspended Solid
VFA	Volatile Fatty Acid

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