BIOLOGICAL REMOVAL OF SULFUROUS POLLUTANTS OF SKIM LATEX WASTEWATER

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This thesis submitted in partial fulfilment of the requirements for the

Degree of Master of Philosophy

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May 2020

DECLARATION OF THE CANDIDATE AND THE SUPERVISOR

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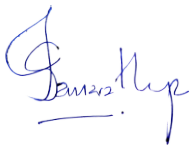

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ABSTRACT

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℃. 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

ACKNOWLEDGEMENTS

Completion of the Master of Philosophy has been one of the most significant challenge I have faced in my whole academic carrier. I would kindly extend my deepest gratitude for those who stood behind me as giant pillars providing me the courage and strength to successfully complete my Degree on Master of Philosophy. Without the enormous support, patience and guidance of the following personals, the completion of this study would not have been possible.

First, I would like to convey my heart-warming gratitude to my supervisor, Prof. P.G. Rathnasiri for his inspiring and motivating guidance throughout the research in a framework of freedom for creativity, patience with kindness, openness and fullest back screen support towards the successful completion of this study. His passion of carrying out the research and wide technical knowledge on anaerobic digestion and micro-aeration supported me to overcome the barriers of this research.

I would like to extend my gratitude to Prof. S. Walpalage the present Head and former Head, Dr. S. Gunawardana, former Head and of Department of Chemical and Process Engineering, University of Moratuwa for giving permission to utilize the laboratory as well as the other facilities in the department premises towards the completion of my MPhil studies.

I am immensely grateful to the Senate Research Council for their generous financial support extended in many ways whenever I required. Special thank is offered to Prof. Priyan Dias, the Chairman, Senate Research Council for his great encouragement and understanding in extending my grant facility to few months to cover the time lag due to difficulties setting up the experimental setup and analysis at the beginning.

The support provided by the Senior Assistant Bursar and the staff of the finance division and Supply division is also highly appreciable. Special thank offer to maintenance division of University of Moratuwa who facilitate me to develop the basic infrastructure facility of 24 hours' laboratory suitable for research and the general administration division as well for their immense support.

I am grateful to Dr. M.Y. Gunasekera who was the former postgraduate research coordinator and the current postgraduate coordinator Prof. P.G. Rathanasiri of the Department of Chemical and Process Engineering Department, University of

Moratuwa for their support for conducting and providing guidance to move forward my MPhil studies. However special thank is offered to the members in the external review panel, Prof. J. Manatunga and Dr. M. Narayane for their valuable knowledge contribution in formulating the hypothesis and direct my research study in the correct path.

I owe my gratitude for Dr. D. Botheju and Institute of Porsgrunn, Norway for the advices received in developing the experimental setup and planning the experiments as well as finding and developing analysing methods. I am grateful to Mr. Isuru Somasiri who technically support me to develop experimental setup and for the encouragement always extended towards the betterment of the research. Without your dedicative support qualitative experimental work would have been successful.

Special thank is conveyed to the Eng. Mr. J.A.A.D. Jayasooriya, The Head, Energy and Environmental Engineering, National Engineering Research and Development Centre (NERD) for granting permission to conduct in detail biogas analysis utilizing Gas Chromatograph at their premises. I highly appreciate the service received from the staff of the NERD to get my analysis done.

I am grateful to Lalan Rubber (Pvt) Ltd for their enormous support, providing me the opportunity to study the skim latex generation process and collect samples whenever required. Without their corporation this research would not have been successful.

I am deeply thankful all the academic and non-academic staff whoever wish for my success even from a word. However special thank convey to Ms. P.D.M. Rodrigo the technical officer and W.S.A.S. Fernando the lab attendant of the Environmental Engineering laboratory, Mr. J. Wijesinghe the chief technical officer, the Analytical chemist, Mrs. D Martino and I.K Athukorala the technical officer in charge of microbiology and chemistry laboratory for their enormous support during my research. Nevertheless Mr. Danajaya Epa and Mr. N.A.C Narangoda are also remind with great appreciation for facilitating the research work.

Most importantly, none of would have been possible without the love, patience and helping hand from my family, my parents and Imal's parents. I owe my deepest gratitude for my husband and children for bearing up the hard time had in the family for letting me time for my research study and always been encouraged and believed in me in my entire endeavour. My deepest thank goes to Ms. Rani Perera for taking care

of the housework and my children work responsibly and support me, releasing me from the burden of housework. Without her understanding and enormous support achieving the challenge of completing the MPhil would not have been possible.

Friend in need is the friend indeed. I am grateful for their generous support and fruitful advices from my post graduate friends, Sachini Thilakerathne, Bhagya Herath, Thamali Rajika and Gayani Jayathunga. My sincere thank conveyed to Dr. S. Sooriyaarachchi of Computer Engineering Department for strong and direct advices to overcome many difficulties and barriers of my research.

Finally, thank you very much for all those who ever extend their fullest and kind corporation, but I couldn't mention the names separately.

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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

LIST OF APPENDICES