DYNAMIC MODELING AND SIMULATION OF THE IMPACT OF LIPID INHIBITION ON ANAEROBIC DIGESTION OF DESICCATED COCONUT WASTEWATER

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Thesis/Dissertation submitted in partial fulfillment of the requirements for the degree

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DECLARATION

I declare that this is my own work and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

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Name of Supervisor:

Signature of the Supervisor: Date:

DEDICATION

Dedicated with gratitude to my loving **FATHER**, who has not been with me today, and **MOTHER** for being the greatest blessings of my life.

ACKNOWLEDGEMENT

It is a great pleasure to express my deep sense of gratitude to many individuals for their cooperation and for being supportive throughout the research project. It would not have been possible to complete this without the kind support, patience and guidance of the following people.

First and the foremost, I am highly indebted to Prof. P. G. Rathnasiri for being the constant supervision as well as for giving his valuable time to provide a proper guidance in proceeding the research project and also for providing a proper introduction and an overview of the anaerobic digestion modelling at the beginning. As well as, his passion for anaerobic digestion process and wide knowledge of anaerobic processes modeling was very helpful to overcome the problem I faced.

I would like to extend my sincere thanks to Prof. J. Manatunge, Prof. M. W. Jayaweera, and Prof. (Ms) W. B. Gunawardena who have guided and encouraged us during postgraduate studies to complete the MSc.

I would like to extend my gratitude to Mr. N. A. C. Narangoda, whom working as a system analyst at Process Control laboratory and Mr. Kalana Ranasinghe, whom working at Computer laboratory, Department of Chemical and Process Engineering for lending me a helping hand when the troubles encountered with the BioWin software.

It is very memorable to have a colleague like you Praveena Madhubhani. Bunch of thanks to you for all the mentioned and unmentioned support given.

Most importantly, none of these would not have been possible without the love and patience of my family. I am deeply indebted to my mother, my husband, and two sisters who always supported, encouraged and believed in me, in my entire endeavor.

My sincere apologies go to anyone who I have missed to mention. You all are highly appreciated.

Thank you!

ABSTRACT

Desiccated Coconut Wastewater is categorized as a lipid-rich wastewater that can be treated using anaerobic digestion. Within the anaerobic digester, lipids are hydrolyzed into Long Chain Fatty Acids (LCFAs) and glycerol. LCFAs cause potential inhibitory effects significantly on acetoclastic methanogens and deteriorate digester performance. To study the impact of LCFA inhibition, the BioWin 6.2 integrated Anaerobic Sludge Digestion Model (ASDM) was extended with the lipid inhibition function. Out of all kinetic constants used in the rate equations, maximum specific growth rate of acetate degraders ($\mu_{max\_acetate}$), half saturation rate of acetate degraders ($K_{s\_acetate}$) and LCFA inhibition constant (K_{i_LCFA}) are the most sensitive parameters toward methane production. The calibrated model with lipid inhibition (Model 2) showed a higher negative impact on COD reduction, acetoclastic methanogen concentration, and methane production compared to model without lipid inhibition (Model 1), indicating a significant impact of lipid inhibition on anaerobic digestion. If Model 1 is used to simulate anaerobic digestion of lipid rich wastewater, deviations between the actual results and the model predicted results will be high. Thus, Model 2 can be used as a tool to predict the COD reduction, effect on the acetoclastic methanogens, and methane production in anaerobic digestion, which utilizes lipid-rich wastewater.

Keywords: Lipid inhibition, LCFA, Anaerobic digestion, BioWin, Simulation

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LIST OF ABBREVIATIONS

Abbreviation	Description
AD	Anaerobic Digester
ADM1	Anaerobic Digester Model No.1
ASDM	Anaerobic Sludge Digestion Model
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
DC	Desiccated Coconut
DCWW	Desiccated Coconut Wastewater
ISS	Inert Suspended Solids
LCFA	Long Chain Fatty Acid
UD	User Defined
VFA	Volatile Fatty Acid
μ_{max}	The maximum rate of substrate degradation per unit weight of micro-organisms, h^{-1}
K_s	Half saturation constant
K_i	Inhibition constant

LIST OF APPENDICES