بسم الله الرحمن الرحيم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

MONA MAGHRABY

DESIGN AND PROTOTYPING MODEL FOR

A BIOMASS UNIT TO PRODUCE METHANE GAS

Submitted By

Amro Mohamed Hamza Abbas

B.Sc. of Engineering, Faculty of Engineering, Mansoura University, 1989

Master in Engineering (Environmental Engineering management & technology),

Faculty of Engineering, Mansoura University, 2013

A Thesis Submitted in Partial Fulfillment

Of

The Requirement for the Doctor of Philosophy Degree

In

Environmental Sciences

Department of Environmental Engineering Sciences

Institute of Environmental Studies and Research

Ain Shams University

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Dedication

I would like to dedicate my thesis to my beloved mother

Acknowledgment

*All praise is due to **Allah**, who help me to fulfill this thesis. I would like to thank **Prof. Dr. Adel El-Shabasy** and **Prof. Dr. Magdi El-Saadawi** my major professors and advisor, for continuous support, guidance and encouragement. They have been the source of continuous support and help throughout my DOCTOR OF PHILOSOPHY degree program. I also do not forget the late **Assoc. Prof. Dr. Ahmed Hassan** for his contributions to this doctoral thesis, I will never forget what I have learned from them to do researches in a scientific way with full confidence and hopefulness. Finally, I would like to thank **my mother** and my family for constant love and support that have always give me. Great thanks to Dr. Mohammed Saeed, Dr. Khaled Abdel-Momen, Dr. Bishoy Sedhom and Eng. Samaa Fawzy in Mansoura university for their help and support during my research work.*

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Abstract

There are millions of tons of biomass waste being produced every year for which disposal is a problem. At the same time, the world is rapidly depleting its supply of natural gas, which is known to be the cleanest of the fossil fuels. There are different ways to convert biomass resources into useful energy. One important type of these conversion processes is the Anaerobic Digestion in which the biomass sources are used to produce biogas. Anaerobic digestion (AD) is a collection of biological processes where the organic material is converted by microorganisms to produce a mixture of mainly methane and carbon dioxide (biogas) in the absence of oxygen. Methane is a very powerful greenhouse gas. The combustion of methane releases energy, which can be used to generate heat and electricity. On the other hand, kitchen waste can be used to produce biogas due to its high biodegradability which can reduce the dependency on fossil fuels. This thesis presents a proposed design, modeling, simulation and prototyping of small-scale biogas digester based on kitchen waste. The biological processes of the AD are mathematically modeled to give a complete representation of the physic-chemical reactions depending on several aspects such as microbial activity, substrate degradation, and temperature. A small-scale family size kitchen waste digester is designed to utilize the kitchen waste of an average Egyptian family and provides the required cooking heat of the house. The model is then simulated in Matlab/Simulink environment. The proposed model is simulated under different conditions to investigate the impacts of digester temperature, feed type, and reaction time on

biogas production. The simulation results identify the best parameters for the operation of the proposed model. The design parameters detect the suitable size for a biogas digester based on the kitchen waste of an average Egyptian family. After designing the proposed digester and detecting its dimensions, the physical prototype representing the proposed digester in its final form is fabricated. A novel control system for controlling different parameters of the biogas digester is developed. Finally, the fabricated prototype is examined experimentally by performing three case studies. The case studies examine the impact of time, temperature and feed type on the biogas production of the proposed digester. The results are reported and analyzed to derive the thesis conclusion and recommendations.

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