PRODUCTION OF DESALINATED WATER & ELECTRICITY USING ALGAE PONDS

A Thesis

Submitted to the Faculty of Engineering
Ain Shams University for the Fulfillment
of the Requirement of PhD. Degree
in Civil Engineering
by

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2020

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Date:- ---/--/2020

DEDICATION

This work took a period from my life. I wish to dedicate it to whom suffered to educate, prepare, build capacity and help myself to be as I am,

TO MY Grand FATHER Soul

My first mentor

TO MY Parents

For the suffering for my sake

TO MY siblings

For bearing with me

TO MY Wife

For her support

TO My Main supervisor

For introducing me to new possibilities

STATEMENT

This dissertation is submitted to Ain Shams University, Faculty of Engineering for the degree of PhD. in Civil Engineering.

The work included in this thesis was carried out by the author in the department of Public Works, Faculty of Engineering, Ain Shams University, from January 2017 to November 2019.

No part of the thesis has been submitted for a degree or a qualification at any other University or Institution.

Date:- ---/--/2020

Signature:- ----------------

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ABSTRACT

Name :- EL Baraa Louye Elsayed Mohamed Elghazy

Title :- "Production of Desalinated Water & Electricity Using Algae Ponds"

Faculty : Faculty of Engineering, Ain Shams University

Specialty : Civil Eng., Public works Department

Summary:

Water and energy are two of the most essential resources for human life on earth. With the growing world population, water shortage and fossil fuel depletion have become tangible threats. Seawater desalination and renewable energy sources represent an effective and long-term solution for the ongoing exhaustion of fresh water and energy sources. Most methods of desalination and energy production have technical, economic, and environmental drawbacks. This study presents a new environment-friendly approach for electricity generation and desalination using microalgae.

Electricity production and desalination using the freshwater algae *Chlorella vulgaris* were first investigated on a lab-scale and then tested again on a larger scale. Lab-scale electricity experiments involved constructing a bio-photovoltaic cell that uses an algal biofilm as an anode. The cell was investigated under conditions of varying salinity, cell height and anode to cathode distance. Desalination by *C. vulgaris* was examined by adding algae to water samples with different salinities and measuring the salinity level hourly for 12 hours. To test for practicality, a larger-scale pilot experiment was done examining the potential of *C. vulgaris* to simultaneously cause desalination and energy production and to determine the design equation for such system in algae ponds.

Regarding energy production, the proposed algal bio-photovoltaic cell produced a maximum of 0.12 W/m2. The best output was at an anode-cathode spacing, height and salinity of 2 cm, 15 cm and 20000 TDS respectively. In addition, salt removal from all samples was achieved at varying levels and times depending on the starting salinity. According to the results, *C. vulgaris* requires only 50-60 hours for desalination through a multi-step process. The pilot scale experiment succeeded in achieving the lab results. Furthermore, a model was designed based on the experimental results and produced two equations. The first yields the removal efficiency according to inlet TDS, retention time, and number of basins in the series. The second provides the amount of produced electricity according to inlet TDS

In conclusion, the proposed system provides a , rapid, and clean method of desalination and electricity generation using the green algae *Chlorella vulgaris*.

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Dr. Ola Deyaa Salah Eldin El Monayery

KEYWORDS: ***Algae ponds, Desalination, Electricity production,***

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CHAPTER I
INTRODUCTION

1.1 INTRODUCTION

For the time being, the availability of water appears sufficient for current demands. However, it is anticipated that water scarcity will occur in the near future. Water is the most important element for all living organisms, in addition to its political value. Seawater is the most available water resource, and desalination has become the key to overcome the water scarcity. Several methods have been applied for water desalination but all the available procedures have technical, economic and environmental problems. This has encouraged researchers to consider biological desalination using the natural activity of photosynthetic microorganisms such as algae.

This was previously applied with the fresh water algae *Scenedesmus obliquus* that consumes salts from saline water to create a suitable environment for its survival. Concurrently, some researches succeeded to produce electricity from algae in stabilization ponds applied to treat wastewater. This has opened the field to the use of desalination algae ponds to produce electricity, which may then cover its own energy needs.

Since there are various efforts and research projects towards producing clean energy and implementing a wide capacity of desalination approaches at feasible construction and operating cost, therefore the biological desalination by algae ponds seems to be a promising solution that needs more research effort to investigate and determine all its governing parameters.

This study is dedicated to investigating the possibility of such system, however, more work will be required for the enhancement of the electric output. The value of this study is very significant, as it introduces a new way of supplying enough resources to the future generation either water or power.