

WATER DESALINATION USING ALGAE ACTION

Submitted by

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B.Sc. in Civil Engineering, Faculty of Engineering, Ain Shams University, 1994
M.Sc. in Civil Engineering, Faculty of Engineering, Kuwait University, 1998

**A Thesis Submitted in partial Fulfillment
of
the Requirement for Doctor of Philosophy Degree
in
Environmental Science**

**Department of Environmental Engineering Science
Institute of Environmental Studies and Research
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ABSTRACT

The thesis examines and determines the validity of the new technique for desalination based on the use of algae in the removal of salts from saline water, and water production for use in different purposes. The new concept has been used and tested in previous researches, where using the algae reduced the cost to the minimum while maintained the efficiency with no reduction. The aim of the thesis to determine the viability of the application for the new desalination plants and developed over the possibility of working out. The study was made to assess the removal efficiencies of different nutrients in saline water by the means of the green algae **Scenedesmus** species. The saline water from Suez Canal, Ismailia Governorate (about 40000 ppm) was used.

The work is done in two phases, the first application in the laboratory on several flasks of different concentrations of water to determine the time required and maximize efficiency and ensure the possibility of application while the second phase of the application on the model laboratory plant continuous flow tanks with retention time in one of no more than 7 days, where attention was paid to evaluate and follow up system performance and operational control of the station to reach the highest efficiency of the unit.

The removal efficiency for the continuous flow system was around 97% for Total dissolved solids, Sodium, Chloride, and Phosphate 93% for Nitrate and Sulfate. The experiment results showed a high values of the reduction in concentration of salinity which reflect the success of algae to improve the properties of the seawater by removing most of salinity without any chemical or physical reaction which save a huge amount of energy and protect the environment form the previous methods used for desalination.

This shows the suitability of the serial algae ponds to produce suitable potable water from sea water. Also, the residual amount of algae may be used in the industrial manner such as industrial painting, cosmetics.

The study had built a modeling equation Calculated the TDS removal ratio with error ranged ± 10 % on the experimental data that in the scientific research could be acceptable.

SUMMARY OF PHD THESIS

1- INTRODUCTION

In the last period with the progress in scientific research several methods for desalination were appeared and developed but the main problems were the high initial and running costs, the huge power requirements and complication of the systems that prevent the enlargement of desalination and make only for rich and desert countries.

2- PROBLEM

During the last ten years ideas about using the biological desalination had appeared. Several trials made for treating industrial wastewater from 2003 -2006 with successful results that encourage the idea to go to apply in potable water production. This required to make laboratory and field experiments to prove the procedure suitability and put the engineering application for it.

3- OBJECTIVES

The aim of the thesis to determine the viability of the application for the new desalination plants and developed over the possibility of working out. The study was made to assess the removal efficiencies of different nutrients in saline water by the means of the green algae *Scenedesmus* species.

4- SCOPE OF WORK

The scope of work is divided into the following:

- 1- **Theoretical work** that covered the Data Collection Literature review for all the previous studies related to the aim of the study Review the previous models related to algae and ponds. Results, analysis and Discussion Modeling Study & Design then thesis preparation
- 2- **Practical work** which is done in two phases, the first application in the laboratory on several flasks of different concentrations of water to determine the time required and maximize efficiency and ensure the possibility of application while the second phase of the application on the model laboratory plant continuous flow tanks with retention time in one of no more than 7 days, where attention was paid to evaluate and follow up system performance and

operational control of the station to reach the highest efficiency of the unit. The saline water from Suez Canal, Ismailia Governorate (about 40000 ppm) was used..

5- CONTENTS

The thesis consists from seven chapters in addition to references, English and Arabic summary, the chapters could be summarized as follows:

5.1 CHAPTER I: INTRODUCTION

This chapter covers the study background presenting the problem of the study, the study objectives and the scope of work, Also, the chapter presents the thesis organization contents.

5.2 CHAPTER II: LITERATURE REVIEW

This chapter covers the illustration of most of the previous studies in the field of water desalination and the applicable technologies of it then concentrates on the biological desalination studies and the factors governing its success

5.3 CHAPTER III: MATERIAL AND METHODS

This chapter covers the types of algae used and the proposed pilot plant of the study. Also, it covers the operation procedures and the experimental program used. Moreover, it was focused on the analytical method and sampling.

5.4 CHAPTER IV: RESULTS OF EXPERIMENTAL WORK

This chapter presents the results of batch scale and continuous flow from the experimental program for all parameters with tables and figures represent the behavior of the algae to remove theses parameter during the operation period.

5.5 CHAPTER V: MODELING OF ALGAE PONDS

In this chapter the modeling concept will be presented with demonstration of models from the previous studies. Moreover, the steps of designing the model of the experiment will be presented and deduction of the final equation which simulates the actual data obtained from the experiment.

5.6 CHAPTER VI: DISCUSSION

Chapter VI analyzes and discusses the results of the experimental work from the bench scale and continuous flow. Also, the designed model will be examined and verified by calculating the results and comparing the data collected from the experimental work with the calculated value from the equation.

5.7 CHAPTER VII: CONCLUSION

This chapter concludes and evaluates the applicability of a proposed new technique for desalination. The biological desalination technique as a new one was proposed for its low capital and running cost compared with other desalination techniques.

6- RESULTS

The study resulted The removal efficiency for the continuous flow system was around 97% for Total dissolved solids, Sodium, Chloride, and Phosphate 93% for Nitrate and Sulfate. The experiment results showed a high values of the reduction in concentration of salinity which reflect the success of algae to improve the properties of the seawater by removing most of salinity without any chemical or physical reaction which save a huge amount of energy and protect the environment form the previous methods used for desalination. This shows the suitability of the serial algae ponds to produce suitable potable water from sea water. Also, the residual amount of algae may be used in the industrial manner such as industrial painting, cosmetics.

The study had built a modeling equation Calculated the TDS removal ratio with error ranged $\pm 10\%$ on the experimental data that in the scientific research could be acceptable.

7- RECOMMENDATIONS

Based on the results obtained from the experimental program executed in this research and the produced design equation, the following recommendations from this study could be illustrated:-

- 1- The green algae desalination should be applied as a good method for the case of water desalination.
- 2- The system is suitable for the countries with moderate weather considering temperature and sunshine suitable for algae growth to

minimize desalination cost and for its ease of operation and maintenance.

- 3- The application of the Equation could ease the designers role to obtain the plant sizing, the chemicals needs and the algae amounts for startup with high accuracy.

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