

HIGHER TECHNICAL INSTITUTE

MECHANICAL ENGINEERING DEPARTMENT

DIPLOMA PROJECT

DESIGN AND CONSTRUCTION OF A
DEMONSTRATION UNIT FOR WATER PURIFICATION

M / 823

BY: ANASTASSIOS MAVROKEFALOS

1998

HIGHER TECHNICAL INSTITUTE

MECHANICAL ENGINEERING DEPARTMENT

DIPLOMA PROJECT

**DESIGN AND CONSTRUCTION OF A
DEMONSTRATION UNIT FOR WATER PURIFICATION**

M/823

ANASTASSIOS MAVROKEFALOS

1998

HIGHER TECHNICAL INSTITUTE	PROJECT NO. 2909
----------------------------------	-------------------------

**DESIGN AND CONSTRUCTION OF A DEMONSTRATION UNIT
FOR WATER PURIFICATION**

By

Anastassios Mavrokefalos

Project Report

Submitted to

the Department of Mechanical Engineering

of the Higher Technical Institute

Nicosia Cyprus

in partial fulfillment of the requirements

for the diploma of

TECHNICIAN ENGINEER

in

MECHANICAL ENGINEERING

July 1998



HIGHER TECHNICAL INSTITUTE
NICOSIA - CYPRUS
MECHANICAL ENGINEERING DEPARTMENT
Diploma Project 1997/98

Project Number: M/823

Title: "Design and Construction of a Demonstration Unit for Water Purification"

Objectives:

1. To carry out a survey on the state of the art on water purification.
2. To design a demonstration unit suitable for the production of potable water from brackish or saline water, including all necessary controls and accessories.
3. To construct the above unit and commission it in full operation.
4. To carry out performance tests.
5. To prepare detailed guidelines and instructions for the operation of the unit.

Terms and conditions:

1. All equipment and materials needed for the construction will be provided.

Student : Anastasios Mavrokefalos (3ME1)

Supervisor : Dr Ioannis Michaelides

External Assessor:

IM/AEP
objectiv.98(57)

HIGHER TECHNICAL INSTITUTE	PROJECT NO. 2909
----------------------------------	-------------------------

ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to Mr Ioannis Michaelides, my project supervisor, and Mr Charalambos Kaloyirou, Senior Assistant for all the necessary guidance and help that they have given to me for the completion of my project.

I would also like to thank Mr Marios Coutoumbas for all the time and effort that he has put to help me with the assembly of the unit.

CONTENTS

Page

ACKNOWLEDGEMENT	I
CONTENTS	II
SUMMARY	IV
INTRODUCTION	V
CHAPTER 1	
Overview of purification technologies.	1
1.1. Ion-Exchange.	2
1.2. Carbon Adsorption.	4
1.3. Microporous Membrane Filtration.	5
1.4. Ultrafiltration.	6
1.5. Reverse Osmosis.	7
1.6. Ultraviolet Radiation.	10
CHAPTER 2	
Desalination processes.	11
2.1. Thermal Processes.	12
2.1.1. The Multiple - Stage Flash Distillation (MSF) Process.	12
2.1.2. The Multiple - Effect Distillation Process.	14
2.1.3. The Vapour Compression Distillation (VC) Process.	16
2.2. Membrane Processes.	17
2.2.1. Electrodialysis.	17
2.2.2. Electrodialysis Reversal Process (EDR).	20
2.2.3. Reverse Osmosis.	21
2.3. Other Processes.	23
2.3.1. Freezing.	23
2.3.2. Membrane Distillation.	24
2.3.3. Nanofiltration.	24
2.3.4. Solar Desalination.	25
2.3.5. Other Solar and Wind - Driven Desalters.	26

CHAPTER 3	
An overview of the water situation in Cyprus.	27
3.1. Water Resources due to Climatic Factors.	28
3.2. Water Demand.	28
3.3. Description of the Main Water Systems.	29
CHAPTER 4	
The water purification demonstration unit.	31
4.1. General description of the active components of the Unit.	32
4.1.1. JetpaQ Water Pressurising System.	32
4.1.2. Liff Reverse Osmosis Water Treatment System.	32
4.1.3. Liff Ultraviolet Purifier.	33
4.2. Operation of the Water Purification Demonstration Unit.	33
CHAPTER 5	
Experimental results and calculations.	34
5.1. Basic Theory of Conductivity	35
5.2. Basic Theory of pH.	35
5.3. Calculation of the flow rate of the Demonstration Unit.	36
CHAPTER 6	
Comments – Discussions	37
REFERENCES	39
APPENDICES	40

SUMMARY

The first objective of the project was to carry out a survey on the art of water purification. This is shown quite analytically below. Because of the water shortage problem that Cyprus is facing at the moment, more extensive research was carried out in the art of desalination, being one of the most important methods of solving such a problem.

The second objective of the project was to design a demonstration unit for the purification of water and the components used (pump, RO unit and UV unit) They were chosen after eliminating a number of other components (filters, anti-scalants, water softeners) because of the fact that their use is obsolete when using the final equipment.

The third objective was to assemble the unit and commission it in operation and carry out performance tests using the Corning M90 probe and compare it with the Cyprus Standards on potable water

The fourth and final objective was to prepare guidelines and instructions for the operation of the unit.