

HIGHER TECHNICAL INSTITUTE
MECHANICAL ENGINEERING DEPARTMENT
DIPLOMA PROJECT

M/600

COMPUTER AIDED DESIGN
OF A RESIDENTIAL
SOLAR HEATING SYSTEM

By

* KYRIACOU GEORGHIOS *

3M1

JUNE 1992

HIGHER TECHNICAL INSTITUTE	PROJECT NO 2035
----------------------------------	--------------------

INTRODUCTION

Constructive use of solar energy dates back to the earliest periods in history. The greek physicist Archimedes was the first to use solar energy on a large scale , to set fire to the attacking Roman fleet at Syracuses in 212 B.C using a combination of small mirrors to focus the sun rays.

Today ,solar energy designs have drammmatically improved and they still are in order to improve their quality and performance.

This project will be dealing with the design of a solar system that will be used for space heating purposes. In order to reach this objective successfully ,an examination will be attempted of the currently used designs ,and the most suitable will be chosen . It is interesting to know that nowadays computer softwares are being developed that enable the selection of the optimum solar design which will give maximum performance with minimum cost . Such a software will be used in this project with the aim of choosing a solar design which will best fit the heating requirements of the building.

The F-CHART is a computer program which will be used extensively throughout this project. This software allows the solar designer to compute the heating contribution fraction that solar energy supplies as to satisfy the thermal load requirements of the building under consideration .An aux. heating is employed as to make up the difference between the percentage of thermal energy supplied by solar and the total

energy required by the building. From the f-chart's results, several conclusions can be derived concerning the system to be employed in conjunction with its performance throughout the analysis period.

CONTENTS

ACKNOWLEDGEMENTS	4
GUIDE LINES	5
INTRODUCTION	6
<u>CHAPTER 1</u> : THE SOLAR ENERGY (An Overview)	8
1.1 THE SUN τ PROVIDER OF SOLAR ENERGY	9
1.2 RADIATION & THE EARTH'S ATMOSPHERE	10
1.3 SOLAR CONSTANT	12
1.4 INSOLATION	13
1.5 SOLAR ANGLES	14
<u>CHAPTER 2</u> : SOLAR ENERGY COLLECTION	15
2.1 SOLAR COLLECTORS	16
2.2 SELECTION OF SOLAR COLLECTOR	25
2.3 ARRANGEMENT OF COLLECTORS	25
2.4 COLLECTOR ARRANGEMENT SELECTION	28
2.5 COLLECTOR AZIMUTH SELECTION	28
2.6 OPTIMUM TILT ANGLE SELECTION	29
2.7 OVERSHADOWING EFFECT	30
<u>CHAPTER 3</u> : SOLAR ENERGY STORAGE	32
3.1 WHY SOLAR STORAGE	33
3.2 SENSIBLE HEAT STORAGE	34
3.3 LATENT HEAT STORAGE	36
3.4 SELECTION OF STORAGE SYSTEM	37
3.5 COLLECTOR - STORAGE CURCUITS	38
<u>CHAPTER 4</u> : HEATING REQUIREMENTS OF BUILDINGS	42
4.1 ASSUMPTIONS ADOPTED	43
4.2 TYPES OF HEAT LOSSES	44

4.3 U - VALUES COMPUTATION	45
4.4 HEAT LOAD ESTIMATION	50
4.5 EMITTER SELECTION	54
4.6 ACCOMODATION OF EMITTERS	57
<u>CHAPTER 5</u> : SOLAR SYSTEM DESIGN	61
5.1 SELECTION OF AUX. ENERGY & COLL. NUMBER	62
5.2 SOLAR SYSTEM SELECTION	68
5.3 SYSTEM PERFORMANCE	70
<u>CHAPTER 6</u> : SELECTION & SIZING OF SYSTEM'S EQUIPMENT	78
6.1 BOILER SELECTION	79
6.2 BURNER SELECTION	80
6.3 BOILER CHIMNEY	81
6.4 OIL TANK	82
6.5 HEAT STORAGE VESSELS	83
6.6 EXPANSION VESSEL SELECTION	84
6.7 CONTROL EQUIPMENT	85
6.8 PIPING MATERIAL SELECTION	87
6.9 INSULATION CONSIDERATIONS	88
6.10 PIPE SIZING & PUMPS SELECTION	89
<u>CHAPTER 7</u> : SYSTEM'S COST ESTIMATION	98
7.1 INTRODUCTION	99
7.2 COST OF EMITTERS	100
7.3 PIPING & FITTINGS COST	101
7.4 INSULATION COST	101
7.5 CONTROL EQUIPMENT COST	102
7.6 TOTAL COST OF SYSTEM SELECTED	103
7.7 TOTAL COST OF A NON SOLAR HEATING SYSTEM ...	104

CONCLUSIONS & SUGGESTIONS	105
REFERENCES	107

APPENDICES

<u>APPENDIX A</u> : A.1 U - VALUES COMPUTATIONS	109
A.2 HEAT LOAD ESTIMATION	115
A.3 PIPE SIZING OF DISTRIBUTION CURCUIT ...	118
 <u>APPENDIX B</u> : SELECTION & SPECIFICATION LEAFLETS OF THE	
SOLAR SYSTEM'S ACCESSORIES	123