HIGHER TECHNICAL INSTITUTE

MECHANICAL ENGINEERING COURSE

DIPLOMA PROJECT

DESIGN OF A SOLAR HEATING SYSTEM FOR A BUILDING

M/980

BY: ZYMARAS COSTAS

JUNE 2003

DESIGN OF A SOLAR HEATING SYSTEM FOR A BUILDING

By: ZYMARAS COSTAS

Project Report

Submitted to

the Department of Mechanical Engineering

of the Higher Technical Institute

Nicosia Cyprus

In partial fulfillment of the requierements

For the diploma of

TECHNICIAN ENGINEER

IN

MECHANICAL ENGINEERING

June 2003

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

I would like to express my sincere thanks and appreciation for the help and guidance given to me throughout this project by my project supervisor Dr. I. Michaelides.

I would like also to thank the engineers in the companies, "EWALD AND MAKIS", "ARENCO", and "FLOGA" who have helped me a lot in my project.

Specially, I would like to thank my parents, for their support and dedicate my diploma project to them.

I would also like to thank my girlfriend for her help and support and I want dedicate my diploma to her, and finally I would like to thank my best friends who helped me.

Costas Zymaras

June 2003

SUMMARY

Author's name: Costas Zymaras

Title: " Design of a solar heating system for a building"

The purpose of this project was to design a heating system for a building with a combination of solar collectors and a boiler. For the heating of this building it was decided to use a floor heating system.

First, with the help of the architectural drawings of the building, the heating requirements for space heating and hot water services for the building were calculated. From these calculations it seems that the total heat load is 19 KW.

After that, a suitable system for the collection and storage of low temperature solar energy was designed to satisfy the heat requirements of the building. Here the F-CHART software was needed to calculate the optimum numbers of solar collectors with the maximum life savings and the best fraction of the load F, which was found 28 collectors. But in this project a combination of series and parallel arrangement (reverse-return) of 30 collectors will be used with five rows (see Appendix I), which will cover only the 66% of the total heat requirements.

In the next step, with the help of a second computer program the calculations for the floor heating system were performed as shown in Appendix G. From these calculations it appears that the system should include feeding 7 loops and another one feeding 6 loops.

Then the optimum size of the solar collector, the floor heating pipes, storage unit, pumps, piping and other equipment and accessories involved in the system were determined, including all necessary instrumentation and controls

After that, the detail drawings showing the installation of solar collectors, the piping installation of floor heating system, and the diagrammatic layout of the heating installations is performed.

Finally, based on the calculations and design configuration selected as well as the pipe sizing and equipment selection done, a cost analysis was performed for a floor heating system with solar panels and it was compared with a floor heating without solar panels. In the first case the cost is estimated approximately up to £12450 while the second it will approximately be £3900.

INTRODUCTION

In today's climate of growing energy needs and increasing environmental concern, alternatives to the use of non-renewable and polluting fossil fuels have to be investigated. One such alternative is solar energy.

Due to the nature of solar energy, the two components are required to have a functional solar energy generator. These two components are a collector and a storage unit. The collector simply collects the radiation that falls on it and converts a fraction of it to other forms of energy (either electricity and heat or heat alone). The storage unit is required because of the non-constant nature of solar energy; at certain times only a very small amount of radiation will be received. At night or during heavy cloud cover, for example, the amount of energy produced by the collector will be quite small. The storage unit can hold the excess energy produced during the periods of maximum productivity, and release it when the productivity drops. In practice, a backup power supply is usually added, too, for the situations when the amount of energy required is greater than both what is being produced and what is stored in the container.

Methods of collecting and storing solar energy vary depending on the uses planned for the solar generator. In general, there are three types of collectors and many forms of storage units. The three types of collectors are flat plate collectors, focusing collectors, and passive collectors.

People use energy for many things, but a few general tasks consume most of the energy. These tasks include transportation, heating, cooling, and the generation of electricity. Solar energy can be applied to all four of these tasks with different levels of success.

Heating is the business for which solar energy is best suited. Solar heating requires almost no energy transformation, so it has a very high efficiency. Heat energy can be stored in a liquid, such as water, or in a packed bed. Heat energy is also often stored in phase changer or heat of fusion units. Solar energy is frequently used in residential homes to heat water. This is an easy application, as the desired and result (hot water) is the storage facility.

Solar energy is often used directly heat a house or building. Heating a building requires much more energy than heating a building's water; so much larger panels are necessary. Generally a building that is heated by solar power will have its water heated by solar power s well. The type of storage facility most often used for such large heaters is the heat of fusion storage unit, but other kinds (such as the packed bed or hot water tank) can be used as well. This application of solar power is less common than the two mentioned above, because of the cost of the large panels and storage system required to make it work. Often if an entire building is heated by solar power, passive collectors are used in addition to one of the other two types. Passive collectors will generally be an integral part of the building itself, so buildings taking advantage of passive collectors must be created with solar heating in mind.

Solar energy can be used for other things besides heating. It may seem strange, but one of the most common uses of solar energy today is cooling. Solar cooling is far more expensive than solar heating, so it is almost never seen in private homes. Solar energy is used to cool things by phase changing a liquid to gas through heat, and then forcing the gas into a lower pressure chamber.

Besides being used for heating and cooling, solar energy can be directly converted to electricity. Most of our tools are designed to be drive by electricity, so if you can create electricity through solar power, you can run almost anything with solar power. The solar collectors, and the silicon components of these collectors are photovoltaic cells.
Solar power has two big advantages over fossil fuels. The first is in the fact that it is renewable it is never going to run out. The second is its effect on its environment.

Of all the energy sources available, solar has perhaps the most promise. Numerically, it is capable of producing the raw power required to satisfy the entire planet's energy needs. Environmentally, it is one of the least destructive of all sources of energy.
Practically, it can be adjusted to power nearly everything except transportation with very little adjustment, and even transportation with some modest modifications to the current general system of travel,. Clearly, solar energy is a resource of the future.

In this project the possibility of heating of a house with the aid of floor heating system and using solar energy as the energy source will be examined.