AIN SHAMS UNIVERSITY
Faculty of Engineering
Energy and automotive engineering department

A THESIS SUBMITTED ON

"Application of Solar Energy in Heating"

Presented By
Eng. Ibrahim Asmatt Helmy Aly Zayan
(B.Sc. and Diploma Mechanical Power Engineering)

For The degree of Master of Science

Supervised By
Prof. Dr. Ahmed El Said Gad El Mawla
Ain Shams University
Associate Prof. Dr. ZAKARIA GHONEIM
Ain Sahms University

Cairo, 1983.

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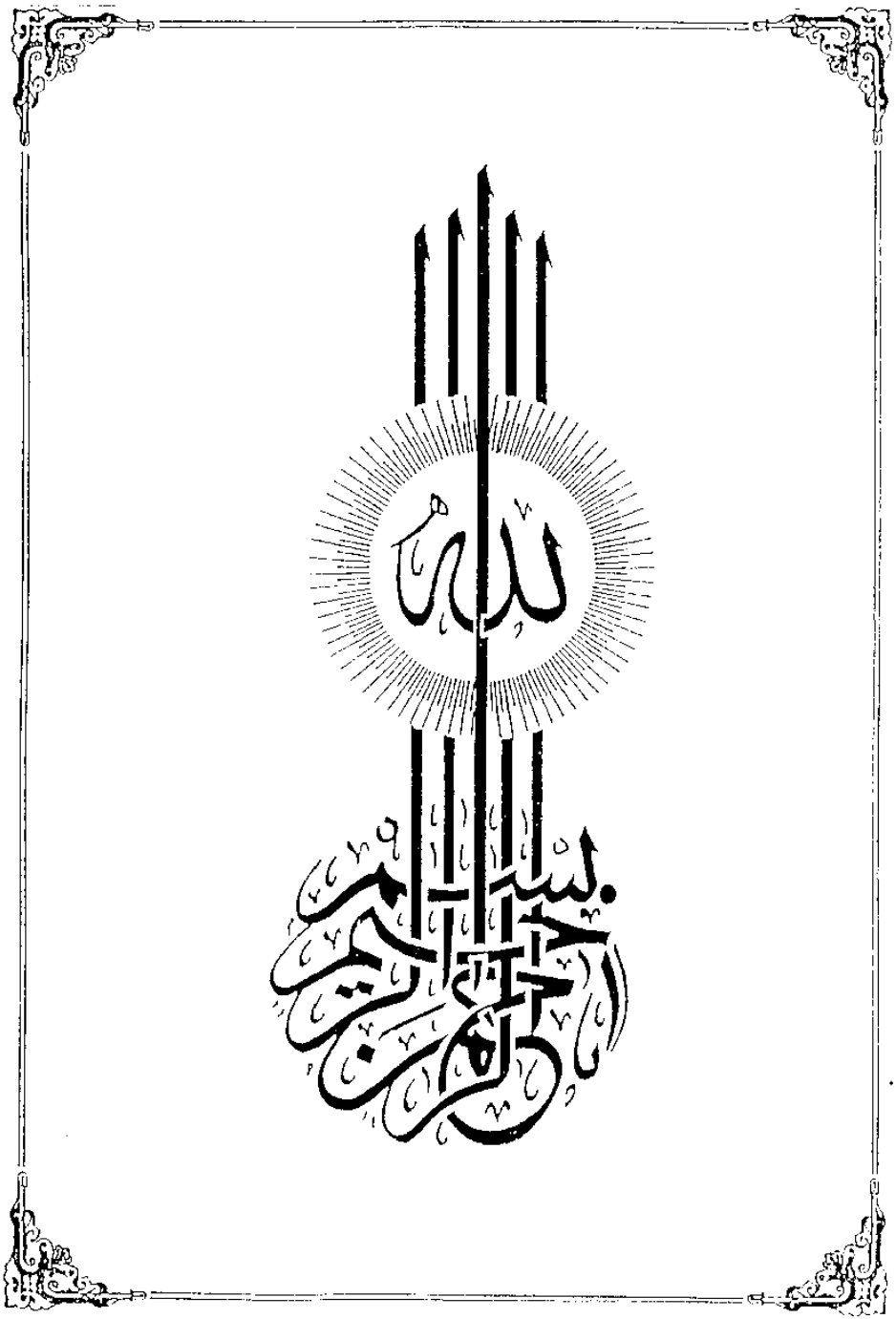

ACKNOWLEDGMENT

Before starting to record my humble effort in this study, I ought to take to opportunity of illustrating my deepest sensations and full gratitude to the great and valuable help of my professors who have given me the great momentum and enable me to come to a successful end of my research.

This occasion enabled me to readily beleived when I say that this research on the application of solar energy in drying process did not originate and never wood have originated without the help of Professor Dr. Eng. Ahmed El Said Gad El Mowla, Prof. of Heat Engines, Faculty of engineering, Ain Shams University who contemplated for a long resies of miscellaneorss orientations during the long supervision of four years work. In the same to me I must be allowed to familiarise the readers of my research with the contribution of Associate Professor Dr. Zakaria Ghoneim; who did not preserve any effort in implimentation of this research.

I have to mention with gratitude the great help of Professor Dr. Salah Arafa Head of physics department, Faculty of Science, American University of Cairo.

Undoubtedly the great help to be mentioned is that of his excelency the minister of defence and his great assistances who spared me the time and means to reach my aim and whose encouragement filled me with the momentum to the end of the way.

Finally I voice a special note of thanks to my family and my wife for the support they gave and sacrifices they mode to complete this thesis.

S U M M A R Y

Design and manufacturing a solar drier. This study was concerning designing and manufacturing a drier of 2.5 meter square area to dry the agricultural products and food stuff by using the solar energy as an alternative source for the conventional energy to heat the air flow used.

This drying process is essential to preserve the stored stuff for an adequate period without any decay to keep it adible.

In this study calculations for the average hourly values of the radiation intensity incident on the unit area of the drier's cover with an inclination of 45° to the horizontal surface were made all over the year by using (LIU & Jordan) method.

This study included counting the average of mass air flow passing through the openings at the bottom end of the drier per hour and successively per day all over the year and the quantity of that air ranged between 40 to 47 cubic meter per hour.

The temperature of the hot air inside the drier was counted by the same way and it ranged between 65 to 78°C all over the year.

The study included also the factors controlling the quantity of the air flow passing through the drier by erecting a chimney 1.3 meters height at the top of the drier and got the proportional relation between the dimensions of that chimney and the mass air flow through the drier.

A study has been made on the effective factor on the temperature of the air flow inside the drier and due to that an equation has been deducted to show the relation between the dimensions of the drier with the temperature of the air heated inside. Other results from this equation showed the relation between the radiation intensity and the physical characteristies of the material used and the air temperature.

The study also illustrated the most suitable way to determine the mass of the product to be dried by knowing the moisture content of the product before and after the drying process.

Many practical measures were taken all over two years to indicate the temperature of the air in and outside the drier and the absorber plate, and to measure the mass air flow in the first year with the plastic cover and in the second year with the glass-cover.

In both cases mentioned above the temperature of the air inside the drier ranged between 60 to 70°C and the absorber plate temperature ranged between 85 to 120°C and the mass air flow ranged between 37 to 45 cubic meter per hour all over the year.

The study was assisted by computer programs to ensure the most accuracy possible beside that a comparison between the results of the theoretical and practicals measures and the difference ranged between 6 to 8°C in the air temperature while it ranged between 2 to 3 cubic meters per hour of air flow during the year.

In spite of all that mentioned above, the study did not neglect the economic side of the solar drier to maintion the practical and economic feasibility, and the pay back period covered three years.

The thesis contains the following eight chapters :

Chapter I :

This chapter shows historical demonstration for the various kinds of solar driers and classifies them according to the heating mode and the way of heating the product.

The characteristics, performance, and the nationality of each drier was illustrated separately.

Chapter II :

This chapter illustrates the prototype of the drier which was designed, manufactured and erected in the laboratory and workshops of the faculty and describe's the various steps taken to put the drier into a working conditions.

Chapter III :

This chapter describes the theory of heat transfer of the drier and the drying process from the theoretical point of view. Due to that some equations were put to determine the temperature of the air flow

in the drier in case of plastic or glass cover. In addition some simple equations were put to illustrate the drying operation and counting the product required and studying the effective factors on the operation.

Chapter IV :

The chapter presents the practical measurements which were made all over two successive years to measure the temperature of the surrounding air and inside the drier, the plate temperature and the mass air flow through the drier during the first year the cover of the drier was a plastic sheet while the second year the cover was a sheet of white glass.

Chapter V :

This chapter deals with the calculations which were made and the results we reached. It showed the pressure difference across the bed and in case of the plastic cover sheet a computer program was made to get the out put all over the year as follows :-

(a) Hourly plate, cover, and air temperature.

(b) Hourly mass air flow.

C O N T E N T S

Page

LIST OF TABLES