

Some Studies on Solar Distillation and Water Heating Systems

By
MADHURI

Thesis Submitted to the
Indian Institute of Technology, Delhi
for the award of the degree of
DOCTOR OF PHILOSOPHY



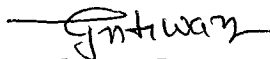
Centre For Energy Studies
INDIAN INSTITUTE OF TECHNOLOGY, DELHI
INDIA

January, 1986

To
My husband Anil
And daughter Aarushi

CERTIFICATE

It is certified that the thesis entitled "Some Studies on solar distillation and water heating systems" being submitted by Madhuri is worthy of consideration for the award of the degree of Doctor of Philosophy and is a record of the original bonafide research work carried out by her under our guidance and supervision. The results contained in this thesis have not been submitted in part or full to any other University or Institute for award of any degree or diploma.



Dr. G.N. Tiwari
Centre of Energy Studies
Indian Institute of Technology,
Delhi



Prof. H.P. Garg
Centre of Energy Studies
Indian Institute of Technology,
Delhi

ACKNOWLEDGEMENTS

It is my great pleasure and privilege to express my deep sense of gratitude and profound indebtedness towards Prof. H.P. Garg and Dr. G.N. Tiwari for their incessant, invaluable guidance, direction and inspiring encouragement and kind cooperation in each and every phase of this research work.

The helpful suggestions and continuous interest of Prof. M.S. Sodha and Prof. S.S. Mathur is gratefully acknowledged.

My hearty thanks are also extended to Prof. O.D. Grover Head, Centre of Energy Studies (CES) and other staff members of CES for their encouragement, advice and timely help at every stage of the research work.

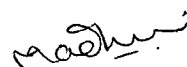
I express my heartfelt gratitude to Dr. (Mrs.) N.K. Dhiman, for taking deep interest in my work.

My special thanks go to my colleagues and friends for their valuable assistance and fruitful discussions I had during the course of this work. I also wish to appreciate the cooperation extended by the technical and administrative staff of the centre.

I have no befitting words to express my deep sentiments towards my dear parents, understanding husband Mr. Anil Sachan, daughter. Aarushi and other family

members for their endless tolerance and moral support during the course of this work.

Finally, the financial support of Council of Scientific and Industrial Research (CSIR), India which enabled me to reach at this stage is also acknowledged.



MADHURI

CONTENTS

Folio

PREFACE

CHAPTER - I

EFFECT OF WATER DEPTH ON YIELD OF THE SINGLE BASIN SOLAR STILL.

1.1	Introduction	16
1.2	Heat transfer in a solar still	20
1.2.1	Internal heat transfer modes	20
1.2.2	External heat transfer modes	22
1.2.3	Convective heat transfer from basin liner to water mass	23
1.2.4	Bottom and edge heat transfer mode.	24
1.3	Mathematical formulation	25
1.4	Experimental set up.	32
1.5	Numerical results and discussion	33
1.5.1	Theoretical calculations	33
1.5.2	Experimental Observations	39

NOMENCLATURE

REFERENCES

CHAPTER - II

USE OF WASTE HOT WATER IN A SINGLE BASIN STILL

2.1	Introduction	53
2.2	Mathematical formulation	55
2.2.1	Intermittent flow of waste hot water in the basin	55
2.2.2	Once a day feed of water: transient solution.	61
2.2.3	Intermittent flow of waste hot water in the basin with water flow over the glass cover	62
2.3	Numerical results and discussion	66

TABLES

NOMENCLATURE

REFERENCES

CHAPTER - III

SOLAR WATER HEATING SYSTEM WITH n-TANKS IN SERIES

3.1	Introduction	86
3.2	Theory of flat plate collector	89
3.3	Determination of overall heat loss coefficient	95
3.3.1	Top loss coefficient	95
3.3.2	Back loss coefficient	98

3.3.3	Edge loss coefficient	99
3.4	Analysis	99
3.4.1	During sunshine hours	99
3.4.2	During off-sunshine hours	101
3.5	Numerical results and discussion	102

NOMENCLATURE

REFERENCES

CHAPTER - IV

PERFORMANCE OF SHALLOW SOLAR POND

WATER HEATERS

4.1	Introduction	114
4.2	Mathematical formulation	120
4.2.1	Underground shallow solar pond water heater with movable insulation.	120
4.2.2	Underground shallow solar pond water heater with thermal trap	128
4.2.3	With baffle plate (A transient solution)	132
4.3	Numerical results and discussion	137

TABLES

NOMENCLATURE

REFERENCES

CHAPTER - V

THERMAL LOAD LEVELLING OF HEAT FLUX DUE
TO COLLECTOR/STORAGE PCCM AND CONCRETE
ROOF.

5.1	Introduction	168
5.2	Mathematical formulation	172
5.2.1	Effective thermal properties of a PCCM wall	172
5.2.2	Periodic analysis	176
5.3	Numerical results and Discussion	189

TABLES

NOMENCLATURE

REFERENCES

APPENDIX - I	210
APPENDIX - II	211