"Thermal Design And Parametric Studies On An Open Cycle Absorption Solar Cooling System"

by

Jaivir Kaudinya

Thesis Submitted to the
Indian Institute of Technology, Delhi
In Partial Fulfilment
for the Award of the Degree of
DOCTOR OF PHILOSOPHY
in 'Energy Studies'

Centre of Energy Studies
INDIAN INSTITUTE OF TECHNOLOGY DELHI
NEW DELHI-110016
INDIA

July, 1985

To my newly born Son, SAMEER

CANDIDATE'S DECLARATION

I hereby declare that the work, which is being presented in the thesis entitled "THERMAL DESIGN AND PARAMETRIC STUDIES ON AN OPEN CYCLE ABSORPTION SOLAR COOLING SYSTEM" in fulfilment of the requirements for the award of the degree of Doctor of Philosophy, submitted in the Centre of Energy Studies, I.I.T. Delhi is an authentic record of my own work carried out by me during a period from July 1982 to July 1985 under the supervision of Dr. S.C. Kaushik, Assistant Professor, Centre of Energy Studies, Indian Institute of Technology, Delhi. The matter embodied in this thesis has not been submitted by me for the award of any other degree.

JAIVIR KAUDINYA
(Candidate's Signature)

This is to certify that the above statements made by the candidate are correct to the best of my knowledge.

S.C. Kaushik

Supervisor: (S.C. Kaushik)
Assistant Professor
Centre of Energy Studies
I.I.T. Delhi

ACKNOWLEDGEMENTS

Pleasantfully, I take this opportunity of expressing my deep sense of gratitude to all mighty God (An embodiment of supreme power) who blessed me the ability of winning all the hurdles came so far across me to reach this level.

I am beholden to my esteemed supervisor Dr. Subhash Chandra Kaushik, Assistant Professor, Centre of Energy Studies, I.I.T. Delhi for his incessent and valuable guidance in presenting and submitting this thesis in the hands of the learned elite. His dynamic supervision, contributions for suggesting the research problems and his efforts in the planning and management of the thesis work in the present form can not be expressed merely in words as he devoted innumerable times for improvement and critical analysis of this work.

I am very thankful to Director I.I.T. Delhi and Head, C.E.S., who provided me all necessary facilities and funds to complete my venture. I offer my sincere thanks to Dr. N.D. Kaushika, Assistant Professor, C.E.S., for his continuous encouragement and technical guidance. Grateful thanks are also due to Prof. B.C. Raychaudhury and Professor R.S. Aggarwal for various technical discussions with them.

Special thanks are due to my friends Dr. Subhash Chandra, and Dr. Pardeep Kumar for their help during the work. Warm thanks are also due to my colleagues Mr. Salem Gadhi, Mr. Rajesh Mittal and Mr. Sanjay Kaul for their cooperation .

Emotionally, I am also thankful to my wife, Rachana and my friend Naresh Kumar who helped me by sacrificing their time for the sake of my work.

There is no word befitting for my father Shri K.R. Sharma and my Mummy Smt. Rama Sharma without whom, this work could have not been possible to reach this fruition.

My thanks are also due to the staff of Centre of Energy Studies, Solar refrigeration laboratory and Workshop,CES, who helped me in carrying out the experimental work. Thanks are also due to Mr. Ashok Vashistha for excellent typing of the thesis.

The author also gratefully acknowledges the financial support from Tata Energy Research Institute (New Delhi) as the present thesis is a part of the sponsored project.

JAIVIR KAUDINYA

SUMMARY

Due to acute shortage of electricity cooling can be produced by vapour absorption cooling systems, least dependent on electrical energy. A closed cycle vapour absorption cooling system is known to be a casual alternative of the conventional vapour compression system. However a more promising, open cycle absorption cooling system (OCACS) is proved to be a better alternative for solar cooling/airconditioning applications in the present study.

This thesis presents some coherent and systematic thermal design investigations on an open cycle absorption solar cooling system. The proposed system differs from the conventional closed cycle absorption system in a way that OCACS does not need a condenser and a separate collector for regenerator under solar operation unlike the closed cycle. Thus a least bulky, more efficient and a surviver even at lower regenerator temperatures, an OCACS is studied in detail.

In particular, the present thesis has analysed heat and mass transfer processes in various solar regenerator systems. Design parameters and optimization along with experimental validation (wher-ever possible) of the theoretical studies have been reported. The analytical models developed are found to be consistent with the practical design and capable of predicting the regenerators performance under wide range of

operating conditions. Suitability of different alternative working fluids using water as refrigerant for open cycle absorption air-conditioning have been tested and both the climatic zones viz-hot and dry and hot and humid climates have been considered in the present study. It is found that open and forced flow solar regenerators are suitable for hot and dry climates while a brine still solar regenerator is most suitable in hot and humid climate. However, the forced flow solar regenerator may afford to work even in humid climate while an inexpensive open surface solar regenerator may compete well in arid zones.

In addition, thermodynamic assessment, thermal modelling and thermal design of the complete open cycle absorption cooling system have also been undertaken and a comparative study with a closed cycle and the performance of the system with a new working fluid have also been reported. It is found that an open cycle absorption system is thermodynamically and technically feasible, less expensive, more viable and better in performance than the closed cycle absorption cooling system.

CONTENTS

Page