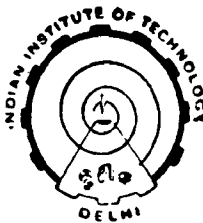


**INVESTIGATIONS ON SOLAR COLLECTOR/STORAGE
AND SPACE HEATING OPTIONS**

by
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*THESIS SUBMITTED TO THE
INDIAN INSTITUTE OF TECHNOLOGY, DELHI
FOR THE AWARD OF THE DEGREE
OF
DOCTOR OF PHILOSOPHY*



Centre for Energy Studies
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February, 1988

DEDICATED
TO
MY PARENTS

DECLARATION

I hereby declare that the work, which is being presented in this thesis entitled, "Investigations on Solar Collector/Storage and Space Heating Options" 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 the research work carried out by me under the supervision of Drs. S.C.Kaushik and N.D.Kaushika, Assistant Professors, Centre of Energy Studies, Indian Institute of Technology, Delhi. The matter embodied in this thesis has not been submitted by me or any body else for the award of any other degree.

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This is to certify that the above statements made by the candidate are correct to the best of our knowledge. We feel satisfied with his work and allow him to submit his thesis.

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SUMMARY

This thesis presents the results of thermodynamic and heat transfer investigations of some solar collector/storage and space heating options. Both active and passive space heating systems have been considered and thermal modelling of the heating device as well as the building itself have been undertaken stepwise in the present thesis.

Conventional active space heating systems involve solar energy storage in the form of hot water storage tanks or phase change materials for continuous system operation. A novel concept of refrigerant storage within the absorption heatpump cycle has been proposed, analysed and thermodynamically assessed. Dynamic simulation for meeting the heating load of a building with the refrigerant mass stored has been carried out for a typical cold winter day. It is found that the refrigerant storage is technically feasible and provides larger storage capacity per unit volume, lower heat losses to the ambient and prolonged storage option as compared to other storage alternatives for absorption systems.

In passive space heating systems, the solar energy collection and storage is accomplished in the building elements (viz. walls and roof). Therefore, a self

consistent periodic heat transfer model has been developed for predicting the thermal performance of a non-airconditioned building with some improved thermal storage walls/roof options for solar space heating. The building modelling incorporates the effects of furnishings, heat conduction to the basement ground and heat transfer due to air ventilation or infiltration etc. along with periodicity of the solar radiation and ambient air temperature. Thermal storage mixed water-mass walls and phase change component material (PCCM) wall/roof have been analysed with this model. It is found that Concrete-Water-Concrete configuration in the south wall is most suited among other storage wall configurations for space heating and thickness distribution and placement of concrete/insulation is found to affect the total heat flux and inside air temperature considerably. An effective thermal properties model for a PCCM slab (wall/roof) has been adopted to predict the inside air temperature in a non-airconditioned building. It is seen that PCCM wall/roof of smaller thickness is more desirable in comparison to an ordinary masonry wall/roof and inside air temperature is more with PCCM south wall than PCCM roof.

The use of honeycomb and slat devices for reducing the heat losses from the roof/wall surface is also proposed and investigated. An air filled honeycomb placed over concrete roof is considered for solar passive space heating. The

honeycomb cellular device is quite solar transparent and cuts the convection heat losses as well as infrared re-radiation losses through it and thus increases the efficiency of solar heat collection for passive space heating. A transverse slat convection suppression device has been tested experimentally and found to be more appropriate and effective in the reduction of heat losses from solar heated walls.

Thus passive heating concepts can be used as means for collection as well as storage of solar energy through building walls and roof and can significantly reduce the thermal (heating) load of the building. It is concluded that the passive space heating systems should be integrated with buildings using active heating systems and the concept of refrigerant storage within the absorption cycle heatpump appears an attractive proposition for meeting the heating load of a building for continuous and cost effective space conditioning. The analytical and numerical results presented in the thesis are useful tools for the thermal design of solar heated buildings and space conditioning devices using solar energy.

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