INVESTIGATIONS OF HONEYCOMB AND SLAT DEVICES FOR APPLICATION TO SOLAR COLLECTOR-CUM-STORAGE SYSTEMS

THESIS SUBMITTED
IN FULFILMENT FOR THE REQUIREMENTS OF
THE DEGREE OF

DOCTOR OF PHILOSOPHY

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DEDICATED

TO

MY

PARENTS

AND

HUSBAND

DECLARATION

I hereby declare that the work, which is being presented in this thesis entitled, "Investigations of Honeycomb and Slat Devices for Application to Solar Collector-Cum-Storage Systems" 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 Dr.N.D. Kaushika and Dr. Anand Prakash. The matter embodied in this thesis has not been submitted to any other University or Institute for the award of any other degree.

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(Candidate's Signature)

Certificate by Supervisors :

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

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ABSTRACT

Convective stability, solar transmission and heat transfer characteristics of honeycomb and parallel slat convection suppression devices have been investigated. The theory of natural convection for the devices is reviewed and the convective heat transfer coefficients for given operating conditions across the device are estimated. Generalised formulations for solar transmittance of CSDs are presented and used to evaluate solar energy collection efficiency which involves the computer modelling. The model is validated by simple experiments and used to generate accurate design data and find the optimum wall separation and aspect ratios for given operational conditions. The square celled honeycomb of wall separation 5-12.5 cm. and aspect ratio of 10-15 and the parallel slat device of wall separation 3-5 cm. and aspect ratio of 8-12 seem optimum for solar collector and storage applications. A comparison is also made between the performance of a square celled honeycomb and the parallel slat device. It is found that for horizontal hot plane, honeycomb is superior to the slat device made from the same quantity of partition material whereas for surfaces inclined to the horizontal in excess of 30°, the slat device is better.

Honeycomb stabilized saltless solar pond is examined as an alternative for conventional solar pond applications. An investigation of the dynamic thermal performance of the system is carried out. Explicit expression for the transient rate at which heat can be retrieved from the system to keep the temperature of the zone of heat extraction as constant is derived. The year round variation of the heat flux as well as the solar collection efficiency is studied as a function of collection temperature and depth of non convective zone. The efficiencies in the range of 30-50% at collection temperature of 90°C are predicted; the efficiencies are higher than those of conventional solar pond by a factor of about two.

A self consistent periodic analysis of heat transfer processes in the system consisting of an air filled honeycomb placed on roof top of an air conditioned building is developed to estimate indoor heat flux and solar thermal gain. Results of numerical computations corresponding to a typical winter day of cold climatic region are reported. Honeycomb of wall separation as 0.0125 m and aspect ratio 8-10 is predicted to be quite suitable to give positive thermal gain at all hours of the day.

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