DESIGN, DEVELOPMENT AND PERFORMANCE STUDIES OF SOME SOLAR AIR HEATERS AND DRYERS FOR AGRICULTURAL APPLICATIONS

by

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Dedicated to

Amma & Babuji

and to

those who

Love me

CERTIFICATE

It is certified that the thesis entitled, "Design, Development and Performance Studies of Some Solar Air Heaters and Dryers for Agricultural Applications", being submitted by Mr. Rai Ajaipat Ray is a record of bonafide research work carried out by him under our supervision. We have permitted the author to submit it for award of the degree of Doctor of Philosophy.

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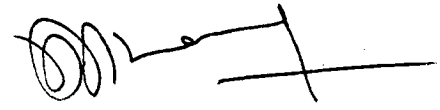

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SUMMARY

In the present thesis the author has presented a detailed study of various solar drying, air heating and storage systems which are employed for agricultural and space heating purposes. A complete drying system should essentially consist of three components viz., a collector to collect the solar energy, a drying chamber to hold the material and a storage system if the drying is to be done on a continuous basis. In the literature, although many types of configurations of these components are available and lot of work has been done on solar dryers, solar air heaters and rock storage systems, not much work has been done on structure integrated dryers which correspond to those configurations which combine two or more of basic drying processes in the same unit. The purpose of this thesis is to study in detail these components and to investigate the effect of integration of two or more components to improve the system performance and reduce the cost.

For evolving a suitable medium capacity solar drying system, three different types of solar dryers viz., cabinet dryer, multistack dryer and integrated solar collector cum drying system, based upon the principles of natural/forced convection in direct-indirect and mixed mode

of operation, are considered with the help of mechanical drawings. The first two components, the collector and the drying chamber of the drying system and their integration effect are investigated. The parametric evaluation of the materials as well as components, the design, and operating parameters of these systems is then carried out. The systems are experimentally studied and the results are compared with those of natural sun-dried product for the evaluation of thermal performance parameters and culinary and organoleptic characteristics. The theoretical model developed for a solar cabinet dryer with simple assumptions is used to predict the instantaneous performance and efficiency of the system.

The possibility of sensible heat storage for agricultural and space heating purposes is studied by integrating the solar collector and storage system in the single configuration. Therefore two matrix solar heaters with single and double glazing, using waste iron scraps and an integrated rock bed collector cum storage system have been investigated. Furthermore, an augmented integrated rock bed collector cum storage system (AIRS, a series combination of conventional flat plate air heater with integrated rock bed collector cum storage system) with augmented thermal yield has been investigated for continuous supply of hot

air. The design details, mechanical drawings and experimental observations of these system are presented. In the case of AIRS, the experimental observations of the fluid temperature, energy storage and other measures of the system performance with the variation of air mass flow rate, number of glazings, effect of night insulation cover on thermal decay characteristics are presented in detail. Also, to further improve the quality of thermal grade, a compact inexpensive system which uses an air filled honeycomb cover over the blackened ground has been proposed and analysed. The variation of collection efficiency with solar angle of incidence is investigated.

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