SEASONALLY ADJUSTED DISCRETE - MIRROR LINEAR SOLAR CONCENTRATORS

BY

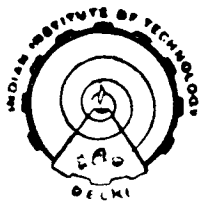
SANTOSH KUMAR NANDA

Submitted

in fulfilment of the requirement of the

degree of

DOCTOR OF PHILOSOPHY



TO THE

INDIAN INSTITUTE OF TECHNOLOGY, DELHI

FEBRUARY 1989

CERTIFICATE

I, the undersigned, certify that the thesis entitled **"Seasonally Adjusted Discrete - Mirror Linear Solar Concentrators"** submitted by Mr. Santosh Kumar Nanda for the award of the degree of 'Doctor of Philosophy' in the Faculty of Engineering of the Indian Institute of Technology, New Delhi is a record of candidate's own bonafied research work carried out under my guidance and supervision. The matter embodied in this thesis has not been submitted in part or full elsewhere for the award of any degree.

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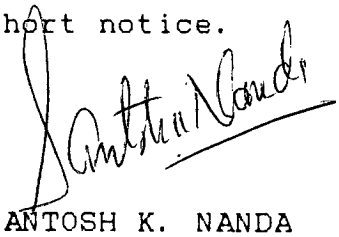

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ABSTRACT

The work embodied in this thesis pertains to study of seasonally adjusted discrete-mirror concentrators. Emphasis has been laid on analysis of thermal concentrators with a glazed tubular absorber.

The geometry of the cusped linear solar concentrator composed of plane mirror elements has been optimized by the discrete maximum principle. The optimization provides the angles (and hence the widths) of the constituent mirror elements that yield the maximum concentration for any specified number of elements and height of concentrator. The optimal designs are evaluated in detail for concentrators with flat horizontal and tubular absorbers. Detailed result are provided to serve as design guide.

The distribution of local concentration ratio on the absorber surface of the optimal concentrators has been analysed through ray trace technique. The variation of LCR with the angle of incidence, number of mirror elements, and mirror reflectance has been studied. The effect of angle of incidence on average number of reflections and intercept factor for a glazed tubular absorber has been investigated.

An improved technique to compute the heat loss factor of a glazed tubular absorber is proposed. The equation for the heat loss factor in analytical form is employed. This

method predicts the overall heat loss factor, U_L, within $\pm$ 1 per cent of the value obtained by iterative solution of the heat balance equations in the range of variables - absorber temperature 60 to 240^{o}C, absorber coating emittance 0.1 to 0.95, wind velocity 1.5 to 10 m/s. The effect of variation of air properties with temperature has been taken into account.

A prototype concentrator with a glazed tubular absorber has been designed, fabricated and tested. The optical and thermal parameters have been determined independently. Both indoor and outdoor test results are presented. The optical efficiency is found constant within the limits of half-acceptance angle, even when no sophisticated method was used for aligning the mirror elements.

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