**MEASURE OF THE SOLAR FLUX CONVEYED ONTO A LAMBERTIAN TARGET BY A NOVEL BI-AXIAL FRESNEL CONCENTRATOR**

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Abstract

This paper deals with the optical analysis of a prototype of a novel concentrator, named as Bi-Axial Fresnel (BAF). This concentrator aims at reducing production and installation costs, as well as keeping as low as possible the weight and the bulk of the mirrors field, making it suitable for building small-dimensions systems, able to be placed on industrial roofs, as an example. The prototype is composed as an array of 3x3 mirrors. Its theoretical concentration is therefore 9. The experiment made use of a very basic equipment, which included a thermal flux sensor and a simple webcam, properly equipped for distinguish grey scales under quite high solar intensities. The concentrator was governed by an Arduino card, while the acquisition took place by means of a National Instruments acquisition board and Labview software. The aim of this experimental setup was the reconstruction of the solar flux on a fixed Lambertian target, based on the grey-scale maps gathered through the webcam and properly scaled accordingly to the punctual solar flux measured by the sensor. This way, the experimental apparatus was able to get an estimation of the solar power conveyed to the target.

introduction

In Concentrated Solar Power, the advantages in concentrating a high solar radiation flux on a very small area receiver inducing high temperature operations is an effective mean for reducing heat losses and achieving high conversion efficiency [1, 2]. Concentrator types differentiate each other depending on the solar concentration ratio, which establishes the power density of concentrated sunlight. Currently, five CSP technologies exist, classified in increasing order of concentration ratio: Compound Parabolic Collectors [3, 4], Parabolic-Through Collectors, Linear Fresnel Collectors, Solar Tower Power and Parabolic Dish Collectors [5, 6]. High concentration systems are often use to drive a gas turbine, in which the solar receiver replaces or integrates the combustion chamber. As concentration increases, however, more and more precise tracking is required and the dimensions of the optical system (mirror or lens) increases. These systems, in short, are expensive and practically impossible to be placed on surfaces such as roofs and coverings. Large free portions of soil are therefore required for their location. From this point of view, the linear Fresnel reflector is to be preferred to the others, since the mirrors are flat and very narrow in cross section and, due to their shape and location, they are less subject to actions by the wind and other atmospheric agents and, thanks to a lighter structure, they can be installed on industrial and residential roofs. However, the low concentration does not generally allow a receiver to surpass temperatures >250 °C.

The novel bi-axial Fresnel (BAF) concentrator is a two-axes concentrator based on the use of flat or slightly-curved mirrors. The concentrator is constituted by an array of strings, each one carrying a plurality of mirrors, which can be rotated along an axis in a coordinated manner by means of a mechanical linkage. A bi-axial movement is then achieved by means of the movement of the mirrors along two perpendicular axes, with a much reduced number of servo-motors with respect to a conventional bi-axial concentrator, which usually requires two motors per mirror. The concentration ratio is roughly the square of a conventional single-axis Fresnel, thereby allowing a higher operating temperature.

**T**he present work deals with an innovative model of solar concentrator based on theFresnel spotlight concept. This plant technology, is wellconsolidated for large size plants [7], but for small size plants it shows losses atextremities that are relevant [8]. A point-based concentration system was therefore developed, rather than linear and moving on two axes instead of on one axis only. In the configuration analyzed in this work, the rows of mirrors, by means of a crank mechanism, are moved, synchronously, by a single servomotor. This synchronous movement also takes place between the mirrors of each single row, where there is a crank mechanism operated by a single servomotor. The target receiver is positioned on the top of the machine and has the function of collecting the radiation as well conveyed and concentrated, remaining rigidly bound to the structure. The two axes of the system, around which the optical elements and each articulated frame move, can be oriented in any way with respect to the apparent motion of the Sun with respect to the Earth.

RESULTS and DISCUSSION

An experimental model of a biaxial Fresnel type concentrator has been created (figure 1), together with its control system. At the same time, the work allowed the set up of the measurement system which, by means of a simple webcam and a thermal flux system, reproduced the solar flux map and measured the overall radiation conveyed on the target. These performance indicators pointed out that the device was correctly operating along the whole day.

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| **Figure 1. The concentrator prototype during a test** |

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