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Measurement, comparison and monitoring of solar mirror's specular reflectivity using two different Reflectometers

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Abstract

Soiling and the resulting specular reflectivity are two of the most important factors influencing the efficiency of the concentrating solar power (CSP) plants. For this reason, and in order to schedule efficient cleaning cycles, it's crucial for the operation and maintenance (O&M) teams to possess accurate and readily available reflectivity measurements of the solar field, especially in periods with high aerosol concentrations.

The aim of this study is to, initially, evaluate the effect of dust on the reflectivity of regular CSP mirrors by means of two reflectometers used in operating power plants. Those mirrors were exposed at the University of Oujda (Eastern Morocco) for twelve weeks during the arid period of the year. After that, a comparison between the values measured by those devices has been done.

Results show that during the dry period, soiling presents an important issue for CSP power plants in Eastern Morocco, where the weekly reflectance drop can reach 30%. Furthermore, the accuracy of the reflectivity measurements and the selection of the most adequate reflectometer have an important influence on the estimation of the solar field's optical efficiency, thus, on the electricity production.

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Keywords: Soiling, CSP; Solar mirrors; Dry climate; Reflectometers.

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1. Introduction

Usually, to select the most suitable sites to host solar power plants, engineers and policy makers focus on the areas blessed by high amount of solar irradiation. Nevertheless, those sites are mostly located in desert regions, which is directly related to the presence of dust and the lack of water.

Morocco has a great potential of solar irradiation [1,2]. For this reason, the country launched an ambitious project to produce 2000MWe of electricity from the sun, and five sites were selected to construct five solar plants. All the selected sites in this project are located on desert areas. Indeed, “Noor Complex” is the first power plant in the Moroccan solar plan. This plant is located at Ouarzazate and the first part (with a capacity of 160MWe) is already operational. Once the full capacity (500MWe) of Noor complex installation is achieved, the second phase of the project will be the construction of a 400MWe power plant in Eastern Morocco [3]. This region processes a considerable capacity to host large scale CSP and PV power plants [4,5]. Furthermore, electricity production from solar energy in this region is considered to be high for both solar technologies [6-8].

However, this part of the country is characterized by a harsh arid atmosphere, which can highly affect the solar field and challenge the O&M teams regarding the mirrors cleaning, especially, during the dry period of the year. Actually, based on our observations and the results of [9], Eastern Morocco experiences large Saharan dust activity during the dry period of the year “from April to September", most obvious in the form of sand storms. This period is characterized also by small rainfall values (figure1) that can highly affect the cleanliness of the mirrors if coincides with a loaded atmosphere. This phenomenon is known as red rain event.

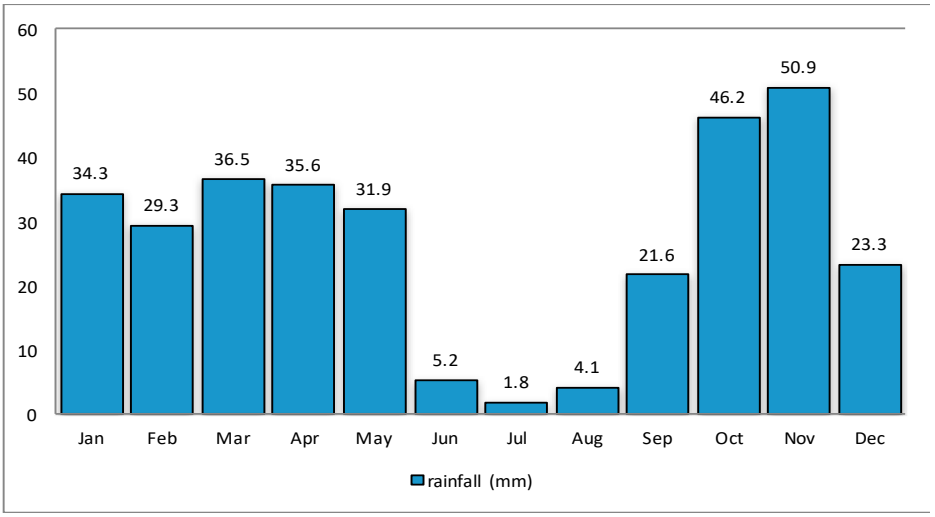

Fig.1. Twenty years of the rainfall records (1995-2015) in Oujda city.

In this study, regular 4mm back silvered glass mirrors were exposed for twelve weeks (from June 15th to September the 7th 2015) at the rooftop of the University of Oujda. The samples were exposed in a weekly basis to get naturally soiled. After that, they were taken off for measurement (using two different reflectometers) and new clean mirrors replace the old ones.

Results show that during the dry period of the year, soiling can cause serious trouble for the CSP power plants in this region, since the drop in the specular reflectivity can reach 30% after only one week of exposition. We believe that those results can be very helpful for the O&M crews in order to be prepared for this period of the year and to schedule efficient cleaning cycles to enhance the optical performance of the solar field.