SOILING INFLUENCE ON THE SHORT-CIRCUIT CURRENT OF SOLAR MODULE MOUNTED AT THE OPTIMAL ANGLE

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Abstract

Short-circuit current is one of the basic parameters of solar modules. Due to solar modules soiling their short-circuit current decreases considerably. In this paper, the results of the experimental investigation of the influence of the soiling on the surface of the solar module mounted at an optimal angle of 32^o for the Nis area with different quantities of soil (mud) on its short-circuit current are given. The paper emphasizes that the short-circuit current of the solar module due to the application of 1 g of soil decreased by 3.997%, due to the application of 2 g of soil by 9.674%, as compared to the clean solar module, and due to the application of 3 g of soil by 15.453%, as compared to the clean solar module. It can be concluded that the short-circuit current of the solar module decreases due to the increased amount of soil.

Keywords: soil, short-circuit current, solar module, optimal angle.

INTRODUCTION

Considering a rapid economic and technological development, life standard has been improving, requiring more and more electricity. Due to the limited reserves of fossil fuels, intensive research in the field of renewable energy sources is further stimulated. A suitable solution for increasing energy security is the use of renewable energy sources, including the photovoltaic conversion system for solar radiation (PV systems). One of the most significant problems when using solar modules is the soiling of their surface, which leads to a decrease in their efficiency [1, 2].

SOILING

Soiling is the term used to describe the deposition of dust on solar modules that reduces the amount of solar radiation that gets to solar cells. Soiling of solar modules is particularly problematic in dry areas and in periods when there is not enough precipitation to clean them. Different factors influence solar module soiling such as relative air humidity, wind speed, tilt angle of solar module, amount of precipitation, etc. [1-8].

SHORT CIRCUIT CURRENT (I_{SC})

The basic parameters of the solar modules are: short-circuit current (I_{sc}), open-circuit voltage (U_{oc}), maximum power (P_{mpp}), fill factor (FF) and efficiency (η) [1, 9].

Short-circuit current (I_{sc}) is a current flowing through an external current circuit when the electrodes of the solar modules are short-circuited. It represents the maximum current of the solar module at zero voltage and is proportional to the intensity of the incident solar radiation. The short-circuit current depends on the surface of the solar module. With the rise in the temperature of the solar module, which in practice is always associated with increasing the intensity of the incident solar radiation, the short-circuit current increases.

The short-circuit current of the solar module linearly depends on the intensity of the solar radiation. As the temperature of the solar module increases, the short-circuit current grows slightly.

Dust deposited on solar modules significantly reduces the short-circuit current. The short-circuit current is proportional to the intensity of the solar radiation, so that due to the deposition of dust on the solar modules, the value of the intensity of the solar radiation that reaches them decreases, and therefore the short-circuit current decreases as well [5, 10-16].

EXPERIMENTAL SETUP

The experiment was conducted at the Laboratory for Solar Energy at the Faculty of Sciences and Mathematics in Nis, Serbia, on two same Isofoton (Spain) ISF-60/12 solar modules, made of monocrystalline silicon.

Fig. 1. *Monocrystalline silicon solar modules ISF-60/12 on the roof of the Faculty of Sciences and Mathematics in Nis, used in the experiment*

Solar modules were mounted next to each other on the roof of the Faculty building, were set at an optimal angle for the Nis area of 32^o and were facing south. Table 1 gives the technical characteristics of ISF-60/12 solar modules [1].

Tab. 1. *Technical characteristics of ISF-60/12 solar module*

Dimensions (size)	776 x 662 x 39.5 mm
Weight	6.5 kg
Cell type	Si monocrystalline
Power of the module	60 Wp
Module efficiency	11%
Maximum power current	3.47 A
Maximum power voltage	17.3 V
Open circuit voltage	21.6
NOCT (800 W/m^2, 20^{o}C, AM 1.5, 1m/s)	47^{o}C
Maximum system voltage	760 V

RESULTS

On 03.08.2017 the influence of different masses of soil on the short-circuit current of the solar modules, set at an angle of 32^o in relation to the horizontal plane, was examined.

On the day of measurement, August 3, 2017 first both solar modules were cleaned to remove all dirt from them. During the measurement, the right solar module was clean all the time and was not soiled. The left module was uniformly soiled by the dispersion of a certain amount of water containing 1 g of soil, followed by the first measurement at 12:20. The surface of each solar module was S=0,514 m^2 so that the soil concentration on the soiled solar module before the first measurement was 1.945 g/m^2. After the first measurement was completed, the left module was additionally uniformly soiled by the dispersion of a certain amount of water containing 1 g of soil, so that the soil concentration on the soiled solar module was 3.891 g/m^2 before the second measurement, and at 12:30 a second measurement was performed. After the second measurement, the left module was additionally uniformly soiled by the dispersion of a certain amount of water containing 1 g of soil, so that the soil concentration on the soiled solar module was 5.837 g/m^2 before the third measurement, and at 12:40 the third measurement was performed.

The dependence of I_{sc} on the surface soiling of the optimally set solar module with different masses of the soil is given in Figure 2.

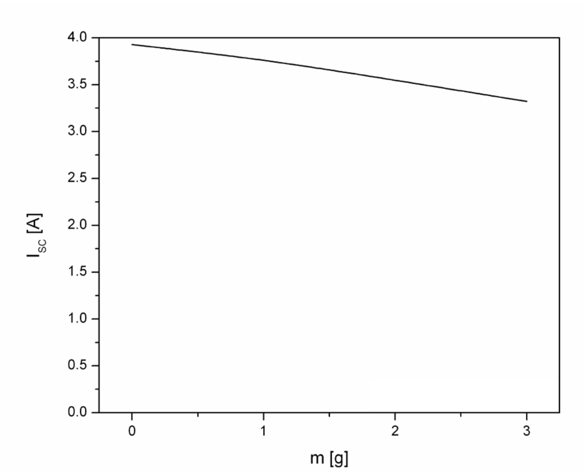

Fig. 2. *Dependence of I_{sc} on the surface soiling of the optimally set solar module with different masses of soil*

Fig. 2 shows that in an optimally set solar module the values of I_{sc} are reduced from 3.93 A for a clean module, to 3.32 A for the module soiled with 3 g of soil.

Comparative display of the I_{sc} for clean (1) and soiled (2) optimally set solar module depending on the time during the day, is given in Figure 3.

In this paper, the results of the experimental investigation of the influence of soil particles on solar module energy efficiency are given.

The experiment was conducted on two same solar modules made of monocrystalline silicon mounted next to each other at an optimal angle (32^o) on the roof of the Faculty of Sciences and Mathematics in Nis, Serbia.

The short-circuit current of the solar module due to the application of 1 g of soil decreased by 3.997%, as compared to the clean solar module, due to the application of 2 g of soil by 9.674%, as compared to the clean solar module, and due to the application of 3 g of soil by 15.453%, as compared to the clean solar module.

On the basis of the above stated, it can be concluded that due to the increase in the mass of the applied soil, the short-circuit current of the solar module is increasingly decreasing.

REFERENCE

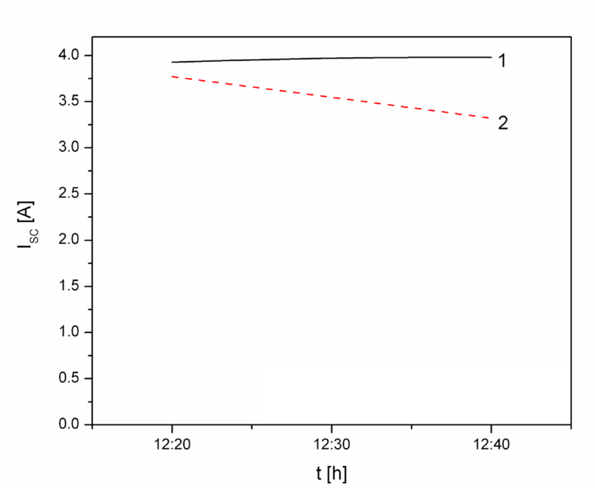

Fig. 3. *Comparative display of the I_{sc} for clean (1) and soiled (2) optimally set solar module depending on the time during the day*

Figure 3 shows that at the optimally set solar modules, the value of I_{sc} ranges from 3.93 A to 3.98 A for a clean module, and from 3.77 A to 3.32 A for the module soiled with different masses of soil [1].

CONCLUSION

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