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Investigation of the effect of changes in the temperature of the solar panel on the output parameters

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ABSTRACT: Currently, the production of electricity using solar energy in the world is growing day by day. In order to improve the efficiency of solar photoelectric plants, the study of external and internal factors affecting solar panels is one of the urgent issues. The article examines the effect of solar radiation intensity and the effect of temperature changes of solar panels on the output parameters. The experiment was carried out mainly on polycrystalline solar panels of a 130 kW solar photoelectric power plant installed in the Pap district of Namangan region. Observations revealed brightness reversion of the surface of the solar panel due to an increase in the intensity of solar radiation during actual operation. This spiral defective solar panel and a new experimental method for solar panels studied the effect of radiation intensity and the effect of temperature changes of the solar panel on the output parameters. The temperature dependence of the output power and volt-ampere characteristics is given. It was found that brightness reversion of solar panels reduce the power output by 1.09.

KEYWORDS: Solar photoelectric plant, solar panel, photoelement, defect, output power, degradation, effectiveness.

I. INTRODUCTION

Renewable energy sources are of great importance in compensating for the energy needs required in the future. Today, the installed capacity of solar photoelectric plants is increasing day by day, since solar energy is considered from renewable energy sources with great potential compared to other renewable energy sources. It is known that the useful work factor of existing solar panels, not so large, converts only 17-18% of the sun's rays into electricity. Therefore, in order to optimally use all the parameters of solar panels involved in the production of electrical energy, great scientific research is being carried out by scientists around the world [1-8]. Solar photoelectric plants have two important aspects, namely their variability of output parameters during the exploration process and the dependence of electrical energy production on seasonal climate change [9-10].

Experimental studies have shown that during the summer season, the temperature of the solar panel rises due to the strong influence of the intensity of solar radiation in the open air during the day. This tempering effect may impede the efficiency of the incident light beam into electrical energy, but may also lead to the acceleration of the degradation processes of the solar panel, causing the solar panel to reduce the production of electrical energy and reduce the efficiency of solar photoelectric plants. This in itself is intended for obtaining electricity using solar energy in the climatic conditions of Uzbekistan and is of great importance in determining the provisions for repaying investments in its development.

In this article, in the 7-year operation of polycrystalline solar panels installed on a solar photoelectric plant with a capacity of 130 kW, HANHWA (HSL 250) laboratory determined the change in output parameters due to brightness reversion caused on the surface of several solar panels and compared with this company's new solar panel of this type. Based on an experimental study, there were studied the effect of radiation intensity and the effect of changes in the temperature of the solar panel on the output parameters.

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II. OBJECT OF THE RESEARCH

As an object of the research, in 2015, there was studied a solar photoelectric plant with a capacity of 130 kW, built in a test manner in Pop District of Namangan region. All polycrystalline solar panels installed in this studied photoelectric plant were manufactured by HANHWA, JSPV, s-ENERGY and TOPSUN of the Republic of Korea. The solar photoelectric plant is connected parallel to the electrical grid in the area, and each company's solar panels are equipped with separate inverters and electric meters.

According to the results of scientific research [11-12], during 2015-2021, a total of 830739 kW/h of electricity was supplied to the electric network by the solar photoelectric plant. Including the solar photoelectric plant, which produced 141,556 kW/h in 2015, and seven years later 138,448 kW/h in 2021. From these cited numbers, it follows that the production efficiency of solar photoelectric plants has decreased by 2.2% over these years. In an effort to investigate the cause, defects in Hanhwa (HSL 250) company panels were discovered when the outer surface of all solar panels installed on the solar photoelectric plant was surveyed. (Figure 1).

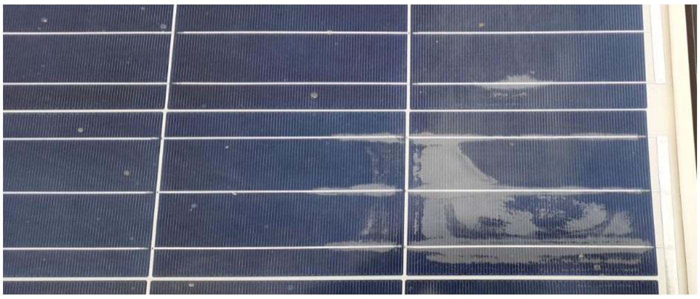

Figure 1. Defected solar panel of the company HANHWA (HSL 250)

Air bubbles have been observed in some parts of the solar panel between a layer of EVA film coated on its surface and a photoelement. As a result, part of the sun's rays falling on the photoelement do not reach the photoelement as a result of scattering in these bubbles. In order to determine the efficiency of the operation of solar panels with such defects, a new, not yet used solar panel of HANWA (HSL 250) company in the reserve for comparing a single solar panel with defects from photoelectric plant, as well as its parameters, was selected and brought to the laboratory for conducting scientific research.

III. METHOD OF THE RESEARCH

In the laboratory there is an "EESFC" device of the company "EDIBON", with the help of which the intensity of rays falling on the solar panel was measured J(W/m^2), at the expense of change, the output parameters produced current strength I (A), voltage U(V) and power P(W). In addition, the room temperature was measured as T_{rt} (^{0}C), the temperature of the rays falling on the solar panel as T_{trf} (^{0}C), and the temperature of the panel as T_{spt} (^{0}C), when each time the radiation changed. These measurements were taken separately for the new non-exploited solar panel and separately for the solar panel, which was exploited in real climatic conditions for 7 years. An overview of the experimental research device is shown in Figure 2.

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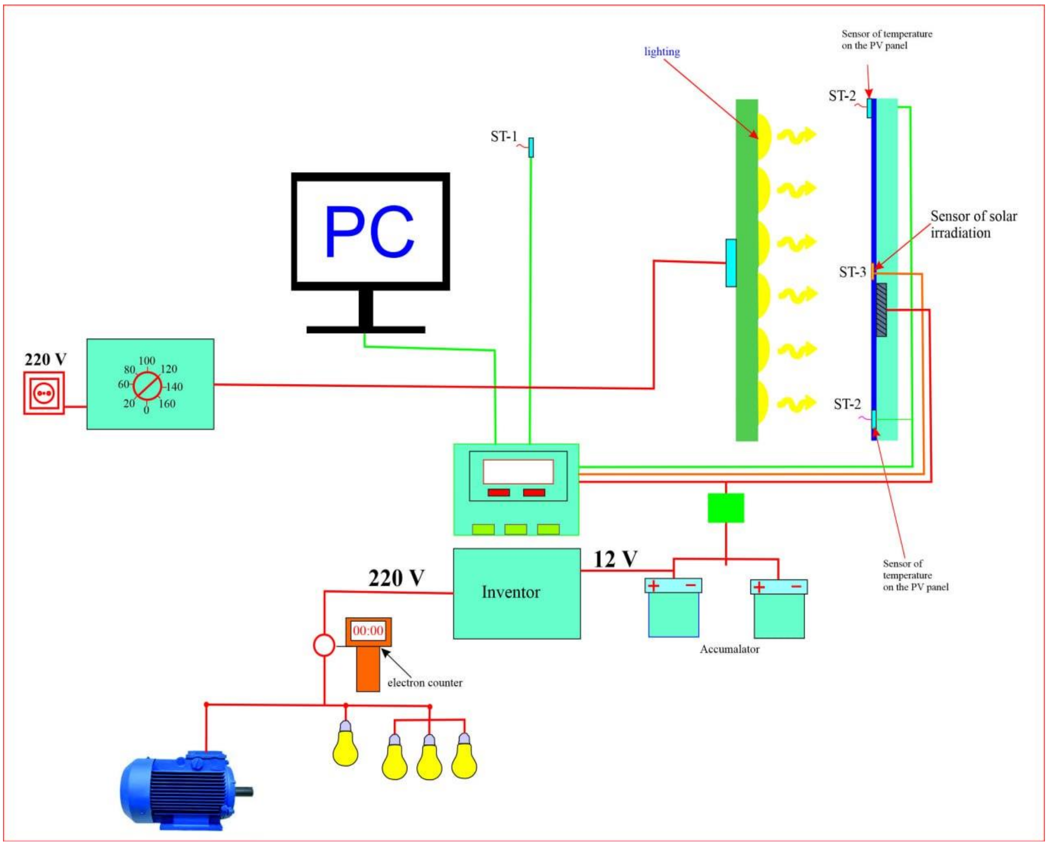

Figure 2. Device of conducting experimental research

8 of the NH-J117 type halogen lamps were installed in the experimental research device. Each halogen lamp has a beam current of 9,500 lm and a power of equal to 500 W. Using a special modifier, the light flux was changed from 200 W/m^2 to 750 W/m^2. At the expense of increasing the light intensity J(W/m^2), the output parameters produced current strength I(A), voltage U(V) and power P(W) were measured. The experimentally obtained results were analyzed on the basis of Exel programs.

IV. RESULTS OF THE RESEARCH

Table 1 lists the experimental results obtained on the effect of the temperature of the solar panel on the output parameters in the case of J=750W/m^2, the intensity of the rays falling on the new non-exploited solar panel.

Table 1.

Energetic parameters	Temperature of solar panel, ^{0}C									
	31	35	39	43	47	51	55	57	59	61
U (V)	32.9	32.2	31.9	31.5	31.1	30.9	30.5	30.3	30.2	30.1
I (A)	6.71	6.84	6.85	6.87	6.88	6.89	6.95	6.98	7.00	7.01
P (W)	220.8	220.3	218.5	216.4	214.0	213.0	212.0	211.5	211.4	211,0

From Table 1 it is known that as the temperature of the solar panel increases T(^{0}C), the power produced P (W) has also decreased slightly, in which the voltage U (V) has also decreased to some extent, but the current I (A) has increased.

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Similarly, the experimental study was carried out for 7 years for a defective solar panel, which was exploited in real climatic conditions. Table 2 lists the experimental results obtained on the effect of the temperature of the defective solar panel on the output parameters.

Table 2.

Energetic parameters	**Temperature of the solar panel, ^{0}C**									
	31	35	39	43	47	51	55	57	59	61
U (V)	30.8	30.7	30.7	30.6	30.5	29.8	29.2	28.8	28.5	28.1
I (A)	6.58	6.58	6.59	6.59	6.61	6.62	6.63	6.64	6.65	6.66
P (W)	202.7	200.6	202.3	201.7	201.6	197.3	193,6	191.2	189.5	187.2

Using the obtained experimental results, the graph of T(^{0}C) dependence of the output power of the solar panel on P(W) temperature is presented in Figure 3.

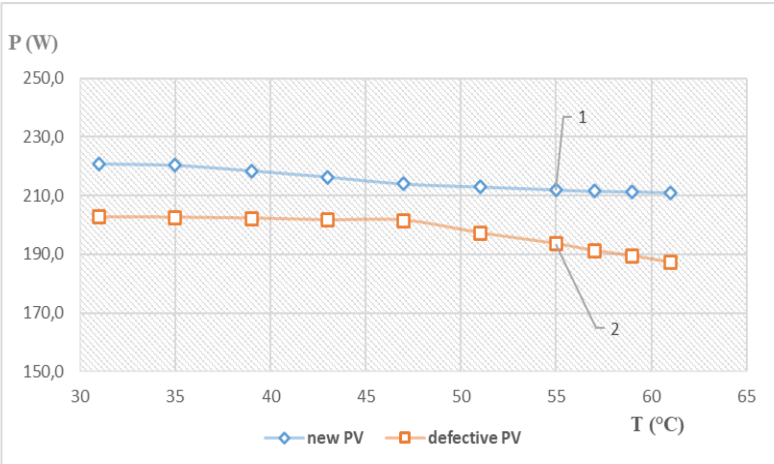

Figure 3. Temperature dependence of the output power of the solar panel: 1 - a new non-exploited solar panel; 2 - a defective solar panel that has been exploited in real climate conditions for 7 years.

From the results obtained, it follows (Figure 3) that from the influence of rays falling on the solar panel, the temperature of the photoelement increases, and the efficiency of electrical energy production decreases. Figure 3 shows a graph of a new non-exploited solar panel and a temperature dependence of the power generation capacity of a defective solar panel, which has been exploited in real climatic conditions for 7 years. In doing so, the production capacity of the exploited defective solar panel P (W) has been found to be low compared to the new non-exploited solar panel. The exploited defective solar panel has been shown to sensitively reduce production capacity P (W) when the temperature exceeds 60 ^{0}C.

Based on the results obtained, the volt-ampere characteristic is presented in Figure 4.

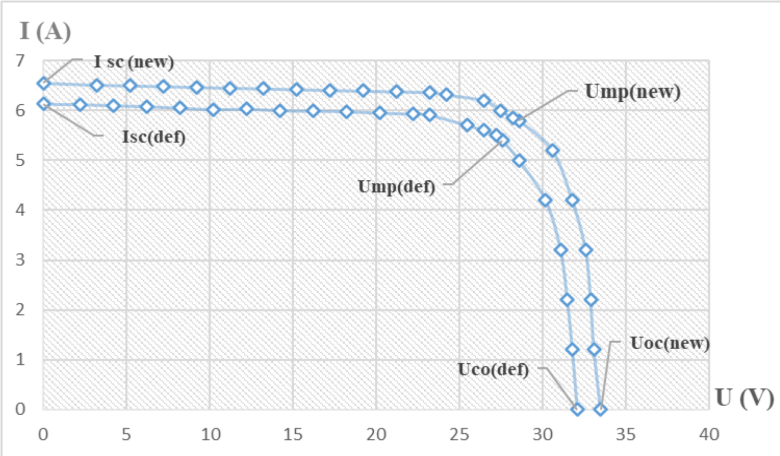

Figure 4. Voltampere characteristic of defective and new solar panels.

As you know from the volt-ampere characteristic of defective and new non-exploited solar panels (Figure 3), the maximum voltage of a defective solar panel exploited in real climate conditions for 7 years is $U_{mp(def)}$ = 30,2 V, the maximum voltage of a new non-exploited solar panel is $U_{mp(new)}$ = 32,9 V. Hence, the voltage produced is voltage U (V) and current i (a) reduced to a certain value of 1.09.

We will analyze the output parameters by changing the intensity of the radiation falling on the new non-exploited solar panel. The dynamics of the change in volt-ampere characteristic i.e. the values of short circuit current I_{sc} (A) and load-free voltage U_{oc}(V) by changing the intensity of radiation to 550 W/m^2 , 650 W/m^2 and 750 W/m^2 are shown in Figure 5.

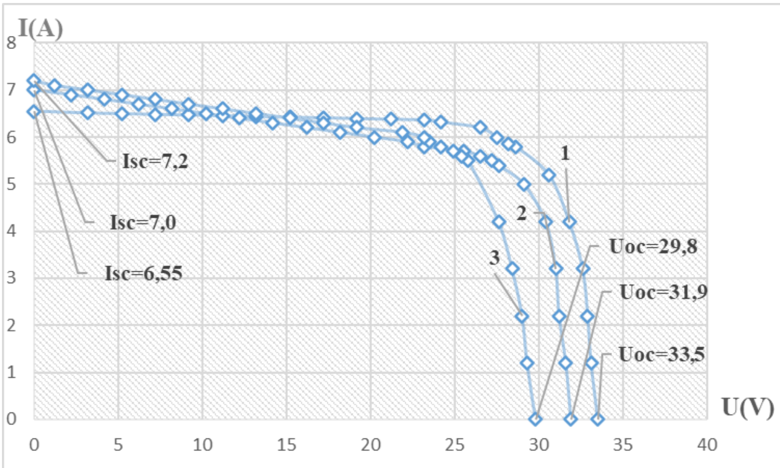

Figure 5. Voltampere characteristic change at different radiation intensity: 1- 750 W/m^2; 2- 650 W/m^2; 3-550 W/m^2.

As the intensity of radiation falling on the solar panel increases with J (W/m^2), the load-free voltage U_{oc} (V) decreased while the short circuit current I_{sc}(A) increased slightly. It was observed that if the radiation intensity was 750 W/m^2 the load-free voltage was U_{oc} =33,5 V, and the short circuit current was I_{sc}= 6,55 A. Similarly, changes were observed in other radiation intensities.

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V. DISCUSSION OF THE RESULTS

Analysis of the intensity of light falling on solar panels at J=750W/m^2, in the case: the effect of P_{new}(W) on the output power of the newly non-exploited solar panel temperature and the effect of P_{def}(W) on the output power of the defective solar panel temperature exploited in real climate conditions for 7 years showed that even for two solar panels as the temperature of solar panels T (^{0}C) increases so output power P(W) decreases.

Based on the results obtained experimentally, it is known from the analysis of the volt-ampere characteristic that with an increase in the temperature of the solar panels T(^{0}C), the voltage of the solar panel U(V) decreases, and the current T(^{0}C) increases.

At the expense of increasing the intensity of radiation falling on solar panels by J(W/m^2), there were observed changes in the values of the output parameters P(W), voltage U(V) and current I(A) change. As the temperature of solar panels increases, production capacity decreases slightly, while current I(A) increases.

It was found that compared the obtained experimental results with the results of the following scientific articles [5,8], the effect of the power of the output parameters on the values of P(W), voltage U(V) and current I(A), indeed, as a result of an increase in the temperature of the solar panel by T(^{0}C) are corresponded to each other.

VI. CONCLUSION

In the process of real exploitation, there were determined brightness reversion of the surface of the solar panel caused by an increase in the intensity of solar radiation J (W/m^2). It has been found that air bubbles have formed between the photoelement with a layer of EVA film coated on its surface in some parts of the brightness reversion of solar panel. As a result, some of the sun's rays falling on the photoelement do not reach the photoelement as a result of scattering in these bubbles. Brightness reversion of solar panels have been found to have reduced output power by P(W), 1.09 times.

With an increase in the temperature of solar panels T (^{0}C), the output parameters of the solar panel are determined: a decrease in voltage U(V) and an increase in current I(A), and a decrease in power generation capacity P(W).

As the intensity of radiation falling on the solar panel increases with J (W/m^2), the load-free voltage U_{oc} (V) is reduced while the short circuit current I_{sc}(A) is slightly increased.

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