ISSN 2181-8622

Manufacturing technology problems

Scientific and Technical Journal Namangan Institute of Engineering and Technology

INDEX COPERNICUS INTERNATIONAL

Volume 10
Issue 3
2025

Google Scholar Crossref doi SLIB.UZ Scientific library of Uzbekistan

RESEARCH OF MECHANICAL PART OF SOLAR PHOTOVOLTAIC POWER STATION

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Abstract: In dusty atmospheric conditions, various dust particles settle on their surface, which, depending on their thickness, damage the tempered glass, reduce the service life of the panels, and also prevent photovoltaic elements from receiving more sunlight, as a result, their temperature increases, the output power, short-circuit current and, therefore, the efficiency factor decrease by up to 50%. Therefore, in order to increase the efficiency and maintain the operability of solar panels, it is considered important to examine the solar panels of solar photovoltaic stations for dustiness This article considers a photovoltaic station, which was built first on the territory of Uzbekistan. This station, with a capacity of 130 kW, was launched in test mode so that test modern four type of solar in the natural and climate conditions of Uzbekistan, train personnel in the field of solar energy, improve skills in the operation of photovoltaic station, as well as to identify practical conclusions on the basis of which in the future to choose the most effective solutions It was determined that with a contaminated optical area, as well as the absence of cooling and orientation mechanisms, short circuit current of a 250 W solar panel deviates on average from the rated value by almost 27 %, and after cleaning the deviation is 12,85 %, which means that it is possible to increase short circuit current by an average of 10-15 % by regularly cleaning the surface, thereby increasing the generation of the solar power stations itself.

Keywords: Renewable energy sources, photovoltaic station, a solar panel, solar tracker, energy efficiency, electricity, electrical parameters, carbonate anhydride, dust, cleaning system.

Introduction. It is known that limited resources such as gas, coal and fuel oil play a key role in the development of the energy sector, the economy, and the well-being of the population. The main source of energy in our country is natural gas - occupying about 80% in the structure of the primary fuel and energy balance [1]. However, access to these types of resources may end due to their limited nature, and the insufficiency, depletion of reserves and the use of such types of energy over a long period of time confirms that fuel energy causes significant harm to the environment, increases the concentration of CO2, which contributes to the formation of the greenhouse effect, as a result of which environmental problems are caused and exacerbated [2]. It is also not sustainable and will not be able to ensure the country's energy security in the long term and to improve energy security, it is necessary to diversify the energy system, where renewable energy sources (RES) will play a key role, since according to forecasts, RES will account for 30-35 % of the total volume of electrical and thermal energy produced in the world by 2030 [4]. According to calculations, sunny days in our country are approximately 290-310 days a year, which proves the enormous technical potential of solar energy (177 million tons of oil equivalent) and confirms its relevance [5]. Therefore, sunny Uzbekistan has significantly begun to stimulate and pay special attention to solar energy).

In many countries of the world, in order to provide consumers with electricity, taking into account global climate change, there is a widespread introduction of renewable energy sources into the energy system. Among them, solar energy, which has significant advantages, is relevant, acceptable and convenient for use, therefore, special attention is paid to its development. Photovoltaic solar panels, which are one of the important and basic elements of solar energy, are used outdoors, in hard-to-reach places,

where they are exposed to dusty air and dust storms, the likelihood of which increases year after year. In such cases, various dust particles settle on their surface, which, depending on their thickness, damage the tempered glass, reduce the service life of the panels, and also prevent photovoltaic elements from receiving more sunlight, as a result, their temperature increases, the output power, short-circuit current and, therefore, the efficiency factor decrease by up to 50 %. Therefore, in order to increase the efficiency and maintain the performance of solar panels, it is considered important to study the solar panels of solar photovoltaic stations [4-5, 9-11].

In the work of Muhammed J. Adinoyi and Syed A.M. Said the influence of dust on the output of mono- and polycrystalline FBs was studied, in particular concentrated dust on their OP reduced the power by 50 % [5]. The impact of dust on the solar system was studied in the studies by Abdullah Al-Sharafi, Ahmad Bilal Ahmadullah, Ghassan Hassan, Hussain Al-Qahtani, Abba Abdulhamid Abubakar and Bekir Sami Yilbas. It was found that the loss of income due to dust is 35 % per year, and dust prevents solar power plants from receiving energy from the sun by 20 %, which naturally leads to a decrease in short circuit current, output power and efficiency [6].

In the works of L. Boyle, H. Flinchpaugh and M.P. Hannigan the influence of dust on the photovoltaic system was also investigated. It was determined that from 1 to 50 mg of dust can accumulate per day per m^2 of solar panels, in addition, it was revealed that each g/m^2 of dust on the frontal surface reduces the light transmittance of the solar panels glass by 4.1 % [7-8].

In the studies of Bazarbayev R., Kurbanov D., Karazhanov S. and K. Yakubov in a test chamber the influence of external factors on panels was studied. In particular, it was revealed that with dust deposition of 16 mg/m^2, short circuit current panels decreased and it was revealed that it is much more sensitive to dust than open circuit voltage, therefore the importance of work to maintain output power is emphasized, and one of the ways to maximize it is t to study the panels for dustiness [7-8].

Methodology & empirical analysis. The first practical step in the transition of the energy system to renewable energy sources, namely to solar energy, began in 2014. At this year the first test photovoltaic station (PVS) was built. The main purpose of building this station was testing modern types of solar panels in the natural and climatic conditions of Uzbekistan, improving practical skills in operating PVS, training personnel in the field of solar energy, as well as identifying practical conclusions on the basis of which it would be possible to choose the most effective solutions in the future.

The station with an installed capacity of 130 kW was built in the Pap district of the Namangan region in 09.2014. The station is capable of producing about 500 kWh of electricity per day and transmitting it to the grid, as it was integrated with the general grid of the country's energy system. The territory where the solar power plant is located has a slight slope to the south (fig. 1). Below is a figure of the station's location.

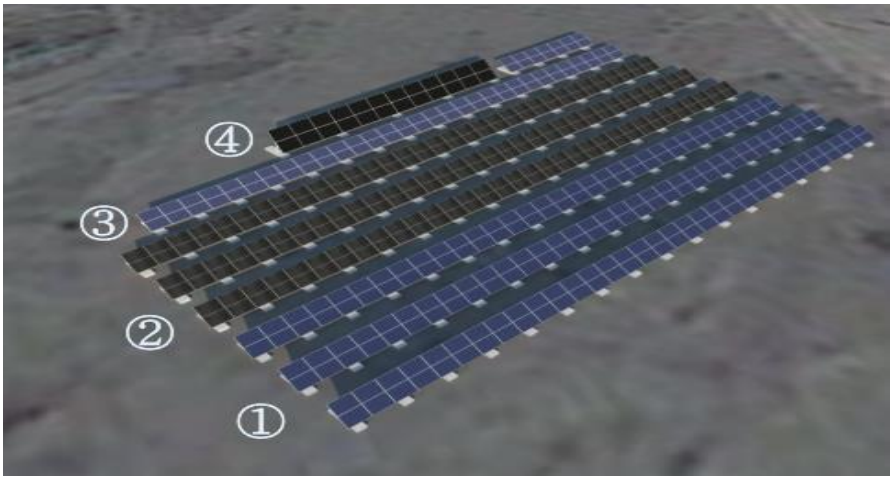


Figure 1. Location of solar panels of solar photovoltaic station

As can be seen from Figure 1, the station consists of 8 rows, where the first three rows are equipped with JSPV solar panels (SP), the total number of which is 198 pieces, rows 4-6 are equipped with HANHWA SP, the total number of which is also 198 pieces, the seventh row is equipped with 72 pieces of panels called S-ENERGY, and the last row consists of TOP SUN panels, the number of which is 24 pieces.

The panels, which have a power of 250 W, are installed on solar trackers, which are shown in Figure 2.

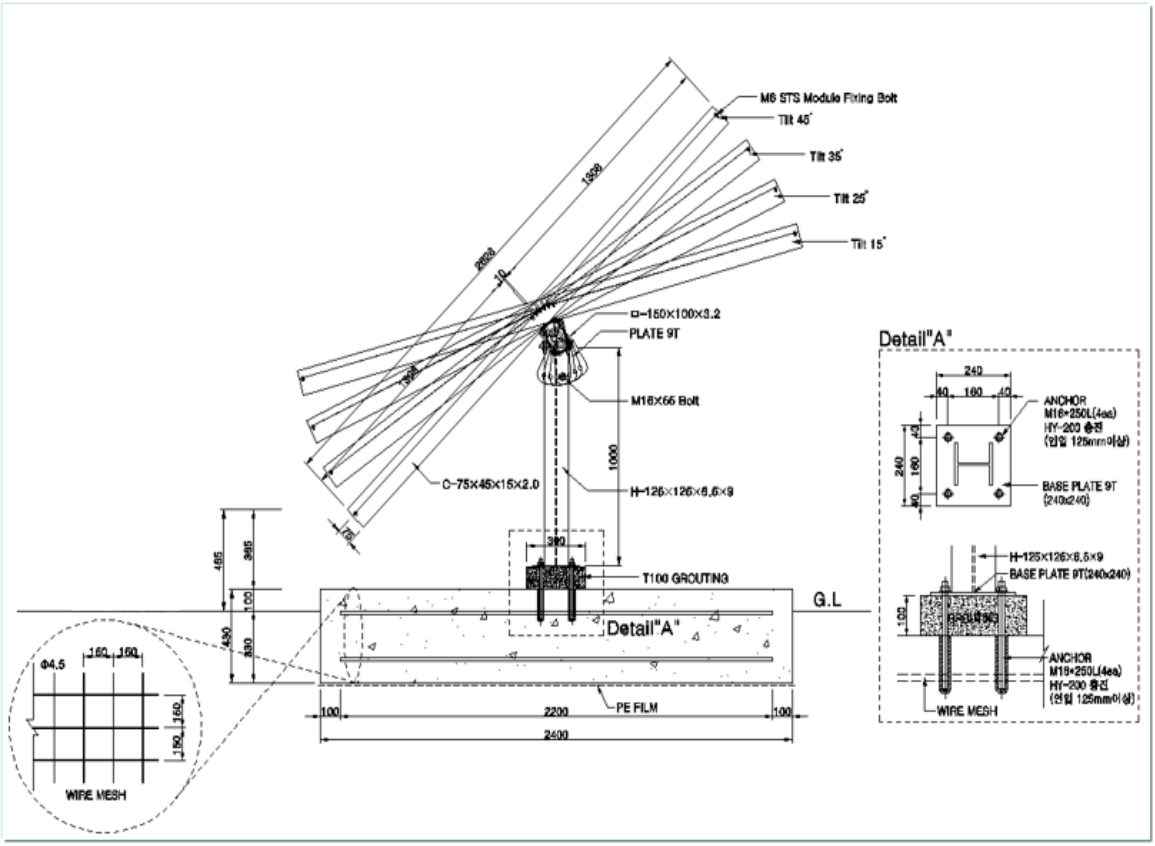


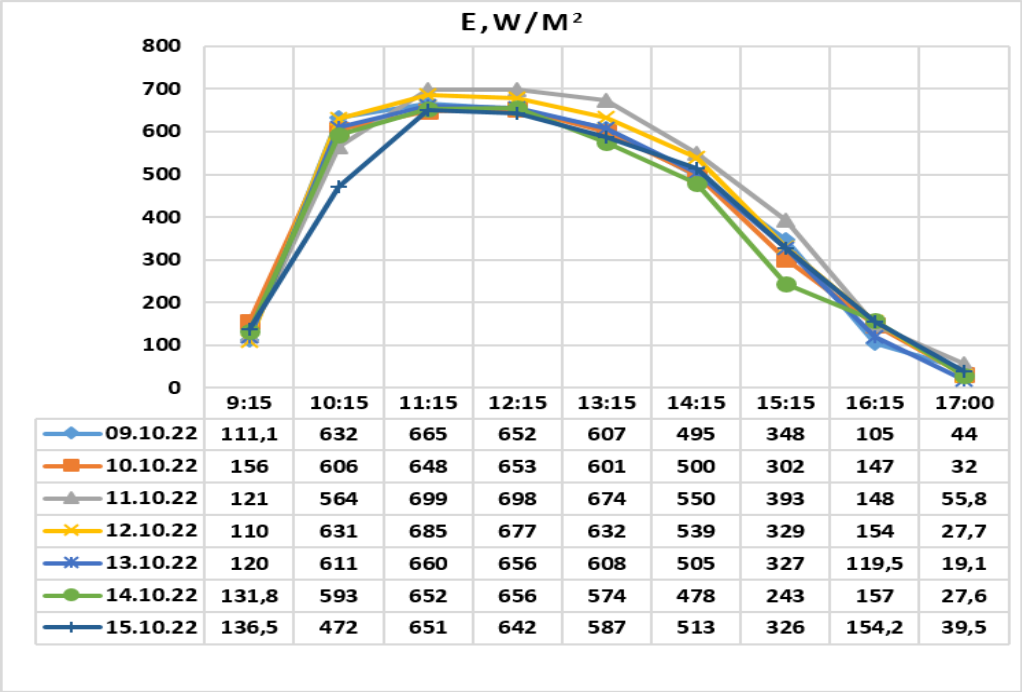
Figure 2. Solar tracker of solar panel TOP SUN

As can be seen from fig. 2, the TOP SUN solar panel tracker, which is installed in the 8th row, has a sun tracking system, only not automatic, but manual, which requires additional labor to change the position of the modules for each season. The trackers (1-7th row) of solar panel HANWHA, S-ENERGY and JSPV are not stationary, not mobile, which means that they are not equipped with a cleaning system and a sun tracking system, as a result of which it becomes impossible to maximally convert solar energy into electrical energy and. The fact is that solar modules operate in the open air, experiencing various natural phenomena, changing and losing their parameters and properties. In order to identify these changes, the authors conducted scientific and practical research at the station.

For the analysis, as well as for the assessment of the current state of the panels of the studied solar photovoltaic station, the electrical parameters were measured every hour for 7 days from October 9 to October 15, 2022. During the research, the following were used: UNI-T UT 204 current clamps (measuring short circuit current Isc); UNI-T UT890C multimeter (measuring open circuit voltage Uoc), DT-1307 pyranometer (fixing solar radiation E). The total measuring instruments are shown below.

Figure 3. General views of used electrical measurements

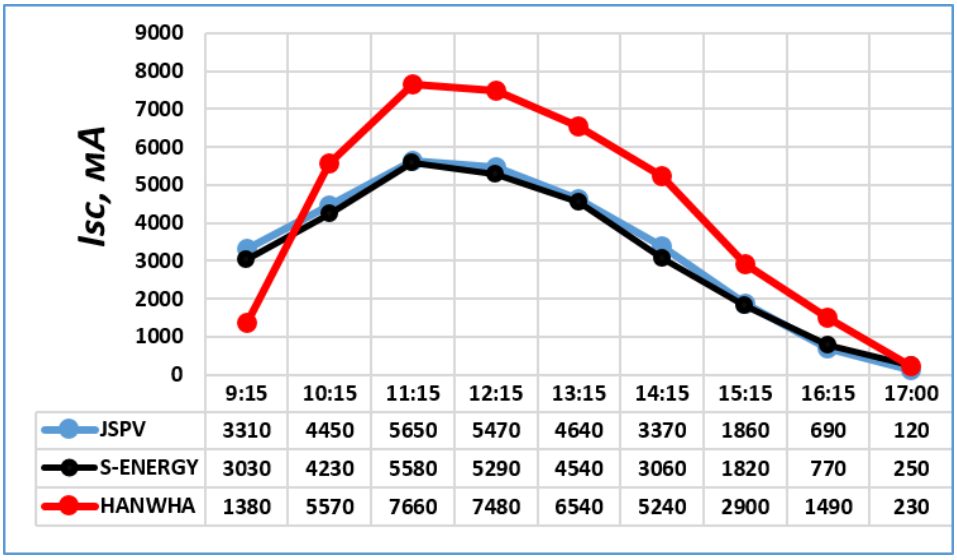
Results. At fig. 5 shows the electrical parameters of solar panels, which are identical in power. The graphs show the short circuit current (Isc) values of the S-ENERGY, JSPV and HANWHA modules, respectively. The modules are all identical in power, their current parameters, entered in the comparison graphs, were obtained by measuring on 15.10.2022 year. The parameters were measured every hour, the radiation value on this day varied E=39,5÷651 W/m^2.



	9:15	10:15	11:15	12:15	13:15	14:15	15:15	16:15	17:00
09.10.22	111,1	632	665	652	607	495	348	105	44
10.10.22	156	606	648	653	601	500	302	147	32
11.10.22	121	564	699	698	674	550	393	148	55,8
12.10.22	110	631	685	677	632	539	329	154	27,7
13.10.22	120	611	660	656	608	505	327	119,5	19,1
14.10.22	131,8	593	652	656	574	478	243	157	27,6
15.10.22	136,5	472	651	642	587	513	326	154,2	39,5

Figure 4. Change in solar radiation

The change in E falling on the surface solar panels is shown graphically (fig.4). If we conduct an analysis, the maximum value of E was observed in the middle of the day, i.e. on October 11, 2022 at 11:15 a.m. (the 3rd day of the study) E = 699 W/m², and the minimum value of E was recorded almost at the end of the day, more precisely on October 13, 2022 at 5:00 p.m. (the 5th day of the study) E = 19,1 W/m². The average value of E for each day of the study (09-15.10.2022) is 406.56, 405, 433.64, 420.52, 402.84, 390.26, and 391,24 W/m², respectively.



	9:15	10:15	11:15	12:15	13:15	14:15	15:15	16:15	17:00
JSPV	3310	4450	5650	5470	4640	3370	1860	690	120
S-ENERGY	3030	4230	5580	5290	4540	3060	1820	770	250
HANWHA	1380	5570	7660	7480	6540	5240	2900	1490	230

Figure 5. Electrical parameters of solar panels

The surface of the HANWHA panel was manually cleaned, after which its parameter increased sharply and this became noticeable on the graph [42,82-87; 49]. For example, when E=651 W/m² current of the S-ENERGY, JSPV and HANWHA panels was 5580, 5650 and 7660 mA, respectively. If we compare, Isc of the cleaned panel is higher than this parameter of these uncleaned modules by 2080 mA (37.27%) and 2010 mA (35.57%), respectively. The average value of Isc (6,44 A) of the HANWHA module before cleaning decreased on average by 26,73% compared to the catalog value (8,79 A). However, after cleaning, the average value Isc was 7,66 A, which is only 12,85% less than with the passport value and is 18,94% (1.22 A) more than the average value Isc before cleaning, which creates the preconditions for a possible increase in Isc by an average of 10-15%, with regular cleaning of the active area of the solar panel from contamination.

Conclusions. On the territory of the solar power plant, where it was located, the level of air pollution exceeds the norm, especially in summer and autumn, which causes a significant decrease in the power of solar panels, as a result of which the energy efficiency of the station decreases. Due to the lack of a sun tracking system in rows 1-7, which consist of HANWHA, JSPV and S-ENERGY solar panels, it becomes impossible to obtain maximum energy from them. Due to the non-automatic, but manual tracking of the sun of the 8-row, which consists of TOP SUN panels, additional labor is required for each season to change the position of the modules. It was determined that with a contaminated optical area, as well as the absence of cooling and orientation mechanisms, Isc of a 250 W solar panel deviates on average from the rated value by almost 27 %, and after cleaning the deviation is 12,85 %, which means that it is possible to increase Isc by an average of 10-15 % by regularly cleaning the surface, thereby increasing the generation of the solar power stations itself.

To increase the energy efficiency of solar panels, the authors propose to develop and apply an automatic panel cleaning system with minimal energy consumption for their own needs, as well as a sun tracking system, as a result of which not only the energy efficiency of solar panels and solar power plants will increase, but also the efficiency, ease of use, service life, and the payback period will be reduced.

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CONTENTS

CHEMICAL SCIENCES

TECHNICAL SCIENCES: MECHANICS AND MECHANICAL ENGINEERING

ADVANCED PEDAGOGICAL TECHNOLOGIES IN EDUCATION

ECONOMICAL SCIENCES