STUDY OF REFERENCE SOLAR CELLS PREPARED FOR MEASURING SOLAR IRRADIATION INTENSITY

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Abstract. *In this work, silicon solar cells of different sizes were tested by measuring the intensity of solar radiation in the conditions of the city of Termez. The results obtained from the reference solar elements were compared with the values measured using the measuring instrument "CEM DT-1307 Solar Power Meter" manufactured at the factory. The results of the study showed that the indicators of both measuring instruments do not differ significantly from each other.*

Keywords: *monocrystalline, reference solar cells, solar radiation intensity, short-circuit current, ammeter, geographical latitude, solar energy.*

Introduction

Solar energy measurement is important in the use of solar devices. To ensure the accuracy and reliability of the measuring instruments, they are checked and calibrated at regular intervals. Solar measuring instruments require accurate measurement of high-intensity solar radiation. Typically, the solar radiation intensity exceeds 1000 W/m^2. Modern measuring instruments are aimed at achieving even higher temperatures and irradiance levels as part of the 3rd generation program of the Solar Energy Technologies Office (SETO) of the Department of Energy [1-2]. Vacuum-type solar energy measuring instruments are very accurate measuring instruments suitable for measuring high-intensity radiation over a wide radiation spectrum. The vacuum radiometer, developed by J.M. Kendall, is an absolute measuring instrument that can measure from the far ultraviolet to the far infrared [3]. In addition, circular film meters, called Gardon meters [4], and axial thermoplastic film sensors, called Schmidt-Boelter meters, are inexpensive, robust, and reliable radiation measuring devices, and are also widely used for high-intensity radiation measurements [5].

Methods and materials

In the experimental work, monocrystalline silicon solar cells with dimensions of 4cm x 4cm and 6cm x 2cm were used. (Figure 1). The experimental work was carried out on September 30, 2025 in the conditions of the city of Termez (Latitude 37°13′). The relative humidity of the air was ~16%, the average wind speed was ~1.4m/s, and the atmospheric pressure was 762 mmHg The measurements were carried out from 9:00 to 15:00, with a time interval of 20 minutes. In the experiment, the short-circuit current of the reference solar cells was measured in the sun-observing mode. In the experimental work, the solar radiation intensity was measured using the "CEM DT-1307 Solar Power Meter" measuring instrument and reference solar cells. The measurement results can be seen in the table below.

Comparison table of solar radiation intensity measured using the CEM DT-1307 Solar Power Meter and reference solar cells

h:min.	E_{SPM} *(W/m^2)*	I_{SC1} *(mA)*	K_1 *(W/m^2·mA)*	I_{SC2} *(mA)*	K_2 *(W/m^2·mA)*
9:00	653	24	27,2	17,3	37,7

9:20	705	26,4	26,7	18,55	38
9:40	757	28,2	26,8	20,1	37,6
10:00	802	29,9	26,82	21,2	37,8
10:20	856	31,5	27,1	22	38,9
10:40	859	31,6	27,1	22,2	38,6
11:00	870	31,9	27,2	22,4	38,8
11:20	875	32,3	27	22,8	38,3
11:40	894	33	27	23,2	38,5
12:00	930	34	27,3	24,1	38,6
12:20	906	33,6	26,9	23,4	38,7
12:40	908	33,3	27,2	23,3	38,9
13:00	899	33,2	27	23,2	38,7
13:20	893	33	27	23,0	38,8
13:40	873	32,3	27	22,8	38,2
14:00	859	31,7	27	22,4	38,3
14:20	827	30,1	27,5	21,5	38,5
14:40	812	29,7	27,3	21,2	38,3
15:00	722	26,15	27,6	19,1	37,8
		Average value	27,1	Average value	38,3

The main purpose of the measurements is to justify the possibility of using reference solar cells made from local materials instead of measuring instruments such as the “CEM DT-1307 Solar Power Meter”, which are expensive in price and transportation costs. For this, reference solar cells made by hand at the Laboratory of Semiconductor Physics of Termez State University were used. The table above shows the ratio of the values measured by the “CEM DT-1307 Solar Power Meter” measuring instrument and the reference solar cell, K, and is expressed by the following equation:

$$K = \frac{E_{SPM}}{I_{SC}} \qquad (1)$$

where, E_{SPM} is the solar radiation intensity measured by the “CEM DT-1307 Solar Power Meter” measuring instrument, I_{SC} is the short-circuit current corresponding to the solar radiation intensity measured at the reference solar cell.

Results and Discussion

The value of the coefficient *K* determined in the experiment has a specific value for each reference solar cell and is used in subsequent measurements. To determine the intensity of solar radiation in real conditions using the reference solar cell, it is necessary to multiply the value of the short-circuit current generated by the solar cell under these conditions by the coefficient *K*:

$$E = K \cdot I_{sc} \qquad (2)$$

The data in the table above confirm that the values for the reference reference solar cells prepared in the research work are equal to K_1=27,1 $W/m^2 \cdot mA$ va K_1=27,1 $W/m^2 \cdot mA$.

In real conditions, the results obtained from the “CEM DT-1307 Solar Power Meter” device and the reference solar cells change proportionally, as can be seen in Figure 2.



Figure 1. Experimental device (Front and back)

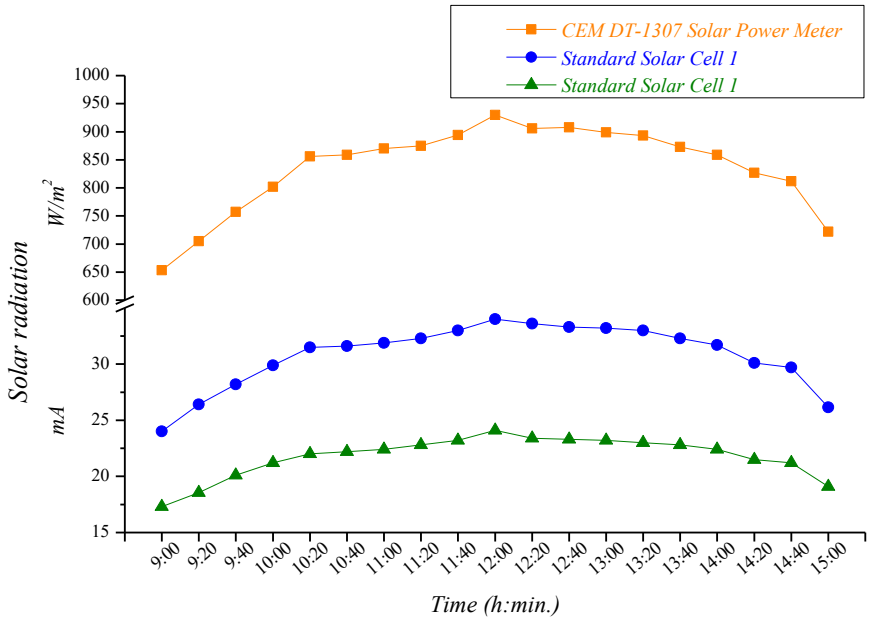


Figure 2. Dependence of solar radiation intensity on time of day obtained from the "CEM DT-1307 Solar Power Meter" instrument and reference solar cells

During the experiment, the "CEM DT-1307 Solar Power Meter" measuring instrument and the reference solar cells were kept in the shade to prevent overheating when not being measured. Calculations show that the reference solar cells prepared as part of the research are 10 times cheaper in price than measuring instruments such as the "CEM DT-1307 Solar Power Meter".

Conclusion

In conclusion, it can be noted that in any conditions, instead of expensive and expensive measuring instruments for measuring solar radiation intensity, it is possible to use reference solar cells made from local materials. The results of experiments conducted in real conditions confirm that the values obtained from these instruments are proportional to each other. Therefore, in the study, the coefficient *K* was determined, which is the ratio of the values obtained from the "CEM DT-1307 Solar Power Meter" instrument and the reference solar cells for continuous measurements.

This study was conducted on a not very hot day in September. Conducting experiments such as the above for hot summer days and anomalous cold winter days will further increase the reliability of using the prepared reference solar cells. For this, experiments should be conducted in other seasons and for other regions.

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