Mini Review

Laboratory equipment for verification of solar sensor-Actinometers and Piranometers

Abstract

This work includes a laboratory stand for calibration of solar sensors. Unlike field stands, our laboratory stand operates year round irrespective of weather conditions. The light source is a halogen lamp with a power of 300 watts.

Keywords: reliable measurement, actinometric devices, pyrheliometer, actinometer, pyranometer, source of radiation, potentiometers Pp-63, galvanometers, stopwatch, thermometer, voltage regulator, radiation stream, voltmeter, solar sensor, comparator

Volume 1 Issue 3 - 2017

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Received: November 09, 2017 | **Published:** December 19, 2017

Introduction

One of the first stages in the practical use of solar energy is the correct measurement of its quantity entering on the surface of the earth of a particular area during the year. For these purposes, actinometers are used to collect information on direct solar radiation and pyranometers for total and scattered solar radiation. Averaged measured solar resources for a certain period can be put as a basis for the design of solar stations and helio plants.

Discussion

Obviously, the above-mentioned devices should meet the corresponding requirements in their technical parameters. As you know, verification of measuring instruments is the main form of metrological supervision of measuring instruments used in various fields of economy, science and technology. In the process of verification, errors and other metrological qualities of instruments are estimated through accurate measurements, their compliance with tolerances by the standards of the country, enterprises and organizations is determined.[1] This makes it possible to obtain reliable measurement results. There are several methods of verification of measuring instruments, which are indicated in the verification schemes. Actinometric devices, such as actinometers, pyrheliometers and pyranometers, are verified according to the verification scheme regulated by the interstate standard GOST 8.195-2013. The verification schemes determine the methods of transferring the sizes of units from the superior measuring instruments to the lower ones. In our particular case, from the standard means of the pyrheliometer, actinometer and pyranometer to the working instruments of measurement-actinometers and pyranometers of the following discharge. The main verification methods are: direct comparison of the verified means of measurement with the model; Comparison using a comparator (comparator); Method of direct measurements; Method of indirect measurements. In practice, the method of direct comparison has received the widest distribution, which is based on the simultaneous measurement of the same value by the verified and model device. This principle of verification of devices was used by us in the development of the measuring device. It is known that the standard actinometric devices pyrheliometer, actinometer and pyranometer are regularly calibrated in the open air in the world radiation center (WRC) in Davos, Switzerland.[2] Other regional radiation centers, for example, St. Petersburg (Russia), Tokyo (Japan), Lindenberg (Germany), calibrate their secondary standards in Davos and continue their production activities by calibrating and verifying the devices of the following discharges, outdoors and in laboratories. It is obvious that the spectral composition of the lamps used in laboratories differs from the solar spectrum in the WRC, but this does not affect the calibration transfer, since the reference and verified device have the same non-selective black coating. This is allowed by the WRC and the interstate standard GOST 8.195-2013. In this connection, for the correct collection of information on solar resources, taking into account the fact that there is no installation for verification of actinometers and pyranometers in the country, we have developed a corresponding laboratory stand, which is shown in Figure 1. It is assembled on the basis of an optical bench and consists of the following main elements: 1-paraboloid mirror, 2-halogen lamp with a power of 300 W, 3-diaphragm, 4-rotatable holder of solar sensors on the table, 5-model solar sensor, 6-verified solar sensor, 7-screen, 8 - voltage stabilizer SD 1000, 9-ADC, 10-computer.

In the laboratory, an electric lamp is used as a source of radiation, which makes it possible to carry out verification work at any time of the year. It is also possible to create a more constant radiation mode of lamp illumination, by means of a voltage regulator, which increases the accuracy of verification. Elements of the installation are able to move horizontally along the optical bench, and the element holders move them in a vertical direction, which allows you to adjust the installation.

The laboratory unit is also equipped with auxiliary devices: voltmeter universal type V7-21A; Two potentiometers PP-63; Measuring bridge MO-62; Galvanometers of zero type GSA-1M-A two pieces, ammeter M1107; Current source B-5-25; stopwatch; Thermometer, etc.

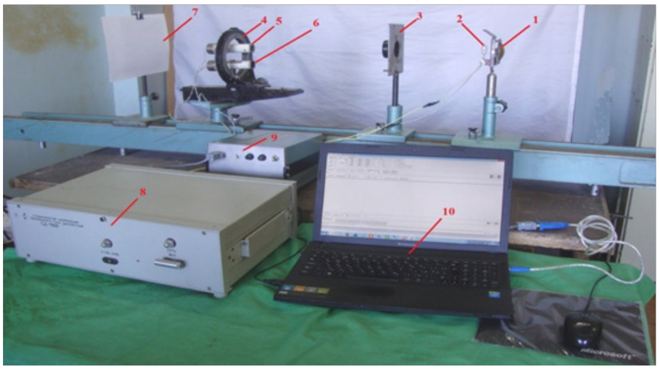

Figure 1 Photo of the laboratory desk for calibration of solar sensors.

Conclusion

Briefly, the verification procedure for comparing solar sensors is as follows. The lighting lamp turns on and the autotransformer sets a specific voltage on the lamp, in our case 30 V, which is fixed and maintained by the voltage regulator with an accuracy of 0.2 V during the calibration series. The devices are not to be compared before 30 minutes later. After the lamp is turned on. The rotary holder is installed in the radiation stream by an exemplary instrument. Not less than 2 min. The readings are taken by a potentiometer and then two more counts with intervals of at least 30 seconds. In parallel, the voltmeter readings are monitored, keeping it constant. Then, by rotating the rotary holder 180° in the radiation stream, a verified instrument connected to the potentiometer is installed and the same operations as those performed with the reference instrument are performed. These operations with the model and verified device are repeated three times. Further processing of verification results is carried out.

Acknowledgments

My research project was partially or fully sponsored by (Academy of Sciences of the Republic of Uzbekistan) with grant number (ИЗ-ФА-Ф005-ИЗ-2015-0910180538). In case of no financial assistance for the research work, provide the information regarding the sponsor.

Conflicts of interest

There is no conflict of interest.

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Citation: Sobirov Y, Fayziev S. Laboratory equipment for verification of solar sensor-Actinometers and Piranometers. *MOJ Solar Photoen Sys*. 2017;1(3):64–65. DOI: 10.15406/mojsp.2017.01.00014