ANALYSIS SOLAR RADIATION

Rusănescu Carmen Otilia[1], Rusănescu Marin[2], Dorel STOICA[1]

[1] University Polytechnic Bucharest, Biotechnical Faculty of Engineering, otiliarusanescu@yahoo.com
[2] Valplast Industrie Bucharest

Abstract: *In this paper is monitored the intensity of solar radiation by the meteorological station in the year 2012 and is calculated: intensity of diffuse radiation, direct radiation intensity, declination angle, hour angle . The the weather station type: AWS / EV is a product born from the need to frequently monitor the environment variables. The usage of the suitable mathematical algorithm makes possible to accurately follow the movement of the sun.*

Keywords: *global, direct and diffuse radiation, declination angle hour angle.*

1. Introduction

Sun is the largest object in the solar system containing 98% of its mass. He is a ball of incandescent gas mass from which we get heat and light. It has a diameter of 1.391 million kilometers which means it is 109 times greater than Earth

Radiation, the most important agent of heat in the atmosphere plays a major role in the processes that occur at medium and large scale. Radiation appears as a genetic element of the climate on a global scale [3].

Even under clear sky radiation that reaches the earth's surface in all directions from the diffusion phenomena, known as diffuse radiation, is 5 ... 15% of the flux of solar radiation that reaches the Earth's surface without being affected by this phenomenon, known as direct radiation. Together, direct and diffuse radiation, the so-called total radiation.

2. Materials and methods

Determination of the Sun-Earth angle (angle of declination, zenith angle, solar azimuth) makes it possible to determine the position of collector of solar radiation from the sun so that its efficiency is maximized. Based on mathematical algorithm, we determine the values of these angles for the period January to June 2012, and the minimum and maximum period.

The efficiency of a solar collector (the heating panel or PV) can be significantly increased if the collector is located under the sun so that the angle of incidence (angle between the radius of the sun and the line perpendicular to the collector) becomes zero or very small. Implementation of this requirement involves modeling the Sun-Earth angle, which must be accurate, relatively simple.

Global solar radiation intensity G horizontally was monitored weather station: AWS / EV Biotechnical Faculty of Engineering, Geco MICROS SIAP program version 2.3.2 software automatically records the following parameters: air temperature, wind direction and speed, atmospheric humidity, solar radiation, rainfall.

The weather station is wireless transmission range up to 300 m and the set of sensors integrated pillar of 1.77m and tripod for. [2]. Solar radiation sensor is manufactured in accordance with international specifications WMO (World Meteorological Organization).

It consists of a transducer which is heated in proportion to the incident solar radiation, absorbed by a special layer of black paint of the measuring surface of the heat. Double layer shielding of special optical glass to optimize the characteristics of the measurement under different environmental conditions.

This transducer is included in the family of smart sensors, as it is equipped with a microprocessor that performs multiple functions: checking the operation right, data preprocessing, A / D conversion to electrical signals, etc..

These features will ensure excellent accuracy and high reliability of data. The protection is made of aluminum alloy corrosion, shield UV-resistant plastic material with a low thermal capacity.

Internal circuits are protected from atmospheric discharges and polarity reversal. This is an analog sensor output signal between 0 and 2 VDC.

Privacy Framework is a aluminum alloy corrosion, UV resistant plastic with low thermal capacity. Internal circuits are protected from atmospheric changes and polarity inversion. This is an analog sensor output signal having a range from 0 V to 2 V [6].

Measurement from 0-1300 W/m^2.
Sensitivity of 1.5 mV / W / m ^{2}
Accuracy + / - 10 W / m^2
Resolution + / - 0.5 W/m^2.
Linearity: + / - 1%
Operating Temperature -30 to 60^{0}C
Output signal: 0 V (0 W/m^2) at 2 V (1300 W/m^2)
Sensor connector 4 pin female
Mounting: with support (mast), the position is important because it must be pointed south.

3. Results and discussion

Based on recorded global radiation intensity, we calculate the direct and diffuse components of solar radiation. Based on 24 hour weather station record of 24 in 2012, we assumed diffuse radiation intensity equal to one fifth of global radiation intensity and the intensity of direct radiation is the difference between global and diffuse [8].

According to equation (1),
D - is the intensity of scattered radiation;
G - global or total radiation intensity
B - Direct radiation intensity

$$D = \frac{G}{5}, B = G - D \quad (1)$$

hour angle: determines the position of the Sun in the sky at a given moment. Is 0 when the sun passes the local meridian corresponding point of the sensor location. This angle is positive to the east (to the east) and negative to the west (at dusk).

Within an hour the sun across the sky at an angle of 15 °, and the position of the clock (T) is determined by the relationship:

$$\omega = 15 \cdot (12 - T) \quad (2)$$

If you are known angle of declination, latitude and hour angle can be determined by calculating the position of the Sun in the sky the sun height angle and solar azimuth angle, applying the above calculation formulas.

The angle between the direction to the sun the place of capture and the equatorial plane is called declination δ.

Relations for calculating the angle of declination δ are:

$$\delta = 23{,}45 \cdot \sin\left(360 \cdot \frac{284 + n}{365}\right) [1] \quad (3)$$

$$\delta = 23{,}45\sin\left(\frac{360(n-80)}{365}\right)[8] \quad (4)$$

where n is the day of the year in which the measurements were taken.
In Figure 1 is the angle of declination.

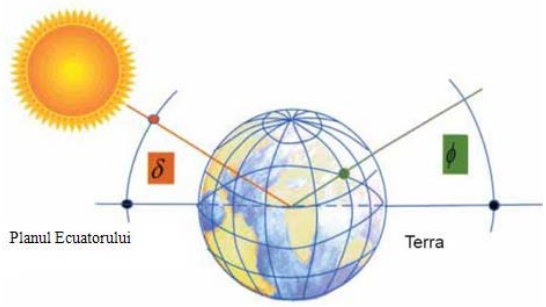

Figure 1 Representation of establishing the position angle sun in the sky [4]

Based on recorded global radiation intensity, we calculated the direct and diffuse components of solar radiation.
Figure 2 shows the proportion of diffuse radiation intensities and intensity of direct radiation in global radiation. It is interesting to note that the intensity of diffuse radiation has a high intensity compared with direct radiation.
Based on 24 hour weather station record of 24 in 2012, I assumed diffuse radiation intensity equal to one fifth of global radiation intensity and the intensity of direct radiation is the difference between global and diffuse.
In Figure 3, we present the variation of global radiation, diffuse and direct weather station recorded in May 2012.
Based on the measured and calculated values of global radiation, diffuse, direct from January 2012 to June 2012 we plotted Figure 4. It is noted that the high value of global radiation was recorded on May 8 at 14, having a value of 879, the 10th of June at 14 was recorded the highest value of global radiation during January 2012-June 2012 which is the 899 [W / m²]. Some authors have performed statistical analyzes on different materials. [2,5].

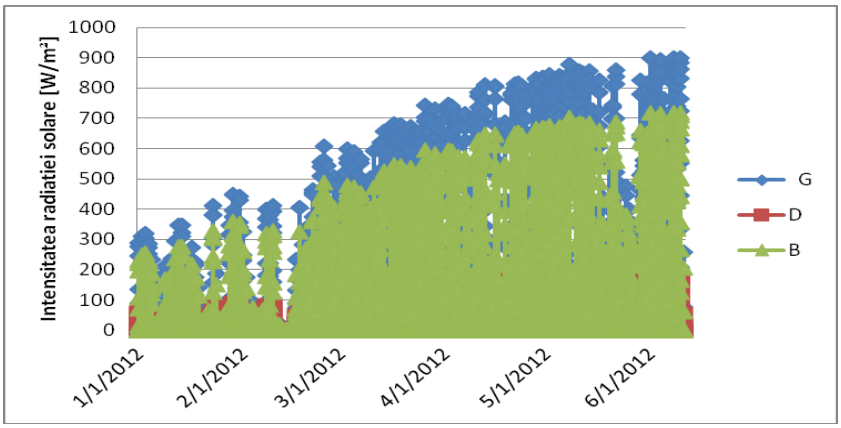

Figure 2 The variation in global radiation, direct and diffuse for January-June 2012

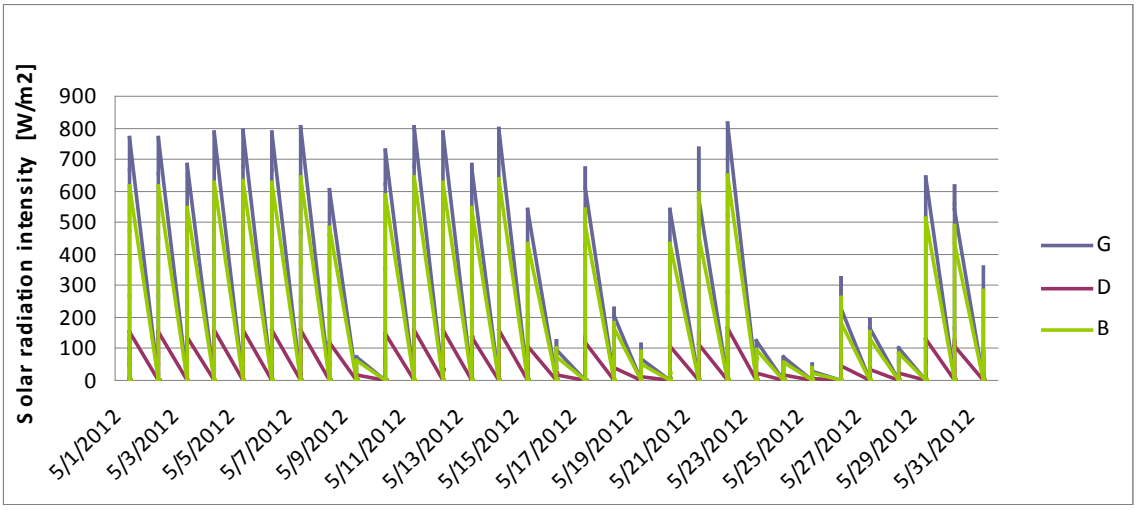

Figure 3 Intensity variation of global radiation, direct and diffuse recorded by the weather station in May 2012 [8]

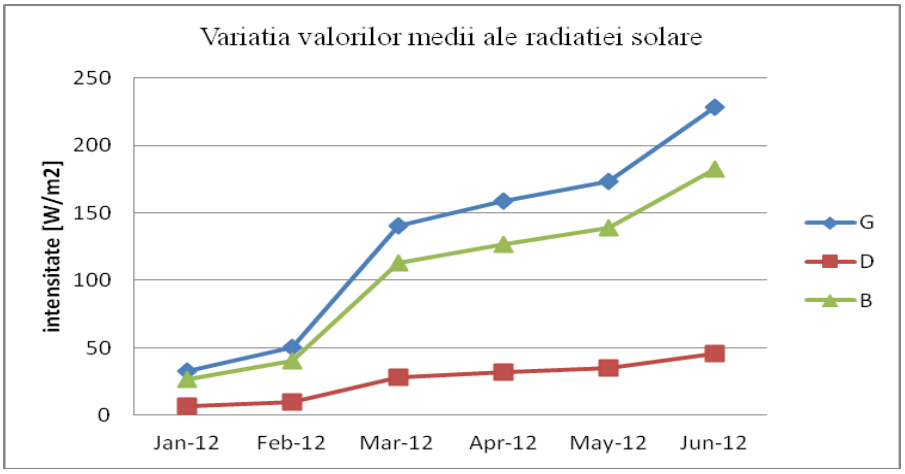

Figure 4 Correlation between components: global direct diffuse solar radiation during January-June 2012 [8]

If you are known angle of declination, latitude and hour angle can be determined by calculating the position of the Sun in the sky the sun height angle and solar azimuth angle, applying the above calculation formulas.

According to figures 5 and 6 the angle of declination is dependent on the day they were made in solar radiation measurements. In Figure 5 are the values of the angle of declination in May 2012 and in Figure 6 are the minimum and maximum declination angle based on statistical analysis in 2012.

From Figure 7 is observed, as shown in the literature [1] that the values are positive hour angle morning and afternoon negative.

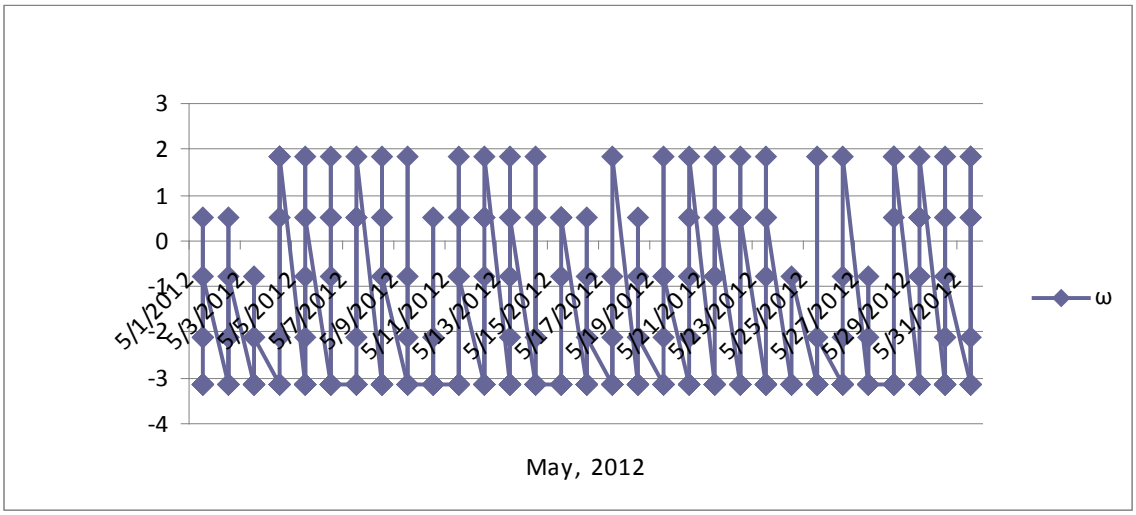

Figure 5 Declination angle variation by day of n calculated in May 2012 [8]

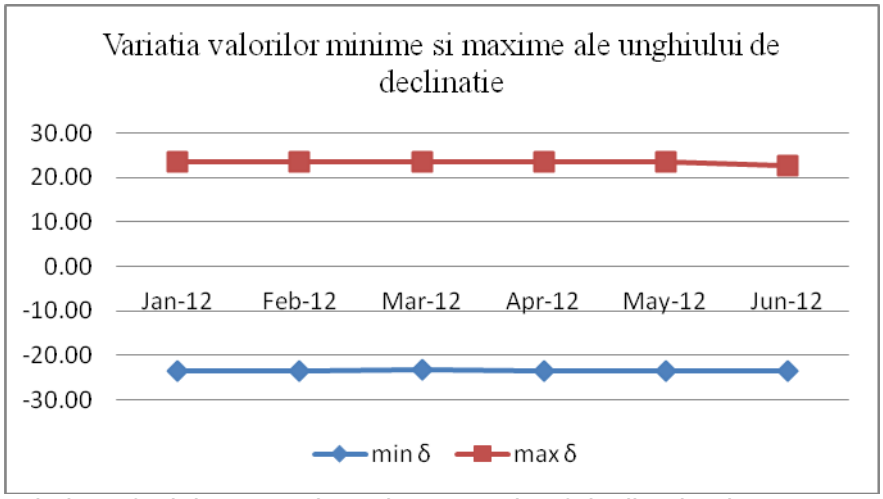

Figure 6 Variation of minimum and maximum angle of declination in January-June 2012

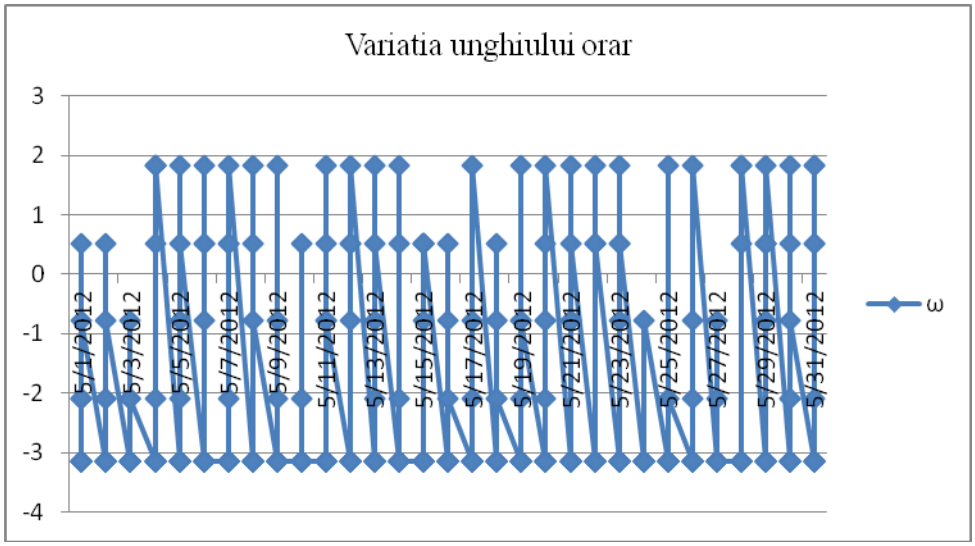

Figure 7 The variation angle zone in May 2012 [8]

Conclusions

Using mathematical algorithms presented in this paper to determine the Sun-Earth angle (angle of declination, zenith angle, hour angle), makes it possible to determine the position of collector of solar radiation from the sun so that its efficiency is maximized. Based on mathematical algorithm, we determined the values of these angles for 2012 and we represented graphically angles for July month was recorded maximum solar radiation and minimum and maximum values for the entire year.

The results of this study to monitor solar radiation, allowing interpretations that may be used to establish local potential use of solar energy. To complete this study, it takes more time to monitor solar radiation. Solar energy is the gateway to a new era, with its use in heating, resulting in reduction of environmental pollution.

The efficiency of a solar collector (the heating panel or PV) can be significantly increased if the collector is located under the sun so that the angle of incidence (angle between the radius of the sun and the line perpendicular to the collector) becomes zero or very small. Implementation of this requirement involves modeling the Sun-Earth angle, which must be accurate, relatively simple.

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