Experimental Study of Dust Effect in Mult-Crystal PV Solar Module

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Abstract – **Photovoltaic system is established as a reliable and economical source of electricity in rural and Sahara areas, especially in developing countries where the population is dispersed, has low consumption of energy and the grid power is not extended to these areas due to viability and financial problems. The production of energy by the photovoltaic system is very fluctuates and depend of meteorological conditions. Wind is a very important and often neglected parameter in the behavior of the solar module. The electric performances of a solar module to the silicon are very appreciable to the blows; in the present work we have studies the behavior of multi-crystal solar module according to the density of dust, and the principal's electric feature of the solar module. An evaluation permits to affirm that a solar module under the effect of sand will collect a lower flux to the normal conditions.**

***Keywords*–** Photovoltaic, Multi-Crystal Module, Experimental, Effect of Dust and Performance

I. INTRODUCTION

The photovoltaic solar energy is produced by the conversion of the solar radiance on the cell in electricity. The solar cells are connected together to obtain the electrical power needed.

The elevated cost of a photovoltaic system in particular the price of the solar module (~ 70% of the system), incites us to apply the technical-economic principles, in order to optimize the system and to maximize the power, the output and efficiency of the modules.

The program of electrification of the isolated centers of the south areas in Algeria by the solar energy concerns some hundred villages situated in regions where the environment conditions are very stern. The socioeconomic development of the Sahara regions is related to the electrical energy mainly (lighting, irrigation, drinking water), unfortunately the vast surface of the Sahara and the remoteness of villages let their connection to the network expensive and sometimes impossible

Silicon multi-crystal is a material romettor in photovoltaic conversion. Currently, worldwide production of modules containing solar cells with silicon multi-crystal does not cease growing for reasons costs considered less than those of single-crystal silicon. It is estimated that 40 % of cells solar are manufactured containing silicon multi-crystal. These considerations led to the introduction of a new die called 'die silicon multi-crystal or semi crystalline'. The advantage with this type of material is the maintenance of the principal technological stages realization of the solar cell to silicon single-crystal to which passivation is assistant grain boundaries. This die forwards at the hour current the best output report of conversion/cost of manufacture with fort Potential of improvement.

II. TECHNICAL DESCRIPTION OF PWX 500

Module PWX 500 is composed of 36 solar cells square of 4 inches, with silicon multi-crystal, laid out in series according to configuration of four garlands containing each one 9 solar cells as illustrated by figure 1. The whole of these cells undergoes the process of encapsulation with copolymer EVA allowing confining with the module the best stability in natural environment. The encapsulation of cells between two plates glass soaked with top coefficient of transmission guarantees the excellent solidity and reliability of the module. Technology of use of glass opposite back (Bi-glass) ensures an optimal behavior this in extreme climatologically conditions (temperature, moisture) to which it can be forwarded. Bi-glass thus profit from the guarantees of the excellent one mechanical behavior and of electric insulation glass at the same time with before and with the back of the module (Fig. 2).

Moreover glass ensures a maximum thermal dissipation. Two diodes D1 and D2, placed in one

Limp carefully protected in accordance with standard IP 55, ensure a protection of the module against possible screenings.

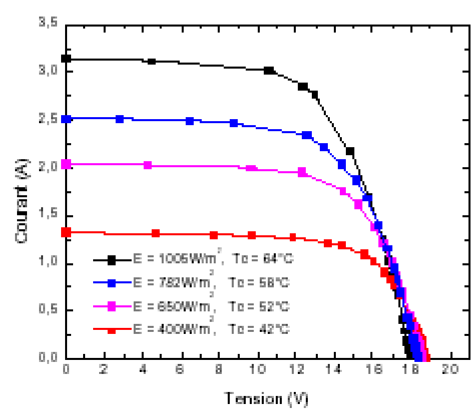

Fig. 1: characteristic of PW500

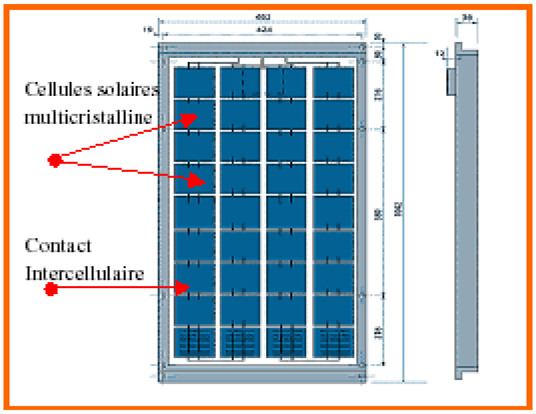

Fig. 2: Module PW500

II. EXPERIMENTATION OF THE SYSTEM

To get the performances of the experimental system, tests have been achieved on a module bound to a variable load and tilted by 39°. The summaries of measures during three-month concern the following parameters:

- the solar flux
- The temperature
- The current versus the voltage, the fill factor and the efficiency

For each measure we vary the density of dust (the initial quantity of dust is P1 then we double it for each measure p1, p2 = 2.P1 , p3 = 3.P1 ; p4 = 4.P1).

We calculate the various parameters of the module at each measure: the power, the fill factor and the efficiency. The results are shown in Fig. 3.

Fig. 3: Characteristic for various densities of dust: normal, dust p1, p2, p3, p4,

These curves show that under the dust, the characteristic is distorted:

- The Icc current drastically decreases (in particular for the first density).
- The working point is displaced (the tension of work decreases).
- The Vco tension varies and decreases slightly.
- For the high dust densities the characteristic loses its shape.

III. RESULTS AND DISCUSSION

In the normal conditions the fine dust is glued to the surface of the module and provokes a reduction of performances:

Fig. 4: Panel power versus voltage

Fig. 5: The efficiency versus voltage

The effect of dust on the various parameters is shown in Fig. 4 to Fig. 8. These graphs present the variations of the power, efficiency, Icc, Vco with the density of dust.

We notice from Fig. 6 that the power decreases quickly, and then consolidates, its give by:

$$P = -1.02.d^3 + 12.091.d^2 - 47.516.d + 63.486$$

where, d: density of dust.

The decrease of power is 69.18% for the first density to 97.16% in the end. These results confirm that the dust decrease the illumination flux which itself lead to a decrease of the power.

The efficiency Fig. 8 also decreases as an effect of a weaker illumination due to the serene formed by the dust. It is reduced by 66.73% with a first rate until 96.94%. This factor decreases following a curve that's shape is:

$$\eta = -0.0026.d^3 + 0.0326.d^2 - 0.1369.d + 0.192$$

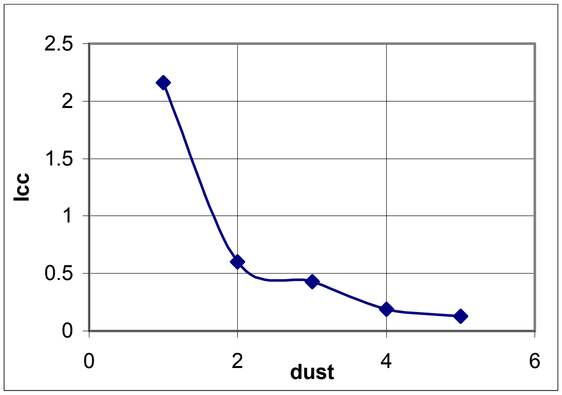

Fig. 6: The Icc current variation with dust

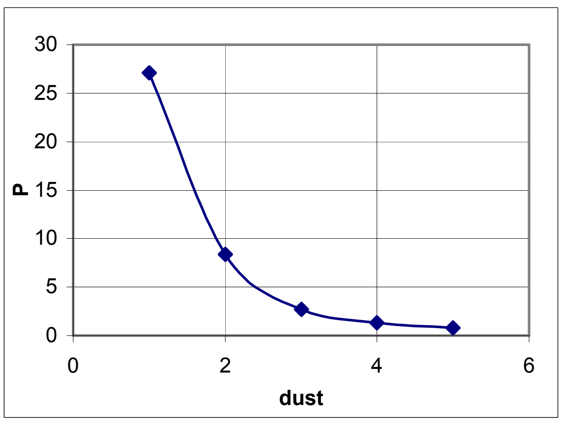

Fig. 7: the power variation with dust

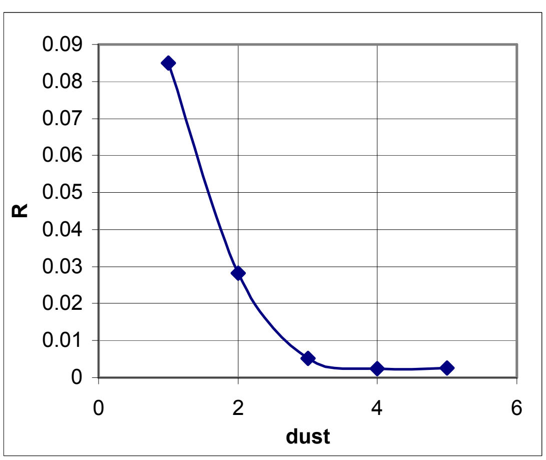

Fig. 8: The efficiency variation with dust

The current Icc Fig. 5 decreases linearly in first time, the important variations concern the first densities of 72.22%, for the last density its value is 93.98%.

$$Icc = -0.1008.d^3 + 1.1168.d^2 - 4.0824.d + 5.202$$

These results show the drastic influence of dust on the power, which fall by 97.16%, the efficiency that decreases by 96.94% and the Icc current by 93.98%.

IV. CONCLUSION

The exploitation of the solar energy to satisfy the energy demand in Sahara areas is limited by the effect of dust on the performances of photovoltaic generator.

In this work, we investigate na experimental study of photovoltaic module performances by influence of dust. Our results show that the dust provoked a fall of the electric parameters of the module, the power deliver by module decreases of 69-97 % according to sand density, as well as the efficiency that falls of 66-96 % and the current Icc following a fast variation of 72 to 93%.

It permitted to show that dust density produce a reduction in performances of the solar module, and therefore one regular cleaning of the face is necessary and permits to increase the power and efficiency (specially in desert area). .

The experimental study of the dust effect on the parameters of the solar module shows that these parameters are sensitive to the dust and its amount on the exposed face of the panel. We notice a reduction of the performances of the module that can be over 80% (in particular in the Sahara zones).

Even in absence of winds the characteristic of the module are influenced by the thin grain suspended on the surface, which lead to a decrease of the power by 17.5% and the efficiency by 1.5%.

These results permit to conclude that the solar modules have to be cleaned regularly (for example every month), and after periods of winds particularly in the Sahara regions. In addition the modules have to be sanded at a sufficient height with strong support to avoid winds effect. It is interesting to study other type of module with various orientations.

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