A REVIEW ON PHOTOVOLTAIC-THERMO ELECTRICAL POWER GENERATION FOR DESALINATION PLANT

Neel Kamal[1] & D.K.P. Singh[2]

[1]Assistant Professor E.E.E. Department, SET, Noida International University Gr. Noida, India [2]Head--EEE Department, Krishna Engineering College, Ghaziabad, U.P, India

ABSTRACT

Renewable energy provides an environmental friendly option at the time when global reserves of fossil fuels are decreasing. Integration of renewable energy resources for desalination and water purification is becoming increasingly attractive. Integration of PV with Thermoelectric modules can increase the overall efficiency of the solar energy conversion system by keeping the temperature constant within limits. In order to increase the availability of the fresh water supplies various approaches have been practiced including but limited to, water conservation, water recycling, increased water use efficiency and water desalination. Particularly desalination has become a major component of the fresh water supply. This paper is an attempt to explore the efficient mean of water pumping through augmentation of thermoelectric conversion to increase overall efficiency of PV array. The study of thermoelectric is done to illustrate its usefulness in hybrid model of PV and thermoelectric modules.

Keywords- Desalination, Integration, PV Array, Renewable energy, Thermoelectric Coolers

I. INTRODUCTION

Before PV systems can be used for pumping water for irrigation of land, as well as for purification of drinking water. Usually different types of electricity generators are combined into a so-called Integrated system. The efficiency of Photovoltaic systems deteriorates with the increase in temperature. However, concentrating the light on PV array surface increases its efficiency but, poses further problem of deterioration due to become bulky and slow in dynamics as the level of concentration is increased. For such type of applications active heat sinks such as *Thermoelectric Coolers* can be used. In this paper, a integration of PV–TE is proposed which can offer the best choice for concentrating type of systems. The subsequent section of the paper deals with integrated PV-TE system for its overall performance improvement. If PV panel is used in configuration; thermoelectric modules are placed on the back of the PV panels which can collect the heat from the PV panel very fast through drawl of current absorbing extra heat with respect to ambience. This way the extra heat will be removed from PV panel and its efficiency would increase, together with this, the TE system would also produce additional electric power. This would in turn increase the efficiency of the PV system, and the integrated system would produce additional energy through drawl of current from principles of the see-beck effect. The temperature of PV panel may be maintained through continuous removal of heat by the TEG.

II. SYSTEM DESCRIPTION

The figure shows the arrangement of solar panel and thermo-electrical generator system. It consists of a parabolic dish collector, uncovered flat receiver plate attached with thermoelectric modules on its focal plane. Thermoelectric modules are electrically connected in series and thermally in parallel between the receiver plate and stainless steel box as the heat exchanger. Thermoelectric modules of the hot side on the inner surface of the receiver plate and the cold side of the outer surface of the stainless steel box are tightly fixed. The collector can be tracked manually or automatic in order to absorb the solar beam radiation on the bottom of the receiver [3].

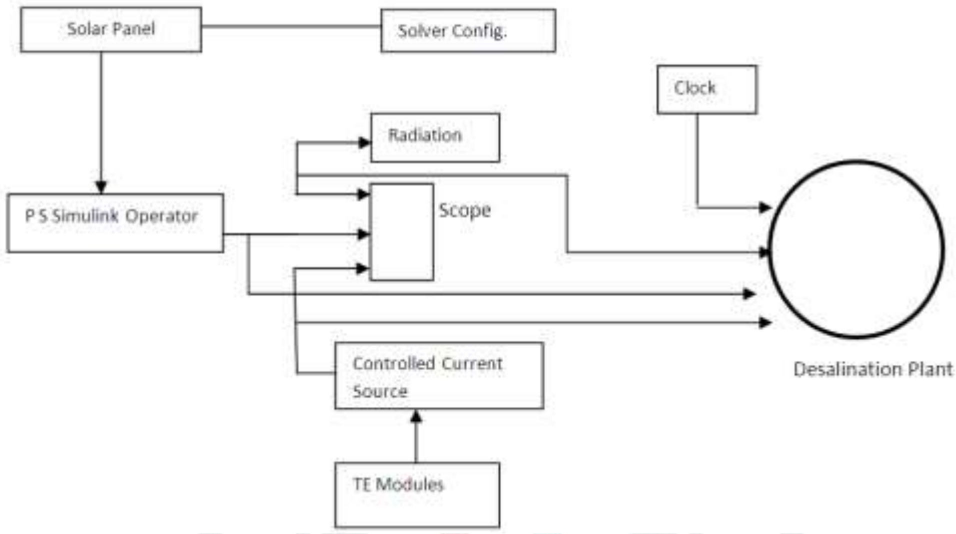

Figure 1. Hybrid Photovoltaic and Thermoelectric Generator system for desalination

Integrated PV-TE system model a block of PV Panel and another of thermoelectric module. These are coupled in such a way that the solar insolation increases the temperature of the hotter side of the thermoelectric module. This rise in the temperature is in effect is the result of rising temperature on the surface of PV array. The control scheme eventually curbs the rise, lower the temperature gradient and finally stabilize it to a lower referenced level. To study the effect of the concept individual loads are connected to each module. The result depicts the current output contribution of each module. The integrated system shown in Fig.1 is operated with resistive load at the output terminals. Solar insolation is increased, in this setup, from zero to about 1500 w/m 2 which depicts the condition from day break till afternoon. As the insolation increases the temperature of the PV array will go on increasing till a saturation point is reached. The considered saturation point is 150ºC which corresponds to a solar insolation of 1000w/m2. The current in Photovoltaic system increases with increase in insolation till a max current is reached at an insolation of about 500 w/m2after this point the current increase is very slow manner. The current in thermoelectric module also increases with increase in temperature of the Photovoltaic panel. The current in thermoelectric module increases parabolically with the increase in temperature. At insolation of 1000 W/m2temperature saturates and the output of the thermoelectric module becomes constant.

III. SOLAR AND THERMAL ANALYSIS

Model of the PV cell:

The simple equivalent circuit of a solar cell is a current source in parallel with a diode [1]. The output of the current source is directly proportional to the light falling on the cell. When there is no light present to generate any current, the PV cell behaves like a diode. As the intensity of incident light increases, current is generated by the PV cell, as illustrated in Figure1.

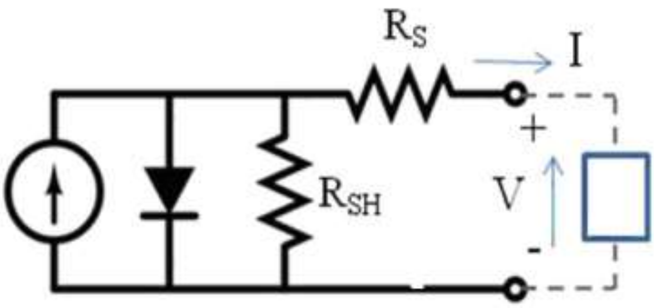

Figure2.Circuit diagram of the PV model

In an ideal cell, the total current I is equal to the current IE generated by the photoelectric effect minus the diode current ID, according to the equation:

$I=I_E-I_D$ ---(1)

$I_E - I_O(\text{EXP } QV/KT - 1)$------------------------------------ (2)

Where I_O is the saturation current of the diode, Q is the elementary charge $1.6\text{x}10^{-19}$ Coulombs, K is a constant of value $1.38\text{x}10^{-23}$J/K, T is the cell temperature in Kelvin, and V is the measured cell voltage that is either produced (power quadrant) or we will concentrate on a single diode model in this document. Expanding the equation gives the simplified circuit model shown below and the following associated equation, where n is the diode ideality factor.

$I=I_L - I_O\{\text{EXP}[\ Q(V+I.RS)/nKT] - 1\}$ --------------------(3)

A solar desalination plant employs a particular technology to desalinate water using solar energy. The solar plant and desalination plant can be combine together into a single unit[5]. Solar electricity generation is increasing rapidly by using the new technologies in compound solar cell. Conversion efficiency of 43.5% achieved at the research level for a concentrated triple junction compound solar cell at 360 times concentrated sunlight. Compound solar cell utilize photo absorption layers made from compounds consists of two or more elements such as indium and gallium[6].

TEG Simulation:

Thermoelectricity is the conversion between the heat and electricity. A thermoelectric generator harvests waste heat from the other substance and convert it into the electricity. Even the overall efficiency of the conversion is low but researchers are working hard to discover new p and n type semiconductors which can do this more efficiency on the research level the PbTe and the Bi2Te3are the best suited materials for the thermoelectricity generation [7].TEG simulation equation can be shown as

$P = n[a(T_1 - T_2) * (R+R_L)^2$ -------------------------------(4)

Power output of the thermoelectric module depending on the Temperatures T_1 & T_2 of the surfaces of the generator

n = no of thermoelectric elements.

IV. MAXIMUM POWER POINT TRACKING

Maximum power point trackers (MPPTs) are used to track the peak output power of the solar photovoltaic sources. The maximum available power is tracked using specialized algorithms such as Perturb and Observe (P&O), which is an industry standard[4]. The classical P&O algorithm requires the use of both voltage and current sensors. This classical algorithm also requires ad-hoc tuning measures at design time for selecting the right size of the search step. In most cost-and space-constrained systems, an algorithm with minimal sensing it utilizes instantaneous voltage ripples at PV panel output terminals caused by the switching of a chopper connected to the panel in order to identify the direction for the maximum power point (MPP).

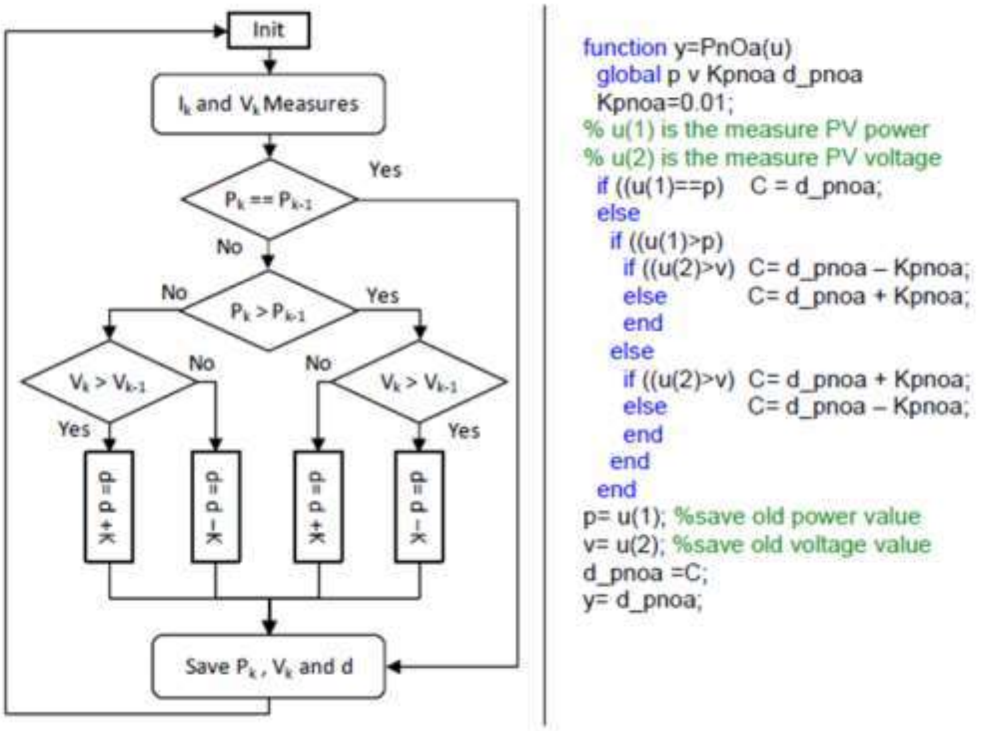

Fig.3.4. P&O algorithm and the code of Mat lab embedded function

The principle is based on perturbing the voltage and the current of the PV regularly, and then, in comparing the new power measure with the previous to decide the next variation. Three Perturb and Observe (P&O) Methods are well known:

P & Oa with a fixed perturbing value.

P & Ob with a variable perturbing value.

P & Oc or Three-Point Weighted Method, where the direction of the perturbing value is defined by three points[2].

The P&Oa method requires the PV voltage and current measurements. The Matlab embedded function is evaluated with a 1 kHz frequency. The P&Ob method is similar to the P&Oa except than the constant coefficient Kpnoa is replaced by a variable coefficient Kpnob:

$Kpnob=0.02.|\Delta P|$

The P&Oc or Three-Point Weighted Method is equivalent to a 2nd Order gradient approximation of the Power derivative. So it means the MPPT convergence will be better and more robust.The tracking for the MPP is achieved by a feedback control of the average terminal voltage of the panel. Appropriate use of the instantaneous and the average values of the PV voltage for the separate purposes enables both the quick transient response and the good convergence with almost no ripples simultaneously.

V. CONCLUSIONS

Photovoltaic systems must be operated near the maximum power point to extract maximum energy from the system. The efficient way of using this heat is by using thermoelectric conversion modules. The presented conclusion reveal the effectiveness of the proposed integration technique of renewable energy. The number of TE modules must be increased to cover the total surface area on the back of PV Panel for proper operation of the controller. The work has carried out for modeling of solar Energy conversion system employing photovoltaic and thermoelectric cells as basic unit for the conversion system to increase the overall efficiency of energy generation system.

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