Journal of Energy Research and Environmental Technology (JERET)
Print ISSN: 2394-1561; Online ISSN: 2394-157X; Volume 2, Number 3; April-June, 2015; pp. 244-247

http://www.krishisanskriti.org/jeret.html

Performance analysis of Water Pumping System using Solar P.V

Manoj Kumar Sharma[1], Mohd.Faisal Jalil[2] and Ravi Gupta[3]

[1]M.Tech (PE&D) KIET (UPTU), Ghaziabad
[2,3]KIET (UPTU), Ghaziabad
E-mail: [1]Mnjsharma324@gmail.com, [2]Mfaisaljalil@gmail.com, [3]ravigupta@kiet.edu

Abstract—*A water pumping system needs a source of power to operate. In many rural areas, water source are spread over many miles of land and power line are scare. In such area's PV systems are highly reliable and are often chosen because they offer the lowest life-cycle cost.*

This paper deals with the performance analysis of water pumping system using P.V system. In this we have designed a circuit such that it delivers constant and stepped up D.C voltage to the load connected to a PMDC motor. Two types of techniques used in this paper; those are without MPPT and with MPPT by which the duty cycle of boost converter can be controlled. In without MPPT method P.I controller is used to obtain constant output voltage of boost converter by controlling the duty ratio of converter. In MPPT method, P&O technique of MPPT is used to sample the output of the cells and use desired load to obtain maximum power. The comparison analysis is done on the basis of with and without MPPT method. The complete model is designed by a simulation program MATLAB/Simulink.

Keywords: *PV PANEL, BOOST CONVERTER, PMDC MOTOR, MPPT, PI CONTROLLER*

1. INTRODUCTION

The entire world is facing a challenge to overcome the hurdle of energy crisis. The diminishing deposits of non renewable energy resources such as coal, natural gas, fossil fuels etc. have added to this worry. It is thus fairly evident that a need exist for developing alternative energy sources. The immediate need would be to vitiate the problems caused by depletion of oil and natural gas, while the long term need would be to develop means that can replace coal and fossil fuels. Rapid population growth and industrialization, demands for an increased amount of electrical energy. Solar energy is a renewable, inexhaustible and ultimate source of energy. If used in a proper way, it has a capacity to fulfill numerous energy needs of the world. The power from the sun intercepted by earth is approximately 1.8 x 1011MW [1].This Fig. , being thousands of time larger than the present consumption rate enables more and more research in the field of solar energy so that the present and future energy needs of the world can be met. Thus Even though the PV system is posed to its high capital fabrication cost and low conversion efficiency, the skyrocketing oil prices make solar energy naturally viable energy supply with potentially long-term benefits. PV module represents the fundamental power conversion unit of a PV generator system. The output characteristics of PV module depends on the solar insulation, the cell temperature and output voltage of PV module. Since PV module has nonlinear characteristics, it is necessary to model it for the design and simulation of maximum power point tracking (MPPT) for PV system applications. The mathematical PV models used in computer simulation have been built. [2] - [3]. Almost all well-developed PV models describe the output characteristics mainly affected by the solar insolation, cell temperature, and load voltage. Recently, a number of powerful component-based electronics simulation software package have become popular in the design and development of power electronics applications. However, the Sim Power System tool in Matlab/Simulink package offers wind turbine models but no PV model to integrate with current electronics simulation technology. Thus, it is difficult to simulate and analyze in the generic modelling of PV power system. This motivates me to develop a model for PV cell, module, and array using Matlab/Simulink. However, the solar energy is a dilute source of energy and its availability varies widely with time. So, it is very necessary to make a complete utilization of solar energy in available time. Many maximum power point tracking algorithms are available for a solar panel in order to produce maximum output. It is very necessary that it is operated consistently at the maximum power point. The Perturb & absorb Method of MPPT is described here with its maximum power point

1. System parameter analysis The parameter analysis of the system is shown as:

(a) Rating of PMDC motor: - For the rating of PMDC motor, we have to know about the output power, required to load (pump), which is connected to PMDC motor. So if the pump shaft power is-

Ps=Hydraulic power/Pump efficiency

Consider, hydraulic power is 42.3W and pump efficiency is 75%, then the pump output power is 56.5W.So the PMDC motor rating is 70W, selected for such application. Now, if

consider efficiency of motor is 80%, then boost converter with a power rating of 85W is selected.

(b) Sizing of PV panel: - Considering the efficiency of boost converter is 90% then,

PV array size=85/0.9=94.4W

With considering the PV panel operating factor 0.75 and mismatch factor 0.85 then,

PV array size=94.4/0.75*0.85=148W

2. DESCRIPTION OF THE PUMPING SYSTEM

Fig. (1) shows the block diagram of a water pumping system. In which a PMDC motor is feed by a PV array using boost converter and MPP Tracker.

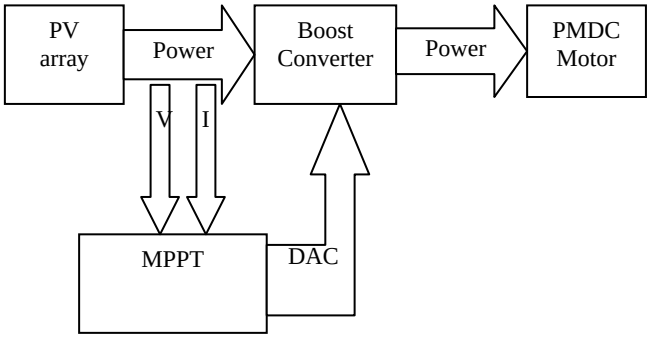

Fig. 1: Block diagram of entire system

(a) Photovoltaic source: - a solar cell basically is a p-n semiconductor junction. When exposed to light, a dc current is generated. The generated current varies linearly with the solar irradiance**.** The standard

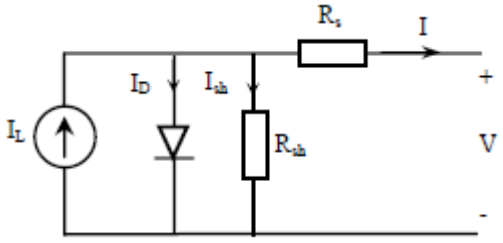

Fig. 2: Equivalent circuit of solar PV cell

The basic equation that describes the (I-V) characteristics of the PV model is given by the following equation:

$$I = I_L - I_O\left(e^{\frac{q(V+IR_S)}{KT}} - 1\right) - \frac{V+IR_S}{R_{SH}} \qquad (1)$$

Where:

I is the cell current (A).

I_L is the light generated current (A).

Io is the diode saturation current.

q Is the charge of electron = 1.6x10-19 (coul).

K is the Boltzman constant (j/K).

T is the cell temperature (K).

Rs, R_{SH} are cell series and shunt resistance (ohms).

V is the cell output voltage (V)

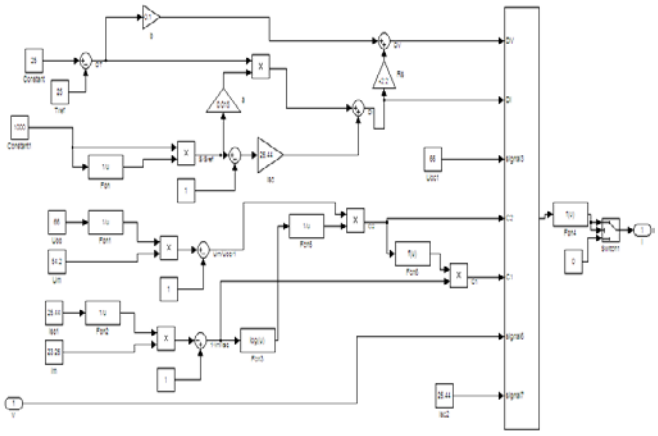

Fig. 3 Simulation of the PV array

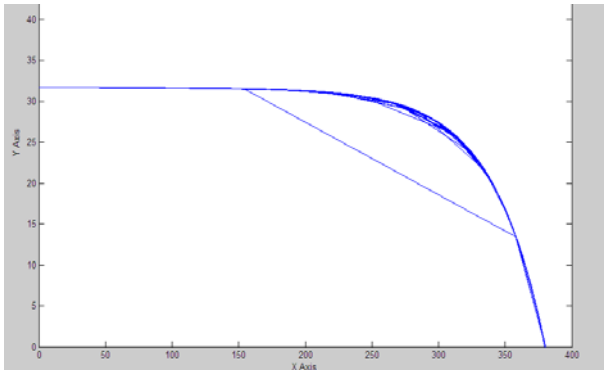

Fig. 4: I-V characteristics of solar array

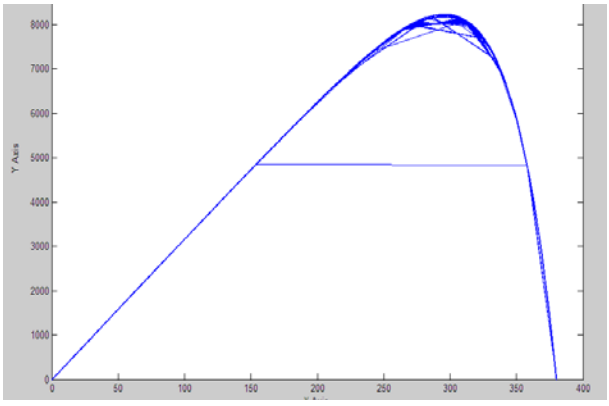

Fig. 5: PV characteristics of solar array

(b) MPPT Technique: - The efficiency of a solar cell is very low. In order to increase the efficiency, methods are to be undertaken to match the source and load properly. One such method is the Maximum Power Point Tracking (MPPT). This is a technique used to obtain the maximum possible power from a varying source. In photovoltaic systems the I-V curve is non-linear, thereby making it difficult to be used to power a certain load. This is done by utilizing a boost converter whose duty cycle is varied by using a MPPT algorithm. Few of the many algorithms are listed below [3], [4], [5] and [8].

A boost converter is used on the load side and a solar panel is used to power this converter. There are many methods used for maximum power point tracking a few are listed below:

- Perturb and Observe method
- Incremental Conductance method
- Parasitic Capacitance method
- Constant Voltage method
- Constant Current method

Perturb and Observe method: - This method is the most common. In this method very less number of sensors are utilized [5] and [6]. The operating voltage is sampled and the algorithm changes the operating voltage in the required direction and samples$dPdV$. If $dPdV$ is positive, then the algorithm increases the voltage value towards the MPP until $dPdV$is negative. This iteration is continued until the algorithm finally 16 reaches the MPP. This algorithm is not suitable when the variation in the solar irradiation is high. The voltage never actually reaches an exact value but perturbs around the maximum power point (MPP) Flow chart for perturb & observe:

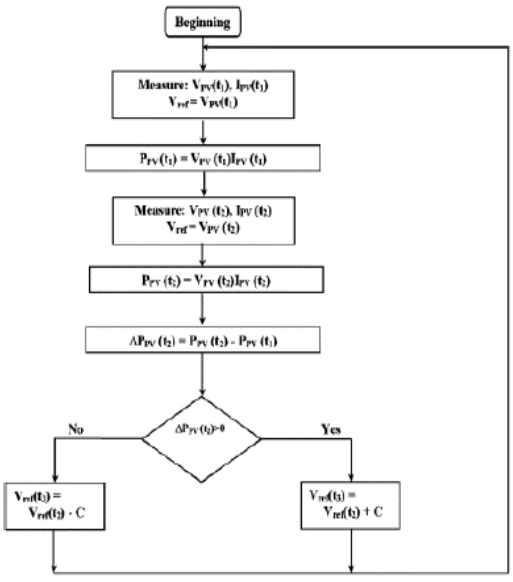

Fig. 6: Flow chart of P & O technique

3. SIMULATION RESULTS

The PV module of 148W and 70W PMDC motor, 57W pump is used for this analysis. The simulation results are given below:

(a) Without MPPT: -Fig. (7) shows the input voltage of the PV array and output voltage of the boost converter.

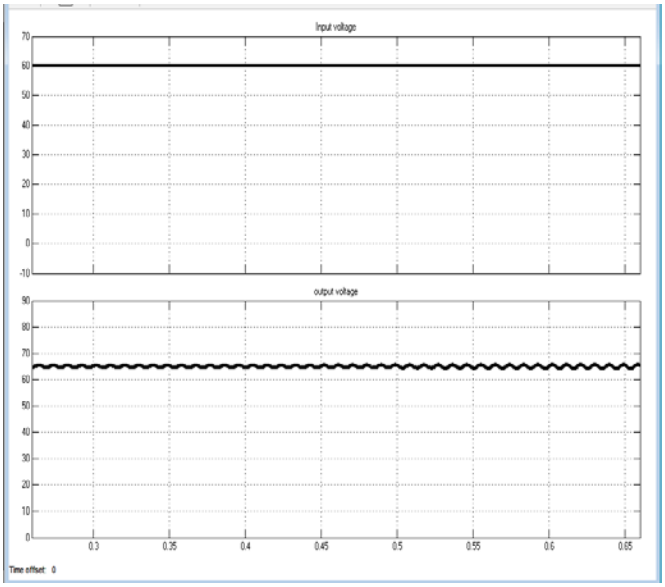

Fig. 7

Fig. (8) shows the machine characteristics of PMDC motor without MPPT.

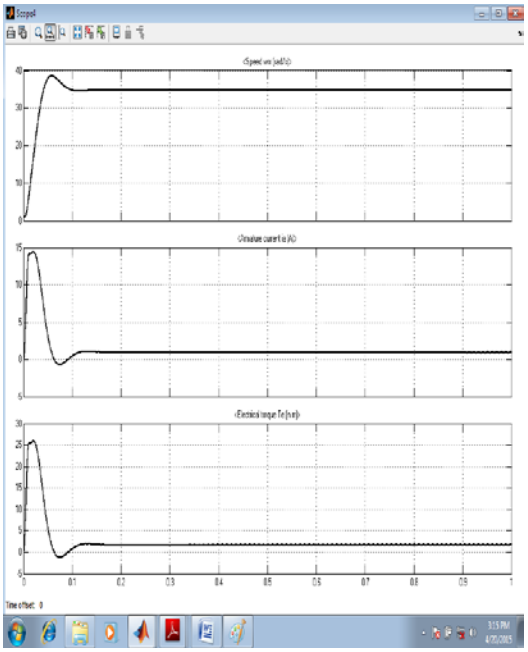

Fig. 8

(b)With MPPT: -Fig. (9) shows the output voltage of the boost converter.

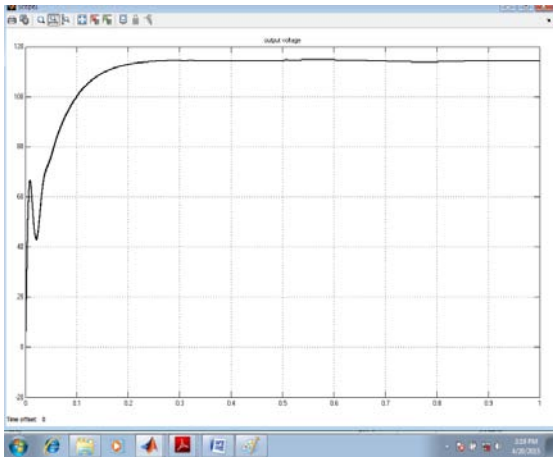

Fig. 9

Fig. (10) shows the machine characteristics of PMDC motor with MPPT using P& O technique.

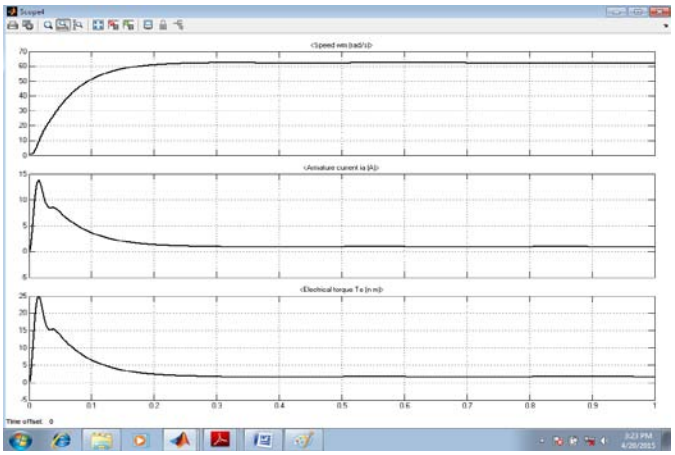

Fig. 10

By comparing the above results, we conclude that the power to the PMDC motor with MPPT is much more than the power to the PMDC motor without MPPT.

4. CONCLUSION

In this paper design and simulation of a PMDC motor based PV pumping system is done. Simulation results show the effective performance of the PMDC motor. In this better performance of PMDC motor is achieved by using a MPPT with P & O technique in comparison of using without MPPT. Now a day's PMDC motor is one of the latest choice due to their linear torque speed characteristics and high torque, more compact size.

Advancements in power electronics and digital signal processors have added more features to these motor drives to make them more prevalent in huge application.

MANOJ KUMAR SHARMA received the B.Tech degree in electrical and electronics engineering from sunder deep engineering college, Ghaziabad U.P which is affiliated to UPTU Lucknow in 2011. M.Tech will complete from Krishna Institute of Engineering And Technology, Ghaziabad U.P in 2015.

During 2014-15, he worked on dissertation.

5. ACKNOWLEDGEMENTS

I would like to thanks my supervisors**,** asst. Prof. Mohd.faisal jalil & associate Prof. Mr. Ravi Gupta for giving me the opportunity to join and collaborate with his research group during this year. The accomplishment of this research would not have been achieved without his extensive support, encouragement and guidance.

I also would like to thank my parents, for their faith in me and allowing me to be as ambitious as I wanted.

REFERENCES

[1] R. Messenger and J. Ventre, Photovoltaic Systems Engineering, CRC Press, 2000, pp.41-51.

[2] S. W. Angrist, , Direct Energy Conversion, Allyn and Bacon, Inc., 4th edition, 1982, pp. 177-227.

[3] O. Wasynczuk, "Dynamic behavior of a class of photovoltaic power systems," IEEE Transactions on Power System.

[4] R. Sridhar, Dr. Jeevananathan, N. Thamizh Selvan, Saikat Banerjee, "Modeling of PV Array and Performance Enhancement by MPPT Algorithm", International Journal of Computer Applications (0975 – 8887) Volume 7– No.5, September 2010.

[5] Hairul Nissah Zainudin, Saad Mekhilef, "Comparison Study of Maximum Power Point Tracker Techniques for PV Systems", Cairo University, Egypt, December 19-21, 2010, Paper ID 278.

[6] Katherine A. Kim and Philip T. Krein, "Photovoltaic Converter Module Configurations for Maximum Power Point Operation", University of Illinois Urbana-Champaign Urbana, IL 61801 USA.

[7] Huan-Liang Tsai, Ci-Siang Tu, and Yi-Jie Su, "Development of Generalized Photovoltaic Model Using MATLAB/SIMULINK", Proceedings of the World Congress on Engineering and Computer Science 2008 WCECS 2008, October 22 - 24, 2008, San Francisco, USA.

[8] M. Berrera, A. Dolara, R. Faranda and S. Leva, "Experimental test of seven widely-adopted MPPT algorithms", 2009 IEEE Bucharest Power Tech Conference, June 28th - July 2nd, Bucharest, Romania.

[9] P. S. Revankar, W. Z. Gandhare and A. G. Thosar Government College of Engineering, Aurangabad, "Maximum Power Point Tracking for PV Systems Using MATLAB/SIMULINK", 2010 Second International Conference on Machine Learning and Computing.

[10] Ramos Hernanz, JA., Campayo Martín, J.J. Zamora Belver, I., Larrañaga Lesaka, J., Zulueta Guerrero, E. Puelles Pérez, E.," Modeling of Photovoltaic Module", International Conference on Renewable Energies and Power Quality (ICREPQ'10) Granada (Spain), 23th to 25th March, 2010.