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Implementation of a High-Efficiency, High-Lifetime, and Low-Cost Converter for an Autonomous Photovoltaic Water Pumping System-A Review

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Abstract *– A new design of an efficient batteryless pumping system powered from photovoltaic panels, comprising a push–pull converter and an induction motor, is presented. Detailed evaluation of the energy processing cycle has allowed the formulation of a set of design principles and the optimization of a sensor less induction motor drive system. The resulting performance enhancement is demonstrated experimentally. These techniques differ in many aspects as: convergence speed, Simplicity, digital or analogical implementation, sensors required, cost, range of effectiveness, and in other aspects. This paper is study about high efficiency and low cost of pv water pumping system.*

Keywords*: Resistivity, Mean Free path, Pseudo Potential*

I. Introduction

Photovoltaic technology is one of the most auspicious for low-power distributed electrical generation. The steady reduction of price per peak watt over recent years and the easiness with which by adding panels the installed power can be increased are some of its striking features. Pumping is one of the most promising. Among the many applications of photovoltaic energy. Solar energy is stored, In a photovoltaic pump-storage system as potential energy in a water reservoir when sunlight is available and paid according to demand. There are few advantages in escaping the use of large banks of lead acid batteries, because they are heavy and lavish and have one- fifth of the lifespan of a photovoltaic panel. It is important, however, the efficiency of the end-to-end power conversion chain, from panels to mechanical pump, the nonexistence of batteries does not compromise. A typical arrangement of a batteryless photovoltaic pumping system is shown in Fig. 1. The system comprises the following components: 1) photovoltaic panels; 2) dc/dc converter; 3) dc/ac inverter; 4) induction motor; and 5) centrifugal pump. The strategy of an effective photovoltaic pumping system without the use of a battery bank symbolizes a significant task. It is necessary to deal with the effect of the stochastic nature of solar insolation including the nonlinear characteristics of photovoltaic panels, the voltage boost converter, and the electromechanical power conversion device on the entire energy conversion chain,. In general way, to obtain the best performance from each system component over a wide input power range it is necessary. Photovoltaic panels have need of specific control techniques to ensure operation at their maximum power point (MPP). Impedance matching concerns mean that, depending on their series/parallel configuration [1], [2] photovoltaic arrays may operate more or less efficiently . A minimum number of series connections are implemented in this paper. This means that a relatively high dc voltage gain (between six and ten) is necessary to provide the drive voltage required by the induction motor. The proposed system uses a push–pull converter and is based on the solution presented in [3]. The choice for this specific dc/dc converter topology is basically uttered by the requirement for galvanic isolation between the low- and high-voltage sides. Such obligation precludes the use of low-cost and high-efficiency converter topologies [4]. A study of how the converter topology affects the MPP tracking (MPPT) of a photovoltaic system is reported in [1] and [4].

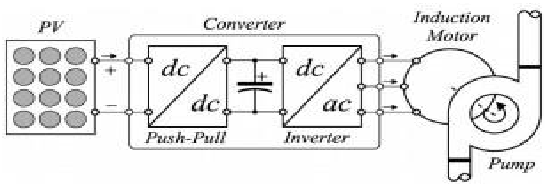

Fig:1. Components of a photovoltaic pumping system not requiring a lead-acid battery bank.

The PV system implementation takes into account the mathematical model of each component, as well as actual

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component specifications. In particular, without lack of generality, we will focus our attention on a stand-alone photovoltaic system constructed by connecting the dc/dc Single Ended Primary Inductor Converter.

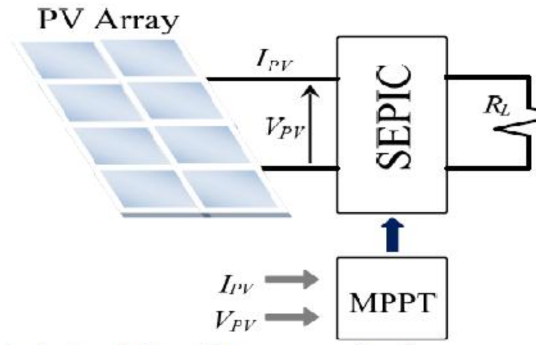

Fig:2 Stand Alone PV System

II. Literature Survey

João Victor Mapurunga Caracas, "Implementation of a High-Efficiency, High-Lifetime, and Low-Cost Converter for an Autonomous Photovoltaic Water Pumping System" In this paper, a converter for PV water pumping and treatment systems devoid of the use of storage elements was presented. To drive a three-phase induction motor The converter was deliberate directly from PV solar energy and was conceived to be a commercially viable solution having low cost, high efficiency and robustness. The standard topology of the TIBC has features like high voltage gain and low input current ripple. In this paper, it is further improved with the use of a no isolated recovery snubbed along with a hysteresis controller and the use of a constant duty cycle control to recover its efficiency. Experimental results show a peak efficiency of 91% at a rated power of 210 W for the dc/dc converter plus the three-phase VSI and a peak efficiency of 93.64% just for the dc/dc converter. The system is expected to have a high lifetime due to the inexistence of electrolytic capacitors, and the total cost of the converter is below 0.43 U$/Wp. So as a result, the system is a promising solution to be used in isolated locations and to deliver water to poor communities. This paper offered the system block diagram, control process,

and design. These experimental results shows that the proposed solution could be a viable option after more reliability tests are performed to assurance its robustness.

MontiêAlvesVitorinoetl, An Effective Induction Motor Control for Photovoltaic Pumping" This paper has valued several control strategies and optimization procedures that can be used for implementing an effective photovoltaic pumping system. The principal offerings are related to the design of the step-up converter and to the optimization of the induction motor efficiency. With respect to converter design, we have exposed that efficiency can be improved possibly when the dc-bus varies with available power. In terms of induction motor control, among the three sensors less alternatives evaluated, IFOC joined with the q-axis voltage model was the most stable at start-up. On the other hand, power factor optimization was the best solution in terms of pumping system efficiency. When using balanced current, it is not necessary to set any reference value. This results in a simpler scheme than power factor adjustment (which needs a reference value that is not easy to compute over the whole operating range). Due to the stochastic nature of sunlight. It was not possible to apply a search algorithm successfully M.A.Vitorino, "High performance photovoltaic pumping system using induction motor " in this paper Photovoltaic pumping is one of the most interesting applications for distributed energy generation. Despite that, cost still a concern, when compared with others energy resources. Therefore, efficiency improvement can be seen as one way for cost reduction. Use of maximum power point tracker allows generating more energy with the same amount of panels, which means more energy per panel. Nevertheless, the whole power processing has more than panels. It also includes converters, inverter, electrical motor, pump and batteries, which store energy for further use during solar outrage. The motive of this paper is to show how to achieve an effective photovoltaic pumping system without batteries. In this solution the role of batteries are replaced by fluid storage and, steady state operation depends on the amount of available power. Evaluations of all system devices, for each processed power level, allow concluding about their efficiency and to clarify how they can be controlled to make the whole system operates at maximum efficiency level. Experimental results help to show how a photovoltaic pumping system can be further improved in terms of efficiency.

Donghao Li "A high step-up current fed multi-resonant converter with coupled inductor" The two input filter inductors of the previously proposed current fed multi-resonant converter (CFMRC) occupy too much volume and hence restrict the power density of the converter. In this paper, an integrated magnetic structure is adopted to the CFMRC's input inductors to cut down the size, cost and loss of the CFMRC. With appropriate design, the inverse coupling of input inductors deceptively moderates the ripple of the current flowing through the inductors. Therefore, the inductance can be reduced to further decrease the cooper length and core size, and hence farther improve the power density as well as the Efficiency of the converter. The above mentioned merits are verified by a 150 W prototype with integrated input

Inductors operating at 255 kHz switching frequency, the volume of the input inductors are reduced from 25410 mm3 to 7056 mm3 after integrating, and the full load efficiency is increased from 95.4% to 95.9%.

ROBERTO FARANDA, "Energy comparison of MPPT techniques for PV Systems" This paper has presented a comparison among ten different Maximum Power Point Tracking techniques in relation to their performance and implementation costs. In particular, fourteen different types of solar insulation are considered, and the energy supplied by a complete PV array is calculated; furthermore, regarding the MPPT implementation costs, a cost comparison is proposed taking into consideration the costs of sensors, microcontroller and additional power components. A ranking of the ten methods has been proposed. Taking into account the analysis results along with hardware and computational costs, the P&Ob and ICa methods receive the best rankings.

III. Method

III.1. MPPT Control:

As acknowledged the output power characteristics of the PV system as functions of irradiance and temperature curves are nonlinear and are crucially influenced by solar irradiation and temperature. Furthermore, the daily solar irradiation diagram has abrupt variations during the day, as shown in Fig. 2. Under these conditions, the MPP of the PV array changes continuously; consequently the PV system's operating point must change to maximize the energy produced. An MPPT technique is therefore used to maintain the PV array's operating point at its MPP. There are many MPPT methods available in the literature; the most widely-used procedures are described in the following sections, starting with the modest method.

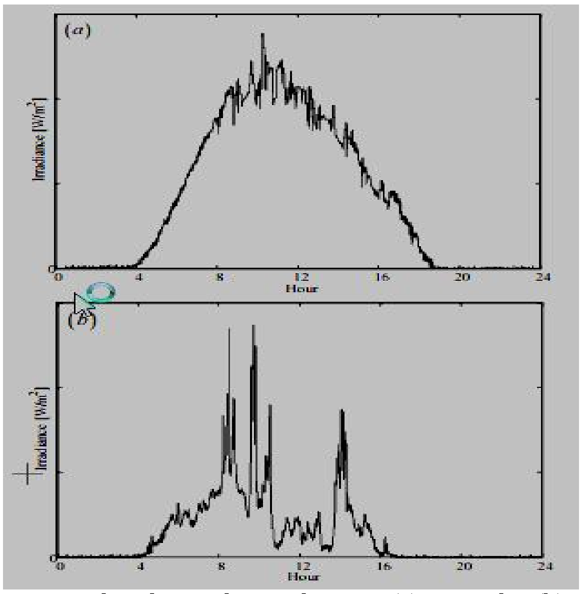

Fig.3. Daily solar irradiation diagram: (a) sunny day (b)

cloudy day.

The MPPT is a strategy, used to ensure that the operating point of the system is kept at the MPP of the PV panel .The most commonly used hill-climbing algorithm was applied due to its simple implementation and fast dynamic response. This MPPT method is can be defined by the shape of the power curve of the PV panel. This curve can be alienated into two sides, to the left and to the right of the MPP. By analyzing the power and voltage variation, one can deduce in which side of the curve the PV panel is currently operating and adjust the voltage reference to get nearer to the preferred point. To increase or reduce the motor speed the voltage reference is used on a PI controller and consequently adjusts the bus and panel voltage by varying its operating point.

III.2. Hysteresis Control:

Inability to operate with no load or even in low-load conditions is the leading drawback of the classical TIBC. Even if there is no output current, the TIBC input inductors are charged and thundery of the inductor is lately transferred to the output capacitor raising its voltage indefinitely until its breakdown. Classically, because there is no alternative path for the inductor current the input MOSFET cannot be turned off. However, with the addition of the proposed snubbed, the TIBC switches can be turned off. So that's why, a hysteresis controller can be set up based on the dc bus voltage level. Every time a maximum voltage limit is reached, indicating a low-load condition, this mode of operation begins. In this case, the switches are turned off until the dc bus voltage returns to a normal predefined level.

Constant Voltage Method

The Constant Voltage (CV) algorithm is the simplest MPPT control method. The operating point of the PV array is kept near the MPP by regulating the array voltage and matching it to a fixed reference voltage Vref. The Vref value is set equal to the VMPP of the characteristic PV module This method assumes that individual insulation and temperature variations on the array are insignificant, and that the constant reference voltage is an adequate approximation of the true MPP. Operation is therefore never exactly at the MPP and different data has to be collected for different geographical regions. The CV method does not require any input. However, measurement of the voltage VPV is necessary in order to set up the duty-cycle of the dc/dc SEPIC by PI regulator, as shown in the block diagram of Fig. 3. It is important to observe that when the PV panel is in low insulation conditions, the CV technique is more effective than either the P&O method or the IC method. Thanks to this characteristic, CV is sometime combined together with other MPPT techniques.

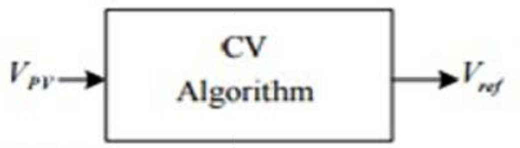

Fig.4. CV block diagram

III.3. Fixed Control:

One of the most important control aspects of this system is the fact that it is possible to use an unregulated dc output voltage and a fixed duty cycle for the first-stage dc/dc converter. As a resonant converter, there are definite time intervals in the switching period for the resonance process to occur. By altering the duty cycle or the switching period to control the output voltage, the converter may no longer operate at ZCS condition. Therefore, the fixed duty cycle is used to overcome these design problems and ensure that the converter is going to operate in ZCS condition despite the input voltage or output load. The duty cycle was chosen to guarantee that the amount of transferred energy occurs during most part of the switching interval. Therefore, it is

possible to transfer the same amount of energy with a smaller rms current. Therefore, the losses in the input inductors (*Li*1 and *Li*2), in the MOSFETs (*Q*1 and *Q*2), and in the transformer are smaller. As a result, the efficiency of the
Converter improves. Fig. 3 shows the *I–V* characteristic curves for a typical solar panel.

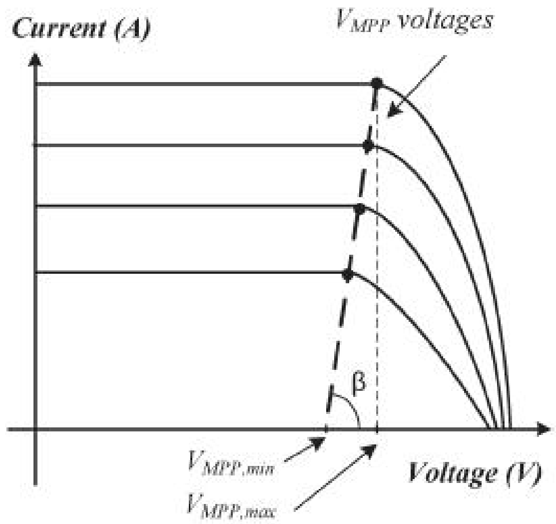

Fig5: PV I-V Characteristic Curve

IV. Conclusion

This paper is based on study of photo voltaic used in water pumping system .This papers how diverse method which is provide high efficiency and low cost. So Basically by the use of MPPT and Hysteresis technique rise life of water pumping system.

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