

ANALYSIS OF PMMT OPERATION FOR RENEWABLE (PV/FC) ENERGY SOURCE

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Summary Utilization and construction of renewable energy sources require complexity of whole system. It is considered to use a set of devices that are necessary for energy conversion, accumulation, preparation and its distribution into electrical power supply network. The way of realization should be to use the system of power converters containing DC/DC converter that is used for mentioned activities (conversion, accumulation, preparation, distribution of energy).

1. INTRODUCTION

Renewable energy sources are becoming more important in the field of back – up power supplies whereby they increase effectivity and energy purity.

Among examples, the gas turbines, recuperative machines, generators running on biomass, solar energy, barrier-layer photocell, fuel – cells, wind turbines, micro – turbines and machines with flywheel could be classified as technologies that are being used in practice.

Nowadays, most used technology is barrier-layer photocell, whose maximum power rating and therefore its utilization depends on various influenceable or non – influenceable factors.

As non – influenceable factor the weather (cloudiness), season (intensity of solar radiation) etc., should be mentioned. As influenceable factor, these factors should be mentioned: purity of protective glass, optimalization of terminal angle (ekvatorial mounting), proper external location (roof of building, field, etc.). These requirements have to be considered before barrier – layer photocell will be installed. The other influencable factor is correspondent topology of power semiconductor converter. For energy accumulation, the storage battery or supercapacitor is suitable for use. It is more favorable to use supercapacitor as energy accumulator, because it has faster energy delivery and bigger amount of supplied current from energy storage tank can be produced, in comparison with storage battery whose reaction time is slow and has limitations on the output current [1], [5], [6].

2. SYSTEM DESCRIPTION

Renewable energy power system consist of renewable energy source (barrier – layer photocell, fuel – cell...), primary DC/DC converter (pre – condition unit), DC – bus, DC/AC sinusoidal filter, high – frequency transformer (if necessary) and of induction linkage that is necessary for power network connection (Fig. 1).

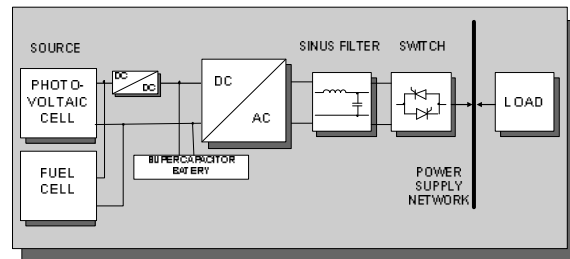


Fig. 1 Block diagram of hybrid system with PV/FC

This system configuration is able to operate in two different operation modes:

- Source that is independent on power supply network (insular operation).
- Parallel operation of power supply network and renewable energy source.

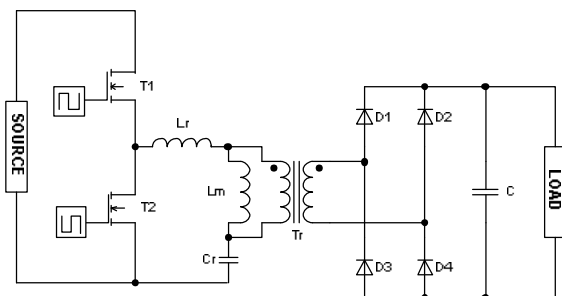


Fig. 2 Principal scheme of DC/DC converter

Characteristics (wide range of output voltage) of barrier – layer photocell determine utilization of power semiconductor converter which has to operate with wide range of input voltage. Principal schematic of mentioned device is shown on fig. 2.

3. OPTIMALIZATION OF CONTROL OVER MAXIMUM OUTPUT POWER (PMMT) OF BARRIER – LAYER PHOTOCELL

The problem of Maximum Power Point Tracking Operation (PMMT) algorithm is being concerned with researchers in rising attention for last decades.

Title of PMMT algorithm indicates that it means to find the operation point with highest efficiency at the same time with maintaining the highest quality of renewable energy source commodity through the use of power semiconductor converter. Typical characteristic of photocell voltage waveform is shown on Fig. 3. Fig. 3 shows that maximum output power of photocell is depending on solar radiation intensity and also on another variable parameters that were mentioned in chapter 1. Also the production and industrial expenses should be reduced to minimum [1], [3].

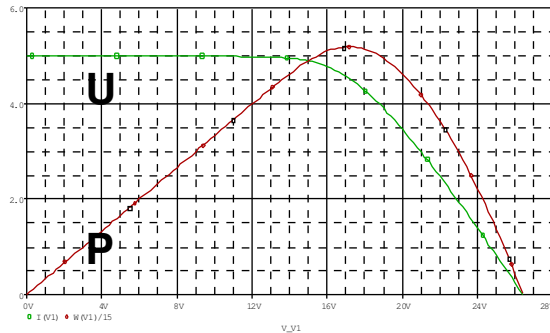


Fig. 3 Typical characteristic of photocell voltage waveform (85 W barrier-layer photocell)

Most of control algorithms are based on output power regulation. Typical waveform is shown on Fig.4. In consequence of that, the control parameter that outgoes from derivation of power on voltage (dP/dV) should be utilized. For better understanding we can use the description of algorithmic variable that is used for control of converter's operating point and is specified with next equation:

$$\frac{dP}{dU} = \frac{dP}{dt} \cdot \frac{dt}{dU} \quad (1)$$

Regulation of voltage in this manner enables to control the output power in dependence on change of voltage and power from time. Considering the photocell's input power of 85 W and efficiency of 70%, it is possible to calculate the output power as:

$$P_{out} = \eta \cdot P_{in} \quad (2)$$

$$I_{(AV)in} = \frac{P_{out}}{\eta \cdot U_{in_min}} \quad (3)$$

$$I_{(MAX)in} = \frac{P_{out}}{U_{in_min}} \quad (4)$$

Then $I_{(AV)in} = 5,83A$ a $I_{(MAX)in} = 25,6A$. This values of current are important for whole system design.

Next figures (Fig.4,5) is shown the algorithm that is mathematically and graphically explained.

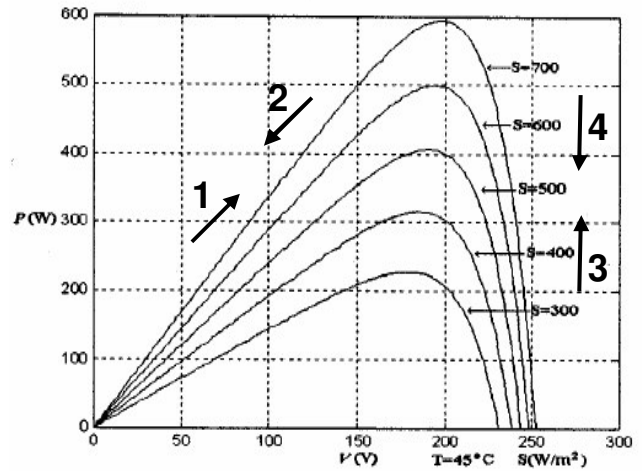


Fig. 4 Graphic interpretation of PMMT control algorithm

1	$\frac{dP}{dt} > 0$	$\frac{dV}{dt} > 0$
2	$\frac{dP}{dt} < 0$	$\frac{dV}{dt} < 0$
3	$\frac{dP}{dt} > 0$	$\frac{dV}{dt} < 0$
4	$\frac{dP}{dt} < 0$	$\frac{dV}{dt} > 0$

Fig. 5 Mathematical interpretation of PMMT control algorithm

Main algorithm could be implemented into microprocessor, which will be regulating the power in respect to voltage [3] of photocell. Also as control system the analog control should be used, the choice is dependent on efficiency of device [6].

4. CONCLUSION

System with photocell, perhaps even fuel-cell is controlled using algorithm that is tracing the point with maximum power. Specific target of research is development of system, which will avoid the shabbiness of weakest part of system, which is accumulator. Next work rests in analysis of system using OrCad Pspice, or similar simulation programs (Matlab), what is the part of dissertation thesis.

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