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Batteries for Solar Stand Alone PV Systems

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ABSTRACT:

Increase in population day by day, our electrical energy consumption also increased. Production of energy from conventional methods are not enough to meet out the demand. Because of limitedly availability of fossil fuels on the earth. To meet out the demand, we need alternate energy sources. One of the attractive and available energy in the world with free of cost are Solar energy. We can use this energy in two forms. One is heat energy and other with more potential one is photovoltaic energy. This PV energy will satisfies our future electrical demand. Storage of PV energy is essential one during the night time. Batteries are the one amongst the best storage device. In this paper we are going to discuss about various types of batteries used for solar PV.

Keywords: PV – PhotoVoltaic, DC- Direct Current, AC- Alternating Current

1. Introduction

The term "photovoltaic" means the direct conversion of light energy to electrical energy by means of photovoltaic (PV) cells. According to historical records, in 1839, A.E. Becquerel experimented with a "wet cell" and recorded the first "photo-electric" effect where the current flown out of the wet cell increased with the intensity of light shone on to the cell.

PV cells have gained popularity and high growth rate within the last decade due to several reasons compared to other renewable energy sources. Among them, low greenhouse gas emission during life time of PV systems is a significant factor for PV energy being favoured and as such giving it a larger share in energy mix in a number of European countries and the U.S [1].

Today, the industry's production of PV modules is growing at approximately 25 percent annually, and major programs in the U.S., Japan and Europe are rapidly accelerating the implementation of PV systems on buildings and interconnection to utility networks [2].

Solar energy can be used only the day time alone. To use it all time we go for storage. Generally four methods are to use for storage: batteries, fuel cells, ultra capacitors and flywheel methods. Among the all batteries are more popular type of energy storing devices. In the following section we are going to discuss about the various types batteries used for standalone solar PV systems.

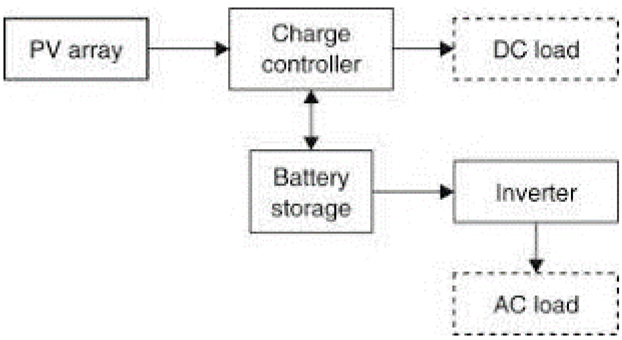

Figure. 1 Block diagram of Stand Alone Solar PV Systems

Depending on the functional and operational requirements of the system, the specific components required may include major components [3] such as a DC-AC power inverter, battery bank, system and battery controller, auxiliary energy sources and sometimes the specified electrical load (appliances). In addition, an assortment of balance of system (BOS) hardware, including wiring, overcurrent, surge protection and disconnect devices, and other power processing equipment. Figure 1 show a basic diagram of a photovoltaic system and the relationship of individual components.

The solar PV generating equipment has no moving parts, which on the whole keeps maintenance requirements to a minimum and leads to long service lifetimes. The modules themselves are typically expected to operate for about twenty years, and should not require much more than the occasional cleaning to remove deposits of dirt.

Photovoltaic power systems are generally classified according to their functional and operational requirements, their component configurations, and how the equipment is connected to other power sources and electrical loads. *The two principal classifications are grid-connected or utility-interactive systems and stand-alone systems.* Photovoltaic systems can be designed to provide DC and/or AC power service, can operate interconnected with or independent of the utility grid, and can be connected with other energy sources and energy storage systems.

2. Batteries for Solar PV

Batteries are often used in PV systems for the purpose of storing energy produced by the PV array [4] during the day, and to supply it to electrical loads as needed (during the night and periods of cloudy weather). Other reasons because batteries are used in PV systems are to operate the PV array near its maximum power point, to power electrical loads at stable voltages, and to supply surge currents to electrical loads and inverters. In most cases, a battery charge controller is used in these systems to protect the battery from overcharge and over discharge.

In stand-alone systems, the power generated by the solar panels is usually used to charge a lead-acid battery. Other types of battery such as nickel-cadmium batteries may be used, but the advantages of the lead-acid battery ensure that it is still the most popular choice. A battery is composed of individual cells; each cell in a lead-acid battery produces a voltage of about 2 Volts DC, so a 12 Volt battery needs 6 cells. The capacity of a battery is measured in Ampere-hours or Amp-hours (Ah).

Cell: The cell is the basic electrochemical unit in a battery, consisting of a set of positive and negative plates divided by separators, immersed in an electrolyte solution and enclosed in a case.

Batteries are classified as according to the usage as primary and secondary batteries. Primary batteries are the batteries to use for only one time and not to be chargeable again. But the batteries are to use for more time after recharge than it is known as secondary batteries. In this following session we are going to discuss about secondary batteries.

In PV systems, lead-acid batteries are most common as we said before, due to their wide availability in many sizes, low cost and well understood performance characteristics. In a few critical, low temperature applications nickel-cadmium cells are used, but their high initial cost limits their use in most PV systems. There is no “perfect battery” and it is the task of the PV system designer to decide which battery type is most appropriate for each application.

2.1 Lead Acid Battery:

The active materials in a battery are the raw composition materials that form the positive and negative plates, and are reactants in the electrochemical cell. The amount of active material in a battery is proportional to the capacity a battery can deliver. In lead-acid batteries, the active materials are lead dioxide (PbO_2) in the positive plates and metallic sponge lead (Pb) in the negative plates, which react with a sulphuric acid (H_2SO_4) solution during battery operation.

Lead-antimony batteries are a type of lead-acid battery which use antimony (Sb) as the primary alloying element with lead in the plate grids. Lead-antimony batteries with thick plates and robust design are generally classified as motive power or traction type batteries, are widely available and are typically used in electrically operated vehicles where deep cycle long-life performance is required.

Lead-calcium batteries are a type of lead-acid battery which use calcium (Ca) as the primary alloying element with lead in the plate grids.

Captive electrolyte batteries are another type of lead-acid battery, and as the name implies, the electrolyte is immobilized in some manner and the battery is sealed under normal operating conditions. Captive electrolyte lead-acid batteries are popular for PV applications because they are spill proof and easily transported, and they require no water additions making them ideal for remote applications were maintenance is infrequent or unavailable. However, a common failure mode for these batteries in PV systems is excessive overcharge and loss of electrolyte, which is accelerated in warm climates**.**

Gelled Batteries, initially designed for electronic instruments and consumer devices, gelled lead-acid batteries typically use lead-calcium grids. The electrolyte is 'gelled' by the addition of silicon dioxide to the electrolyte, which is then added to the battery in a warm liquid form and gels as it cools.

Absorbed Glass Mat (AGM) Batteries, another sealed, or valve regulated lead-acid battery, the electrolyte in an AGM battery is absorbed in glass mats which are sandwiched in layers between the plates. However, the electrolyte is not gelled.

Lead-acid batteries used in PV systems may be susceptible to freezing in some applications, particularly during cold winters when the batteries may not be fully charged during below average insolation periods.

2.2 Nickel-cadmium (Ni-Cad) batteries

Nickel-cadmium (Ni-Cad) batteries are secondary, or rechargeable batteries, and have several advantages over lead-acid batteries that make them attractive for use in stand-alone PV systems. These advantages include long life, low maintenance, survivability from excessive discharges, excellent low temperature capacity retention, and non-critical voltage regulation requirements. The main disadvantages of nickel- cadmium batteries are their high cost and limited availability compared to lead-acid designs.

Sintered plate nickel cadmium batteries are commonly used in electrical test equipment and consumer electronic devices. The batteries are designed by heat processing the active materials and rolling them into metallic case. The electrolyte in sintered plate nickel-cadmium batteries is immobilized, preventing leakage, allowing any orientation for installation.

Pocket Plate Ni-Cads Large nickel cadmium batteries used in remote telecommunications systems and other commercial applications are typically of a flooded design, called flooded pocket plate. Similar to flooded lead-acid designs, these batteries require periodic water additions, however, the electrolyte is an alkaline solution of potassium hydroxide, instead of a sulphuric acid solution. Advantages are, these batteries can withstand deep discharges and temperature extremes much better than lead-acid batteries, and they do not experience the 'memory effect' associated with sintered plate Ni-Cads. The main disadvantage of pocket plate nickel cadmium batteries is their high initial cost, however their long lifetimes can result in the lowest life cycle cost battery for some PV applications.

3. Conclusion

The first thing that we can see is that the only two kinds of batteries that are applied nowadays on a big scale are Lead Acid Batteries and Ni-Cd Batteries. So we have studied in more detail this two kinds of batteries. The government should have an effort to promote the use of more Ni-Cd instead of Lead Acid Batteries, because they have some high advantages, such as long life, low maintenance, survivability from excessive discharges, excellent low temperature capacity retention, and non-critical voltage regulation requirements. The main disadvantages of nickel-cadmium batteries are their high cost and limited availability compared to lead-acid designs, and that´s why governments should make an effort in this aspect. There is no “perfect battery” and it is the task of the PV system designer to decide which battery type is most appropriate for each application

References

1. M. Liserre, T. Sauter, and J.Y. Hung, “Future energy systems: integrating renewable energy sources into the smart power grid through industrial electronics,” IEEE Ind. Electron. Mag., vol. 4, no. March, pp. 18–37, 2010. DOI: 10.1109/MIE.2010.935861. 17

2. A. Chaurey, S. Deambi, Battery storage for PV power systems: An overview, Renewable energy, Vol-2, Issue-3,1992.

3. “Solar PV Electric PV Battery Photovoltaic System Component” – refer https://www.solardirect.com/archives/pv/batteries/batteries.htm

4. Dr. Colleen Spiegel, Battery Energy Storage for the PV System, 2018, https://www.fuelcellstore.com/blog-section/battery-energy-storage-for-the-pv-system