Power Production in Satellites by utilising Solar Energy using Ultra capacitors

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Abstract: **Ultracapacitor is a new way of storing electric energy eclipsing chemical batteries. Instead of storing energy electrochemically, it stores it in an electric field having a capacitance in series with an equivalent resistance. Ultracapacitors having multiple advantages over conventional batteries, including a lifetime of over 10 years, resistance to change in temperature, shock, overcharging and discharging efficiency make it elite in the field of electronics .Eco-friendly, light in weight, no maintenance and low cost brings in an idea that it could be used for power production in satellites in space. Power production being important in satellite this paper reveals a way to store energy and utilise it to optimum level. The ultracapacitors can be charged using renewable solar energy and can be used in satellites for maximum energy requirements.**

Keywords:

Terminologies used for Ultra capacitor

(i)EDLC-Electric double layer capacitor

(ii)Super capacitor

(iii) Standard oil of Ohio research centre

I.INTRODUCTION

Ultracapacitor originated in the work of Standard Oil of Ohio research centre (SOHIO) in early 1960's. Ultracapacitors have an cycle efficiency of 95% plus and lower internal resistance. Ultracapacitor being such an efficient device can be used to provide power for satellites by the energy obtained from solar source. This paper throws light on storing the energy obtained from the sun in the form of electric energy in the ultracapacitors and transmitting it to the satellites in the form of microwaves.

II. SOLAR ENERGY AND ULTRACAPACITOR

Let us take a glance at the principle and construction of ultracapacitor.

2.1.PRINCIPLE

Ultracapacitor uses two pieces of activated carbon immersed in an aqueous electrolyte solution connected across the terminals of a battery to work as a capacitor. Applying a potential across the ultracapacitor electrodes polarizes the electrolyte, with roughly half of the electrolyte molecules transferring an electron to the other half. The resulting positive and negative ions migrate via the impressed electric field to the respective electrodes. The model of conduction-band electrons in metals helps explain what happens inside the carbon when the voltage is applied. All of the involuted surface area of each electrode becomes an energy-level boundary. Just beneath the surface of the negative electrode, for example, in fig.1 conduction band occupied by a horde of roving electrons that lack the energy to escape from the surface in a similar band at the positive electrode, "holes" or "electron vacancies ",rove beneath the surface but are unable to capture electrons from outside. Here the applying potential is obtained from solar energy.

2.2.CONSTRUCTION

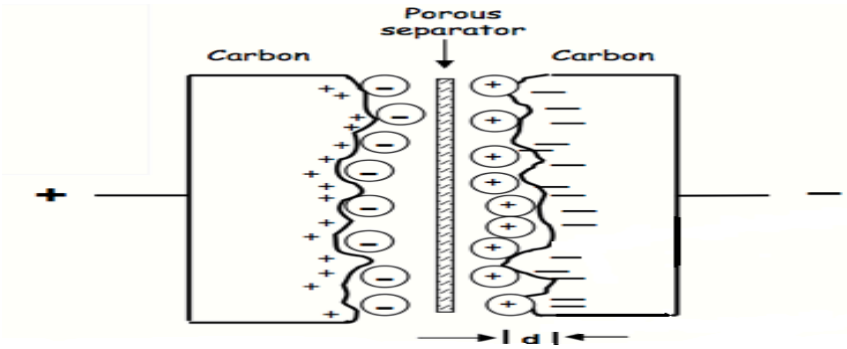

Fig.1Ultracapacitor

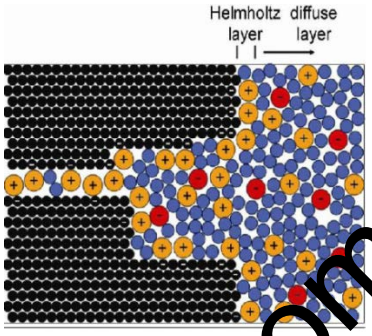

Fig.2 Basic Construction

Jelly roll assembly of two carbon electrodes with paper separator.

- Foil tab ends to aluminium collector plates
- Plates leads to can and terminal ends

The super capacitor active part is made in most of the case of two identical electrodes. There is a spacer between the electrodes, the separator which functions to provide an electronic insulation between the electrodes, while leaving the ions moving through its porosity to ensure the ionic conduction. The active part is impregnated with an electrolyte made up of a solvent containing a dissociated salt and is closed in a tight package.

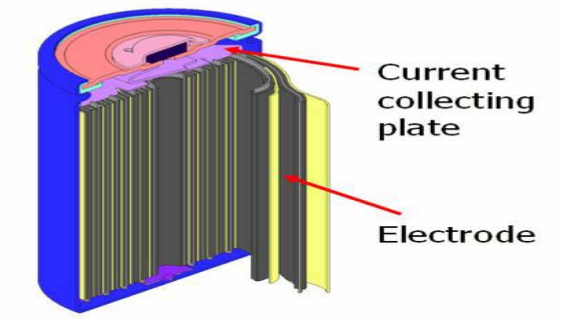

Fig.3 Solar Panels

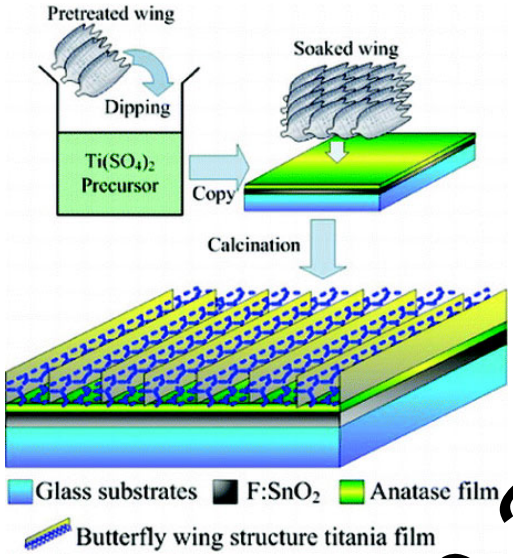

Fig.4 Butterfly wing structure

From the above fig 3, A solar panel or photovoltaic module, is composed of individual PV cells. This crystalline silicon panel has an aluminium frame and glass on the front. These solar panels are placed in areas where there is direct contact of sunlight. These panels absorb the energy from the sun and convert it to electrical energy by the use of PV cells in each panel.

SOLAR COLLECTOR

Solar panels use light energy (photons) from the Sun to generate electricity through the photovoltaic effect. The majority of modules use wafer based crystalline silicon cells or thin-film cells based on cadmium telluride.

III. ULTRA CAPACITOR STORAGE AND SATELLITE

THE ENERGY FROM THE SOLAR PANELS IS CONNECTED TO THE ULTRA-CAPACITOR WHERE IT IS STORED IN THE FORM OF ELECTRICAL ENERGY, FROM WHERE IT IS RETRIEVED FOR CONVERSION INTO MICROWAVES.

These microwaves are transmitted to the satellite for power production.

3.1. WORKING

The basic block diagram of ultra-capacitor working for satellite is shown in fig.5

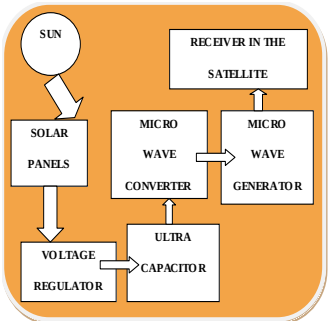

Fig.5 Block diagram of Ultracapacitors

SOLAR PANELS

Fig.6Solar energy is collected in solar panels

VOLTAGE REGULATOR

A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. It operates by comparing the actual output voltage to some internal fixed reference voltage. Any difference isamplified and used to control the regulation element in such a way as to reduce the voltage error.

ULTRACAPACITOR

The supply from the voltage regulator is connected to the suitable terminals of the ultracapacitor. EDLC's do not have a conventional dielectric rather than two separate plates separated by an intervening substance, these capacitors use "plates" that are in fact two layers of the same substrate and the electrical properties, the so-called "Electrical Double Layer".

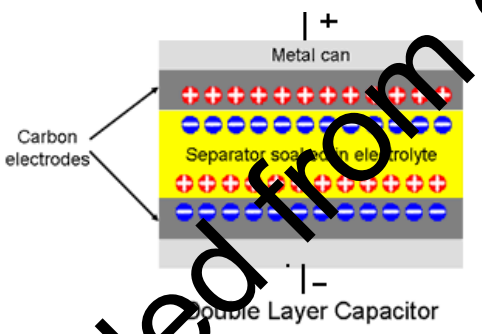

Fig. 7 Electrical double layer

From the fig.7, When positively charged electrolyte ions form a layer on the surface on the negative electrode, electrons beneath the surface pair up with them. These two layers of separated chargers, then, are a capacitor storing static charge. Similarly, at the positive electrode, holes pair up with negative ions, forming a second electronic double layer that itself is a capacitor. This molecular-scale charge-separation distance, coupled with the great surface area of the activated carbon electrodes, yields the ultracapacitors extreme storage capabilities. This stored energy is transferred to the next stage.

MICROWAVE CONVERTER

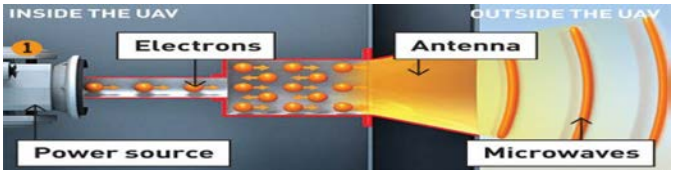

Fig.8 Conversion of Electrical Energy into Microwaves

The microwave converter resembles a cathode ray tube. It receives the energy continuously from one end and emits the generated microwaves through antennas. The above fig.8 shows the conversion of beam of electrons into microwaves by a microwave converter.

MICROWAVE TRANSMISSION

Fig.9 Microwave Transmission

A depiction of a solar satellite that could send electric energy by microwaves to a space vessel or planetary surface.Power transmission via radio waves can be made more directional, allowing longer distance power beaming, with shorter wavelengths of electromagnetic radiation, typically in the microwave range.

Wireless high power transmission using microwaves is shown in fig.9.Experiments in the tens of kilowatts have been performed at Goldstone in California in 1975 and more recently (1997) at Grand Bassin on Reunion Island. These methods achieve distances on the order of a kilometer.

POWER RECEIVING END FOR SATELLITE

Fig.10 Power Receiving End for Satellite

Thus, the transmitted microwaves are received at the receiving end of the satellite and utilized for power production is shown in the above fig.10

ADVANTAGES OF ULTRACAPACITORS

- Low cost
- Light in weight
- No maintenance
- More reliability
- Cycle efficiency is above 95%
- Low internal resistance
- Broad temperature range ($-30C^0$ to $65+C^0$)
- Higher power density, faster

CONCLUSION

This paper reveals the advantages of using ultra capacitors for storing energy and utilising it to optimum level and transmitting it to the satellite for maximum power production.

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