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Investigations on super capacitor: A Case Study

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ABSTRACT: This study presents the description about super capacitors. In this study the basic properties of capacitor mean energy storing capacity is performed. Further, on the basis this studies the other properties and application, advantages and disadvantages of super conductors in comparison to normal capacitors are described. And a conclusion is drawn on simulation results. Moreover, capacitors are also applied to supply the reactive power which in turn improves the system voltage profile. The rapid increase in the global energy consumption and the environmental impact of traditional energy resources has led to tremendously increased research activities on clean and renewable energy sources during the last decade. Super Capacitors are also known as electrochemical capacitors.

Keywords: Super Capacitors, Super Conductors, global energy consumption and system voltage profile.

I. INTRODUCTON

The basic and foremost property of capacitor is to store the charge. The charge capacitor is work as voltage source. The other function of capacitors is to supply reactive power which causes improvement in system voltage profile. This is our Case-study project and we will study about the super capacitors that are very popular for storing very high amount of energy. We will also see its working and applications. The first experiment regarding Super Capacitor was performed in 1905. The material which is applied to form electrode is porous carbon. This porous carbon electrode is used to recharge the batteries. Later in 1957 another experiment was performed by H. Becker and developed a electrode for electrolytic capacitor of same material i.e. porous carbon material which can operate at low voltage. And capacitor developed H. Becker in 1957 That is operate at low voltage and capable to store large amount of energy is known as Super Capacitor. Following are the outcome which are given as

- There is one drawback of conventional capacitor that they have limited capacity to store the energy. Therefore, it is need to develop a capacitor which can store large amount of energy. As it is observed that Super Capacitors are very much effective to store huge amount of energy is advanced device for storage of energy efficiently.
- The energy storage efficiency of devices basically depends material properties and configuration which is used to form the material.
- The advancement development in new era regarding nanotechnology has put forward to the researchers in the field of nanotechnology in order to development of new material which are capable of storing large amount of energy efficiently.

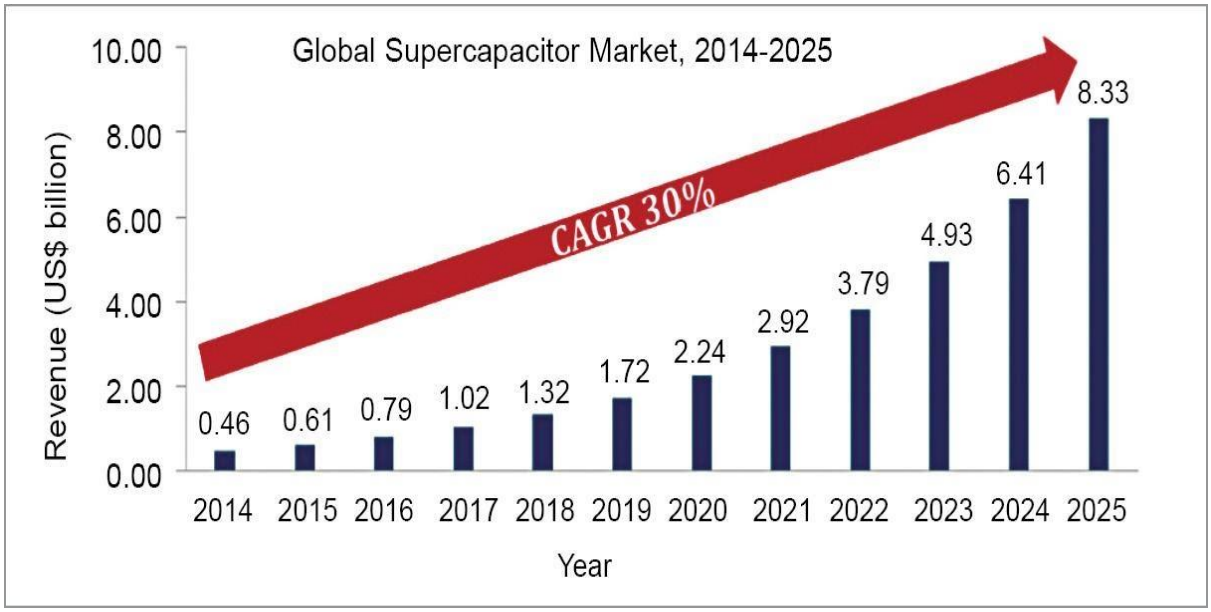

Fig. 1 Scenario of Supercapacitor for different years

II. BASICS ABOUT SUPERCAPACITORS

Similar to conventional capacitor, a supercapacitor containing two plates which are connected in isolated mode. The coating on plates is done by such material or substances which are made up of charcoal having special property i.e. known active form of charcoal. This property of charcoal has an excellent capability of high energy density. Due to this property the Super Capacitor becomes 100 times in energy storage from conventional capacitors.

- As Super Capacitor made up such material or substance having excellent capability nearly 100 times more as compare conventional capacitor that is why Super Capacitor are capable to store energy in large amount nearly 100 times more than ordinary capacitor.
- The other name of Super Capacitor is Electric Double Layer Capacitor (ELDC) or Ultra capacitor because they are made up of two-layer process.
- The available range of size of Super Capacitor is found in 100 Farad to 5K Farad.

III. CONSTRUCTION

The construction of supercapacitor comprising following steps

- The activated carbon material is applied in order to form the two metal foils. These foils are used to make electrode of Super Capacitor, this make Super Capacitors in excellent in order to store the charge.
- The short circuit is common problem which face by electrodes of Super Capacitor in order to prevent this problem of short circuit an insulator is filled in such a way that makes membrane which major cause to prevent short circuiting.
- A rectangular or cylindrical shape can which is made up of aluminum this can is used to house the foil

In practice there is very limited possibility to availability of insulating material which can able separate the electrodes. When plates of Super Capacitor, are connected to power supply the plates are charged i.e. (the electrodes are charged by +ve and –ve charged) which in turn made electric double layer this is the reason Super Capacitors are also called double capacitors.

IV. WORKING OF SUPER CAPACITORS

The composition of Super Capacitor is based on double layer process. In which no chemical reaction takes place in Super Capacitor during charging process. This is happened because the storage process of Super Capacitor is reversible it mean Super Capacitors are charged and discharged simultaneously in very short time. The Super Capacitors are capable to release energy at peak time. This energy can be stored quickly and excessive energy can be release for other purpose.

V. TYPES OF SUPER CAPACITORS

Generally, following types of Super Capacitors are found which can be used for different requirements like

i. Coin type
ii. Winding type
iii. Combined type
iv. High temperature type
v. Hybrid type

Fig. 2 Supercapacitors

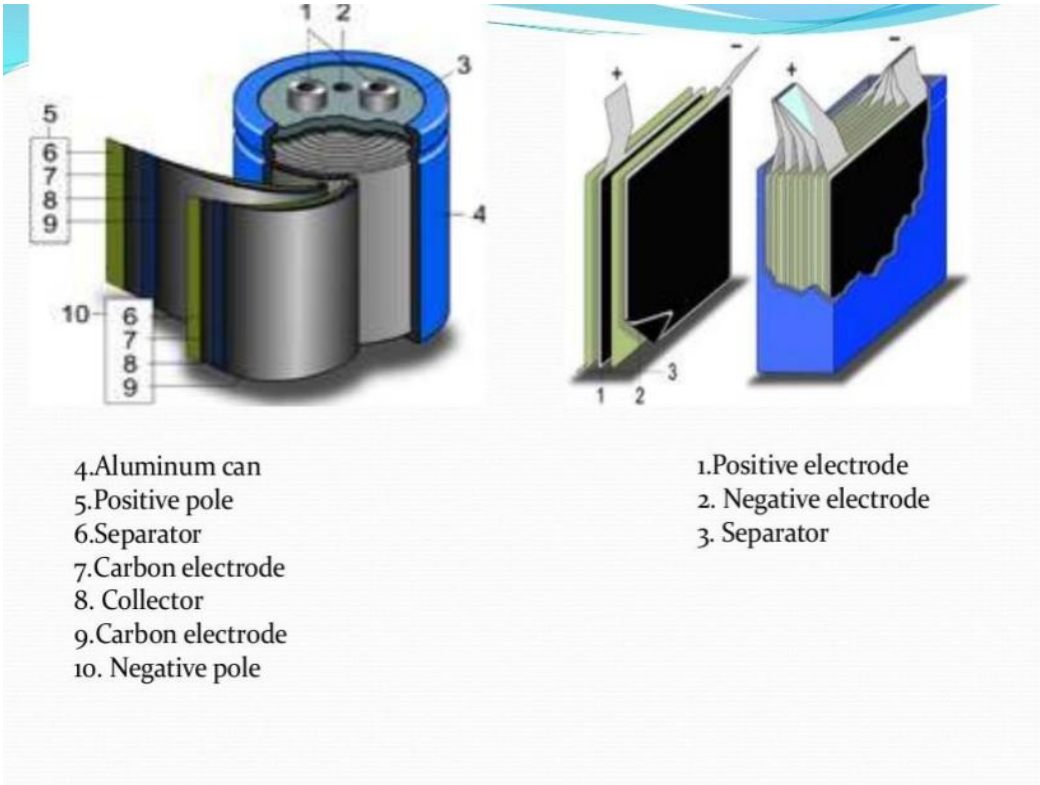

Fig. 3 Different component in Supercapacitors

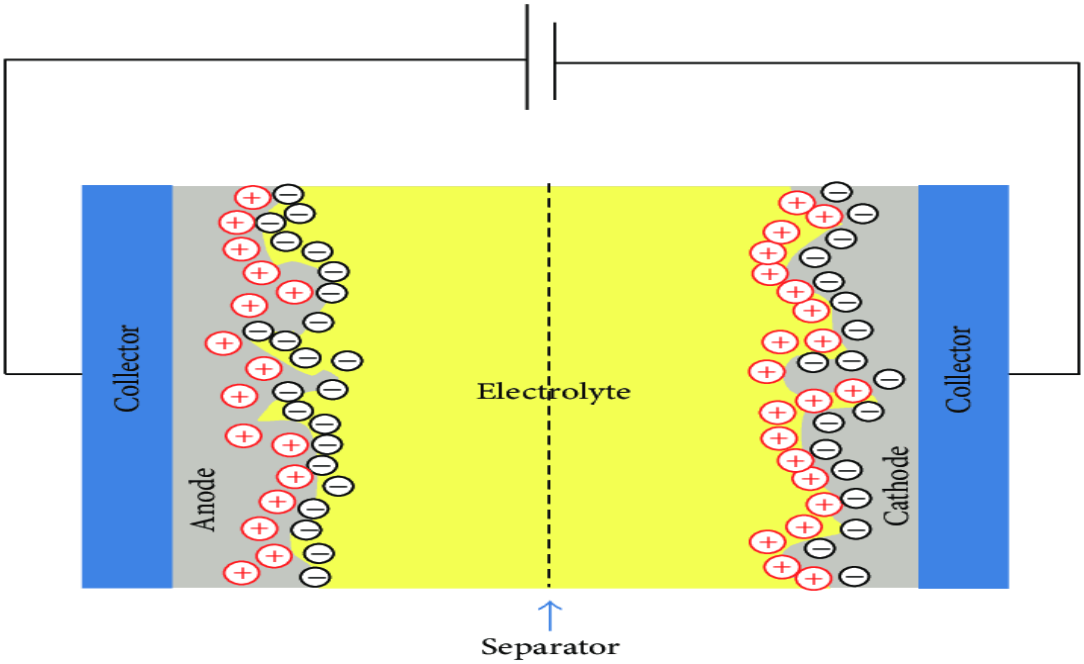

Fig. 4 Process of making of Supercapacitors

Fig. 5 The Bus operated by supercapacitor in Shanghai (Source Internet)

VI. APPLICATIONS OF SUPERCAPACITORS

There are many applications of super capacitors which are summarized as follows

- The super capacitors are widely used in startup mechanism for Automobiles Industry.
- Diesel Engine to start submarine and tank are one of the major examples of application of super capacitors.
- The new form of dielectric is recently experimented in China for testing the running of bus with stored energy not run by power lines but which is major application of Super Capacitors. The beauties of Super Capacitor which make fully charge the bus in very short time at any bus terminus. A few prototypes were being tested in Shangai in early 2005. In 2006 two commercial bus routes began to use supercapacitor buses, one of them is route 11 in Shangai.
- These capacitors are used in Backup Power System in missiles.
- The super capacitors are also used in Power source for laptops, flash in cameras.
- These capacitors are used Voltage Stabilizer.
- These capacitors are useful in Smart Gas Meter
- These can be used in Smart Electric Meter
- The Super Capacitors are useful in Smart Water Metering
- Super Capacitors are applied in Bluetooth Thermometer
- These Capacitors are useful in Smart Home Appliances
- The Smart Capacitors are very useful in making of Smart Grid
- These capacitors are useful in Telecommunications such as Internet of Things, Transformer Terminal, Distribution Terminals and Feeders Terminals
- These capacitors are useful in the process of usage Green Energy.
- Also applied as solar Energy and Solar Milling machine
- In car and automobile industry they are very useful such as Wireless car charger

In electric industry such as UPS, Automated Robots, Automated Guided Vehicle (AGV)

VII. APPLIED TECHNOLOGY FOR PROCESS OF SUPER CAPACITORS

The present section present explains the process of making of super capacitor. The following steps are involved in order to make the super capacitors

- Carbon nano tubes, carbon aero gels are applied in order make the plates or electrodes of super capacitors.
- As we know that the electrolytes are used to make capacitors. The material like Sodium Per Chlorate ($NaClO_4$) or Lithium Per Chlorate ($LiClO_4$).
- To making separator which is applied to make super capacitors. These separators are made of Polyacry Ionitric (C_3H_3N) whose thickness is varying from (0.3 nm – 0.8 nm).
- Lastly Aluminum is applied to packing its component.

VIII. ADVANTAGES OF SUPER CAPACITORS

There are many advantages of super capacitors. These advantages are summarized as follows

- The super capacitors have high capacity for energy storage.
- Power density of super capacitor is very high 102-104 Wt/kg
- There is no requirement of maintenance for super capacitor
- The range of temperature on super capacitor can withstand is more wide as compare to ordinary capacitors.
- These capacitors are Eco-friendly. Therefore, these are not harmful to environment, which in turn lead towards clean and green technology
- The charging time of these capacitor is very less as compare to ordinary capacitors.
- Operating life of super capacitor is more as compare to ordinary capacitor.
- High cycle efficiency (95%).
- High specific power up to 17 kW/Kg.
- Extremely low internal resistance.
- It is safe device in respect of using

IX. DISADVANTAGES OF SUPER CAPACITORS

- Low energy density; usually holds 1/5–1/10 of a battery.
- Cannot use the full energy spectrum for some applications.
- The voltage varies with the energy stored.
- Have high self-discharge rate.
- Individual cells have low voltages, and so serial connections are needed to obtain higher voltages.
- Require expert electronic control.
- Super Conductor cannot be used in AC and high frequency circuits.
- Cost Super Capacitor is high as compare to ordinary capacitor.

X. CONCLUSION

Supercapacitor may be used where high power or energy storage is required. Supercapacitors can be used widely because of their long life & short charging time. On the other hand it has limitations due to its high cost, self-discharge, packaging problems etc.

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