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Super charged capacitor …theory and application

By

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Abstract:

A capacitor or a condenser is generally classified into an electrostatic capacitor, an electrolytic capacitor and an electrochemical capacitor. Super capacitors merged with batteries (hybrid battery) will become the new super battery. Just about everything that is now powered by batteries will be improved by this much better energy supply. They can be made in most any size, from postage stamp to hybrid car battery pack. Their light weight and low cost make them attractive for most portable electronics and phones, as well as aircraft and automobiles.

The electrostatic capacitor includes a ceramic capacitor, a glass capacitor, a mica capacitor and so on and generally has a capacitance of approximately 1.0 to 10 μF. The electrolytic capacitor includes an aluminum electrolytic capacitor and a tantalum electrolytic capacitor. The electrolytic capacitor has a capacitance of approximately ten times the capacitance of the electrostatic capacitor. The electrochemical capacitor, which is also called a super capacitor, includes an electric double layer capacitor (EDLC), a metal oxide pseudo capacitor and a hybrid super capacitor, which have an improved capacitance of approximately 1 mF to 3000 F.
In this paper, we present's the manufacturing and different application of this type of electrical capacitors.
Image restoration, remote sensing and image blur models

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1. INTRODUCTION

A capacitor or a condenser is generally classified into an electrostatic capacitor, an electrolytic capacitor and an electrochemical capacitor. The electrostatic capacitor includes a ceramic capacitor, a glass capacitor, a mica capacitor and so on and generally has a capacitance of approximately 1.0 to 10 μF. The electrolytic capacitor includes an aluminum electrolytic capacitor and a tantalum electrolytic capacitor. The electrolytic capacitor has a capacitance of approximately ten times the capacitance of the electrostatic capacitor.
The electrochemical capacitor, which is also called a super capacitor, includes an electric double layer capacitor (EDLC), a metal oxide pseudo capacitor and a hybrid super capacitor, which have an improved capacitance of approximately 1 mF to 3000 F.

In the super electrochemical capacitor, powder-type activated carbon is mixed with carbon black that is a conductive material and the mixture is attached onto a collector to form an electrode. Here, a binder is added to the electrode to bind the activated carbon, conductive material and collector to one another. Polysaccharide and fluoride-based binders are generally used as the binder. The binder is divided into a water-soluble binder and an organic binder depending on a solvent dissolving the binder. A process of forming the electrode depends on the kind of binder.

For the purpose of fabricating the super electrochemical capacitor, a method of forming a metal collector on a carbon fiber or an activated carbon fiber to fabricate a polarizing electrode, a method of compressing carbon paste on a conductive rubber or a metal collector, and a method of coating a slurry containing activated carbon powder on a metal collector have been developed.
Figur.1 shows different types of capacitors

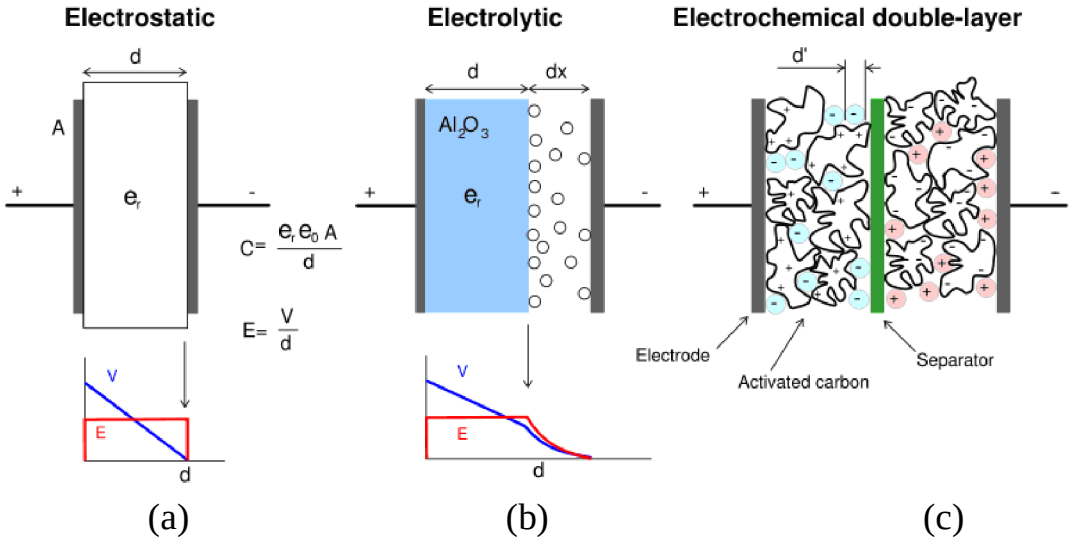


Figure.1 Different types of capacitors
(a) Electrostatic capacitor
(b) Electrolytic capacitor
(c) Electrochemical capacitor,

The electrostatic capacitor includes a two conducting plates separated by ceramic, glass, mica and any other insulting material so on and generally has a very low capacitance such as shown in FIG 1 (a)

The collector layer 12 can use a condenser grade material, polymer film, or a hetero-structure complex of both of them. The capacitor 10 is fabricated in such a manner that the collector layer 12 is interposed between the two electrode plates 11a and 11b, and the collector layer 12 and electrode plate are alternately arranged repeatedly, as shown in FIG. 1(b)

Each of the electrode plates has the collector layer 12 on both sides thereof. The stacked electrode plates and collector layers are dipped in a dielectric solution. Halogen biphenyl was generally used as the dielectric solution. However, the volume of the conventional capacitor should also be increased in order to increase the capacitance or voltage thereof because the two electrode plates of the capacitor have the same electric charge. Thus, a small-size capacitor cannot increase the electric charge and capacitance and make a usable voltage range large. Accordingly, a high-voltage super electrochemical capacitor cannot be realized. Furthermore, a small-sized capacitor having sufficient voltage and capacitance, which can comply with a technology trend toward the compact and slimness of electronic devices, could not be implemented such as shown in FIG 1 (c).

2 MATHEMATICAL MODELLING

Energy in electric field, stored in super-condenser is given by expression

$$E_{ST} = 0.5\ CV^2 \quad (1)$$

Where
E Energy in watt. Second
C Capacitance in farad
V Voltage in volt

For practical applications it is acceptable discharging on 50% voltage drop from its nominal value. Therefore for capacitor with nominal voltage v decrease on v/2level is acceptable. Therefore super- capacitor energy EST, which is under this condition to disposal, is

$$E_{ST} = 0.5\ C\ (V2 - (V/2)^2)$$
$$= 0.5\ C\ (V^2 - V^2/4)$$
$$= 3C\ V^2/8 \quad \text{Watt. Second}$$

$$C = 8E_{ST}/3V^2 \quad \text{Farad} \quad (2)$$

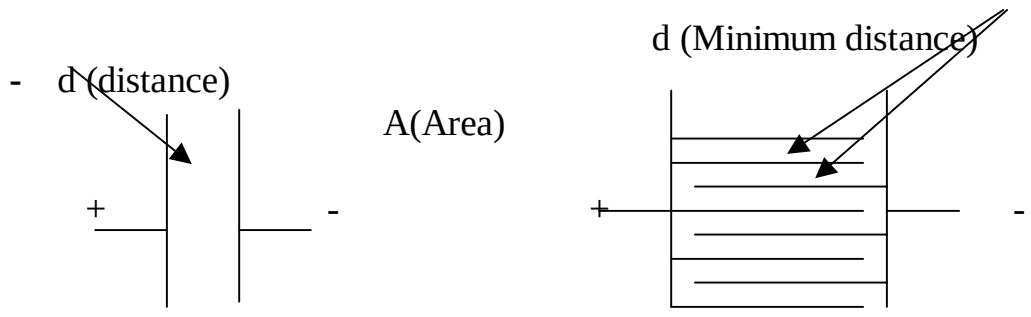
Higher capacitance is needed to have energy reserve for safe driving operation and to cover conversion and aerodynamic losses. When we shall demand 80% energy as safety reserve and when we estimate 20% energy as loses in conversions, the capacitance needed will be approximately

$$C_{EQ} = 2C = 16\ E_{ST}/3V^2 \quad \text{Farad} \quad (3)$$

This higher value of capacitance can be achieved by one of the following methods:

2.1-Super charged capacitor

As shown from figure (2)



(a) (b)

Figure (2) Super capacitor
(a) Electro static capacitor (Ordinary capacitor)
(b) Multi layer –minimum distance capacitor

The capacitance between two metal plates is equal

$$C = \varepsilon A / d \quad (4)$$

Also we can write

$$C_{EQ} = n\varepsilon A / d \quad (5)$$

Where

C Capacitance in Farad
A Area of plates in meter^2
d Distance between plates
ε Permittivity of insulator
n Number of capacitor connected parallel

By using new trend technique, distance d can be value in Angstrom A (10^- 8), so the value of capacitance should be in Farad, (super charged capacitor).

2.2 Electrolyte capacitor

As shown from figure (3)

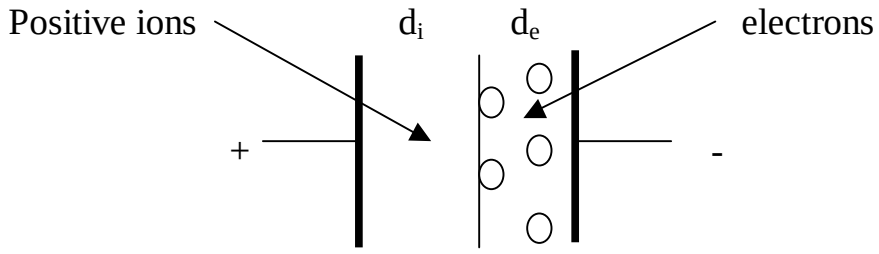


Figure (3) Electrolyte capacitor

Electrolyte capacitor consist from two charged electrode (electron, positive ions) . So stored charge should be increased Q in coulomb
However the capacitance also should be increased

According to the relation:

$$C = Q/V \quad (6)$$

Where
C Capacitance in Farad
V Voltage in volt
Q Charge in coulomb

2.3 Electrochemical capacitor, Electrical Double Layer Capacitor (EDLC).

As shown from figure (4)

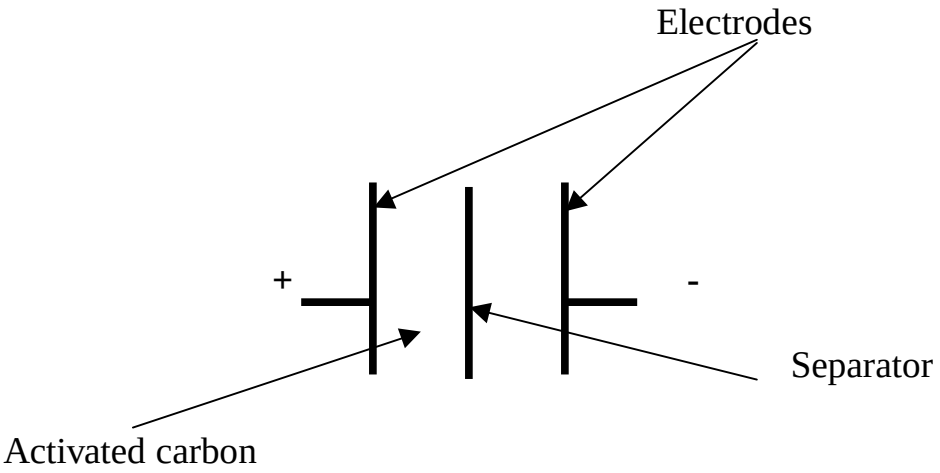


Figure (4) Electrochemical capacitor ((EDLC).

From Equation (3)

$$C_{EQ} = 2C = 16\ E_{ST} / 3V^2 \quad \text{Farad} \quad (7)$$

Electrical Double Layer Capacitor (EDLC) is an energy storage device, and it is a next-generation device with a possibility of being applied to an auxiliary power supply. EDLC has the following advantages:

- Rapid charge and rapid electric discharge are possible.
- A semi permanent life.

- Large current charge and large.
- Compared with the usual aluminum electrolytic capacitor, it has about 1 million times the capacity of ordinary capacitor

Also have the following disadvantages:

- Linear discharge voltage prevents use of the full energy spectrum
- Low energy density - typically holds one-fifth to one-tenth the energy of an electrochemical battery
- Cells have low voltages - serial connections are needed to obtain higher voltages. Voltage balancing is required if more than three capacitors are connected in series
- High self-discharge - the rate is considerably higher than that of an electrochemical battery.
- Requires sophisticated electronic control and switching equipment

3. SUPER CHARGED CAPACITOR APPLICATIONS

There are many applications for these types of capacitors such as, Electric power storage of photovoltaic's and Memory backup power supplies, Such as a notebook PC and a cellular phone. Moreover is used in (hybrid battery).

4. CONCLUSION

Theoretical model and practical calculation of super-condenser capacitance for automobile hybrid drive is now considered. Experimental verification of theoretical results on the new hybrid battery drive bench will be proved besides others. Main inters in presented model is focused on verification of energy conversion efficiency in the string: power splitter-super-condenser-traction motor.

5. REFERENCES

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