DRIVING METRO USING ON BOARD SUPER-CAPACITOR

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Abstract—— Energy can generate from most of the sources like solar, wind, hydro, coal as a fuel in plant etc. But in most there is cost problems for plant establishing, running, maintenance or availability of resources (fuels) which are going to be exhausted one day new generation of rapid transit trains requires a more effective energy management for reduction of energy consumption during the journey. In the country like INDIA where the population is growing up drastically now a day so it is necessary to control traffic in big cities of INDIA and also it is necessary to control of pollution in environment, so that's why metro is the best way to reduce traffic and also these mass transit vehicle enable large reduction in terms of emissions. But the metro train uses overhead transmission lines for running the metro, this system has a major disadvantage of complete shutdown of the system during maintenance and fault condition in the system this creates a mess in the system. So this paper suggests alternate source to drive the metro train such as in the form of super capacitor.

Keywords:- Metro, Overhead Lines, Super-Capacitor

I. INTRODUCTION

Since last few years people mobility has increased in urban areas, Implying the necessity of rapid transit improvement in terms of passenger capacity and number of journey than metro is the best option. Metro train aim to provide safe and comfortable journey to a large number of passenger in a short period of time, which make then become an important part of public transportation to relieve traffic congestion. In addition, metro can transport more passengers with less energy consumption and, thus are regarded as a green transportation mode. which compared to buses and private car services. In INDIA there are several metro cities such as Mumbai, Delhi, Kolkata, Bangalore, etc. Thousands of passengers travels daily in metro, hence metro is a good source of economy for the government. Current metro system uses the overhead transmission line to drive the metro train. This system has some disadvantages of high maintenance cost, complete shutdown of the system during maintenance and fault condition. This creates a mess in the system, there is need for a replacement of super capacitor to drive the metro train and makes system more reliable.

This replacement will bring a drastic change in the current metro system. There will be great savings in cost of maintenance of overhead lines, conductor used for construction of overhead lines, etc. This system will not be completely shut down during maintenance and fault condition, hence metro system will be more efficient. As there is great savings in this system This will effectively reduce the cost for passengers to travel in metro.

3. Super Capacitor:-

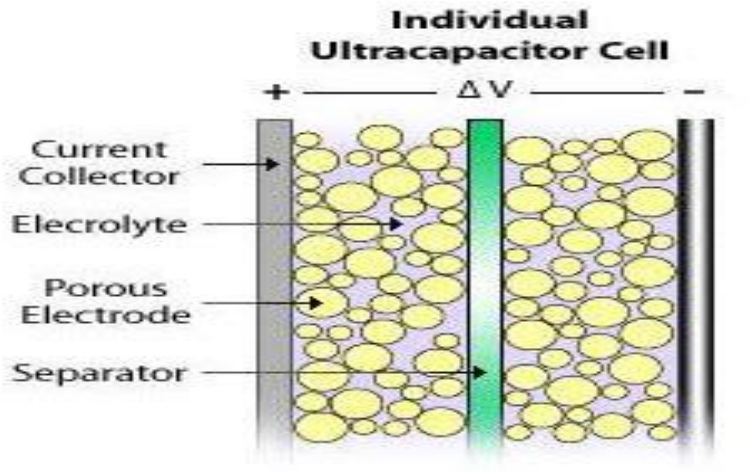
A supercapacitor is a specially designed capacitor with a very large capacity. The supercapacitors combine the characteristics of capacitors and batteries in a single device. Supercapacitors are electronic devices that store extremely large amounts of electrical charge. They are also referred to as double-layer capacitors or ultracapacitors. Instead of a conventional dielectric, supercapacitors use two mechanisms for storing electrical energy: double layer capacitance and pseudo capacitance. The double-layer capacitance is of electrostatic origin, while the pseudo-capacitance is electrochemical, which means that the supercapacitors connect the operation of the normal capacitors to the operation of a normal battery. The capacities achieved with this technology can be up to 12,000 F. By comparison, the total earth's own capacitance is only about 710 μF, more than 15 million times less than the capacity of a supercapacitor. While a typical electrostatic capacitor may have a high maximum operating voltage, the typical maximum charging voltage of a supercapacitor is between 2.5 and 2.7 volts.

The supercapacitors are polar devices, meaning they must be properly connected to the circuit just like the electrolytic capacitors. The electrical characteristics of these devices, especially their fast charging and discharging times, are very interesting for some applications where supercapacitors can completely replace the batteries.\

4.1 Construction and properties of super capacitors

The construction of the supercapacitor is similar to that of electrolytic capacitors because they consist of two sheet electrodes, an electrolyte and a sheet separator. The separator is sandwiched between the electrodes and the sheet is rolled or folded into a generally cylindrical or rectangular shape. This folded shape is placed in a casing impregnated with electrolyte and hermetically closed. The electrolyte used in the construction of the supercapacitors, as well as the electrodes, are different from those used in ordinary electrolytic capacitors.To store the electrical charge, a supercapacitor uses porous materials as spacers to store the ions in the atomic level pores. The most used material in modern supercapacitors is activated carbon. The fact that carbon is not a good insulator results in a maximum operating voltage limited to less than 3 V. Activated carbon is not the ideal material for another reason: charge carriers have a size comparable to that of pores of the material and some of them can not enter the smaller pores, resulting in reduced storage capacity.

Graphene is one of the most exciting materials used in the research of super capacitors. Graphene is a substance composed of pure carbon, arranged in a flat sheet of a single thick atom. It is extremely porous and acts as an ion "sponge". The energy densities that can be achieved using graphene in the super capacitors are comparable to the energy densities present in the batteries. However, despite the prototypes of graphene supercapacitors having been produced as proof of the concept, graphene is difficult and expensive to produce in industrial quantities.which postpones the use of this technology. Even so, graphene super capacitors are the most promising candidate for future super capacitor technology advances.



Individual Ultra Capacitor Cell Diagram

Super Capacitors also known as "Electric Double-Layer Capacitor" (EDLC) or "Ultra Capacitor". Super Capacitor will have very height capacitance values and will not have any conventional solid dielectric, instead of that an electrolyte (solid or liquid) will be used to create medium between the two electrodes this will work as a dielectric. There are three variants are there in "Super Capacitors", based on "Electrode Design".

1. Double-layer capacitors – Will have carbon electrodes
2. Pseudo Capacitors – Will have conducting polymer electrodes
3. Hybrid capacitors – Capacitors with asymmetric electrodes

These cannot be adopted for "High Frequency Circuits" or AC circuits, because its time constant wont suits for them.Super Capacitor Applications require a short duration power boost. And are extensively used in memory functions like power backup, most probablyco nsumer products like mobile phones, laptops, and radio tuners requires these super capacitors.Super Capacitors plays a crucial role for Energy Storing in "Solar Panels and Motor Starters"

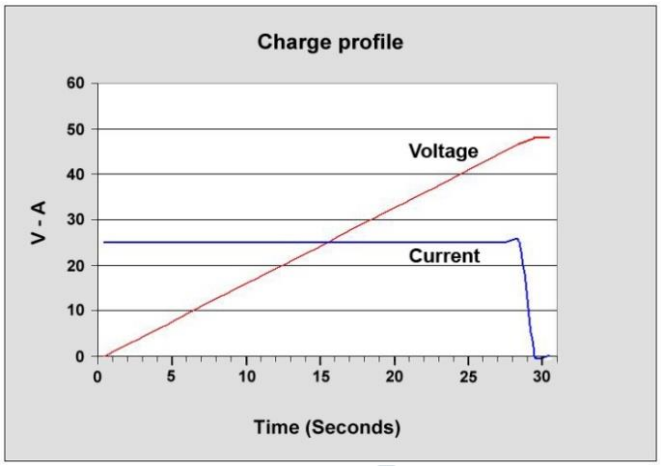
2.1 Super Capacitor As Batteries:-

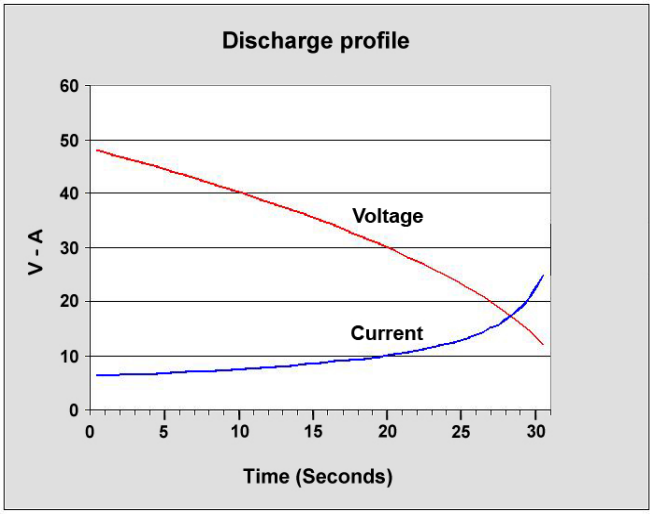
Batteries and capacitors both can do a similar job, but the way that they work is completely different. Capacitors can store electrical energy, but when it comes to discharge/usage, they discharge all of their energy in a single flash, unlike capacitors, super capacitors can store energy as well they can discharge gradually, that's how they can work like a battery without life problem, in addition to that super capacitors can be charged in seconds for many cycles. This is how the super capacitors can work like a rechargeable battery.

2.2 Sizing Of Onboard Super Capacitor For Metropolitan cities:-

The electrical energy needed by trains is transmitted at a distance from the ESS by means of overhead lines. Electric trains that collect their current from overhead lines use a device such as pantographs. The line can be supplied either in dc or in ac with different rated voltages. In case of dc supply, the traction inverter is connected directly to the line via filter capacitors; in case of ac supply, the inverter is connected by means of a rectifier. In any case, onboard supercapacitors are connected to the dc-link of the traction inverter. The traction inverter feeds two three-phase induction motors mounted on the same bogie.

2.3 Charging and Discharging time graph of super capacitor:-

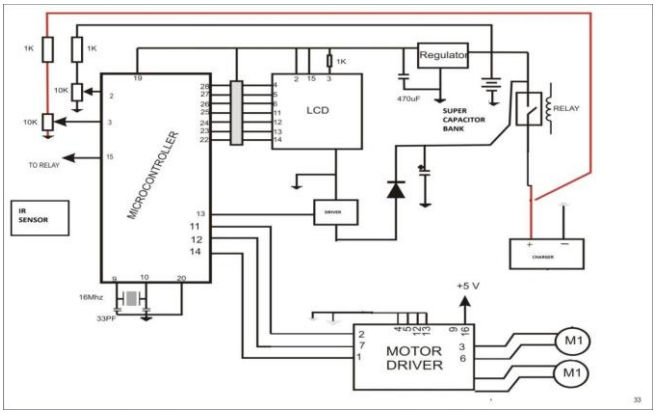




. The above graph show the charging time and discharging time graph of super capacitor. It is seen that the charging time of super capacitor is less and its discharging time is also. It is the most useful property of super capacitor. It combines the property of battery and capacitor. This unique property of super capacitor can be prove most useful property in different regions.

2.4 Use of super capacitor for running metro train:-

Super capacitor is having a combine properties of capacitor and battery both. The super capacitor has fast charging time and slow discharging time. The super capacitor is charged with the help of a pantograph. Due to its property of slow discharge it will not get fully discharged before reaching the other station. Hence it over come the limitations of capacitor for running the metro train. Hence super capacitors are more efficient for running metro train.



CIRCUIT DIAGRAM FOR RUNNING METRO WITH SUPER CAPACITOR

The above fig shows the circuit diagram of the project. Consist of microcontroller which is important part in the system, it operates whole system of metro train. It contains of motor which is operated through microcontroller. From supply it comes 230volts ac but these devices are work on12 volt so it has to be step down this voltage to 12 volt for operating whole project there are two DC motor connected across each other. This motor will move in both direction i.e. forward as well as in reverse direction.

3. Current Scenario Of Metro In INDIA:-

In INDIA the metros are running using overhead transmission lines on 25000 volt AC. These overhead lines are having several disadvantages such as the maintenance of overhead lines is very difficult, the complete system shut down during maintenance of overhead lines and during fault condition. This creates a great impact on whole system, hence to overcome this disadvantage, this paper suggests a replacement of super capacitors for the overhead lines.

4. .Expected Scenario Of Metro:-

Super capacitors behaves as a battery, they are connected in series for increasing the voltage level upto required level. By using super capacitors in metro it will help to save energy and overcome disadvantage of overhead lines. Super capacitor has a very good property of fast charging and slow discharging. Super capacitor gets discharged during travel from one station to another station on that station the super capacitors are charged again through a pantograph. Hence there is no need of overhead lines which will help to save cost required for conductors and equipments required for overhead lines. This project does not shut down the whole system during maintenance and fault condition. The only disadvantage of this system is that it makes the system bulky.

5. Methodology:-

- Super capacitors are connected in series to increase its voltage up required working voltage. They are placed on the top of train.
- The super capacitors will be charged through a pantograph, it will get fully charged within 30 to 40 seconds.
- After getting fully charged it the pantograph will come down and the train will start its movement.
- An IR sensor is connected on side of the train to detect the platform of other station. As the station comes the sensor will sense it and the train stops.
- Another IR sensor is connected in front of train sense the obstacles in front of train.

6. CONCLUSION:-

The use of on board of super capacitors unit represents a solution technically effective and feasible for the reduction of power peak demand up to 50%, with consequence reduction of line drop voltage up to 1% and recovering energy on board during braking operations up to 30%. These improvements can lead to reduction of power demand on the infrastructure allowing an increase of the distance between substations for the planned new lines and the reduction of time intervals between consecutive trains in existing lines. Moreover the onboard energy storage allows an autonomous operation, i.e. moving the vehicle to the next station in case of lost of power. Another benefit could be the additional power of super capacitors used to boost the vehicle when the catenary power is limited. However, the use of onboard super capacitors involves also disadvantages like increases of train mass by approximately 10% and the necessity of additional space to accommodate the energy storage containers.

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