

Super Capacitor Based Metro Train

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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 this metro is not completely depended on electricity means to say that here the continuous supply will be eliminated which is use to drive metro with the help of overhead line. It also eliminated overhead line and other electrical equipment required in metro train system. This paper suggests a replacement of super capacitor for running metro trains, it is a type of battery with huge size and its very bulky as this capacitor unit required some more place to install it on train so that it will give continuous supply to motor. It having one time installation cost and maintenance cost is low with last long of its life. The super capacitor based metro train is one of the best achievement in future by seeing rapid consumption of coal and other fuel in present situation.

1. 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. However, due to the large-scale operations of metro systems especially in big cities and high-frequency services, a great amount of energy is consumed for the daily operation. For example, in Beijing metro systems, there are 18 operating lines, and the passengers can on average reach 10 million per day, which could increase to 11.5 million for peak periods. The annual energy consumption is over 500 MWh. Hence, improving the energy efficiency of metro systems will be of great interest for the operation company to reduce the energy consumption. One of the most important issues in power system is energy.

Due to fossil fuel down fall, global warming and greenhouse effect which are important environmental effects of fossil fuel burning to produce energy and energy price variation, energy saving and recycling industry especially in electrical vehicles and electrical trains are very important and vital. Typically railway traction drives make use of the overhead contact lines for transferring the electrical energy from the feeding substations to the moving rail vehicles, by means of sliding current collector known as pantograph. But here this project eliminated overhead line which is very efficient way to reduce energy consumption this project use supercapacitor to drive a metro train as super-capacitor having capability to accumulate more power than any others ordinary capacitors.

In CHINA there are 14 cities with population over 10 million never before has accessible and efficient public transportation been so critical. As the china railway system continues to experience increased ridership and longer hours

of operation, the opportunity widens to employ super-capacitor power systems for grid energy efficiency and stabilization. As super-capacitor having capabilities of storing more power hence the discharge time of this capacitor is much more, so it is efficient to drive motor of the metro train. This super-capacitor also get discharge by supplying continuous energy to motors of metro train so the charging of this capacitor is necessary to give continuous and trouble-free operation of metro. The charging of this unit is done by using electric supply, and this charging port is positioned on each and every metro station to make available supply to super-capacitor for its charging. The main benefit of super-capacitor is, it take less charging time. It also uses ultra sonic sensors in the metro system in order to avoid accident and maintain the safety of passengers and vehicle. These sensors are to be found in-front of the train. These sensors be full of transmitter and receiver. When metro train engages in the braking action, the super-capacitor unit converts kinetic energy-energy that is lost in friction braking system into stored electrical energy. Unlike batteries, super capacitor rapidly charge and discharge, enabling them to capture and store energy during braking. Battery based system have limited ability to absorb energy in few second required to stop metro train.

2. SUPER CAPACITOR:-

Basically capacitors are passive devices which are capable of drawing, storing, and releasing energy, in a circuit and are possible by means of providing the potential difference to two conductors which were separated by an insulating dielectric, thus electric field will be created and electric charges will be stored. Whenever the potential difference is removed from those two electrodes and if were connected, then the stored charge or current will flow to neutralize the electric field or potential difference.

Consider capacitors as a conductor for AC and will act like an insulator in DC. Capacitors with a very high energy density can be considered as "Super Capacitors". The Simple difference between these Electrolyte Capacitor and Super Capacitor is the number of layers used. Normally capacitors use single dielectric material, whereas Super capacitors use two layers which were separated by a dielectric medium. This Electric Double Layer Capacitor Effect was identified in 1957.

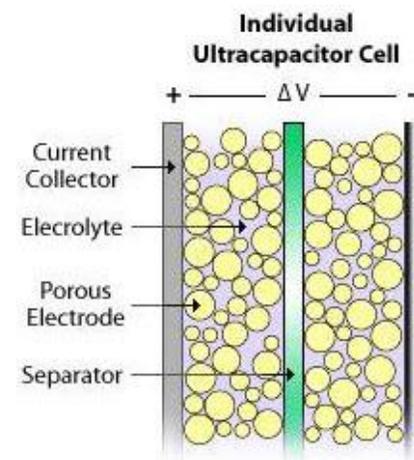
Super Capacitors also known as "Electric Double-Layer Capacitor" (EDLC) or "Ultra Capacitor". Super Capacitor will have very height capacitance values and will

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".

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

Super capacitors can store maximum energy per unit volume over capacitors, these can store up to 10000 farads/ 1.2volts, but the power density is noticeably less. This is around 10% of regular conventional batteries, this is the major cause for many number of charge and dis-charge cycles over conventional batteries.

Super Capacitors must be operated with proper polarity as they are polarized. Polarity can be controlled by design for asymmetric electrodes and will be controlled by potential applied, at the time of manufacture for symmetric electrodes.



Individual Ultra Capacitor Cell Diagram

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 probably consumer 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:-

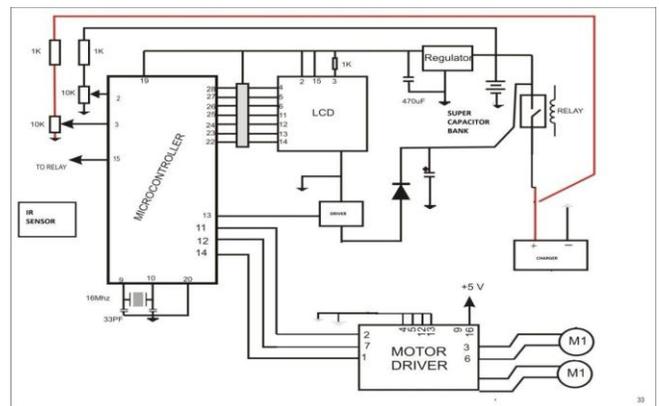
The electrical energy needed by trains is transmitted at a distance from the ESS by means of overhead lines. Electric trains that collect their current from overhead lines use a device such as pantographs. The line can be supplied either in dc or in ac with different rated voltages. In case of dc supply, 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.

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.



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 on 12 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.

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.

5. 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.

6. REFERENCES

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