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Extended Battery Life-Time Using Super Capacitor

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ABSTRACT

Reduction in conventional resources led to a very high level of reliability in the generation of renewable energy resources. For these power resources, batteries are a major storage source and battery storage projects have been the primary investment in these projects. It is therefore important to preserve them for the correct reasons. The batteries used in renewable energy systems suffer many partial or irregular charging or discharging cycles, owing to the variable characteristics of renewable generation. TIts effect is detrimental to battery life, thereby increasing the costs of project maintenance. This research requires the use of the battery supercapacitor hybrid energy storage system for an improvement in the battery life of the small wind power system. The monitoring control unit with hysteresis comparator is explained and simulation evaluates the projected long-term advantages of the proposed system. The analysis is presented with a view to potentially improving the battery life through short-term loading / unloading cycles to a super-capacitator energy storage system. This study introduces a method by which super capacitor based battery energy storage system and supervisory controller can be evaluated analyzed for an application area to be considered.

Keywords: Battery Storage, Super capacitors, Renewable Resources, Wind Power, Supervisory Controller, Battery Lifetime

I. INTRODUCTION

Rapidly increasing population, energy consumption, and the need to reduce emissions through the conventional vehicle have motivated researchers to study the electric hybrid vehicles (EHVs). In developing countries like India, China, SE Asia, etc., two-wheels are an integral part of life. The two-wheelers are similar in use and function to cars in developed countries. Traffic and road conditions are the reasons for its popularity in India for the two-wheelers (motorcycles and scooters and motorcycles): the short traffic distance, the weather, the high cost of fuel and the reduction in consumption spending power are also a major factor. As illustrated in figure 1, two-wheel distribution worldwide.

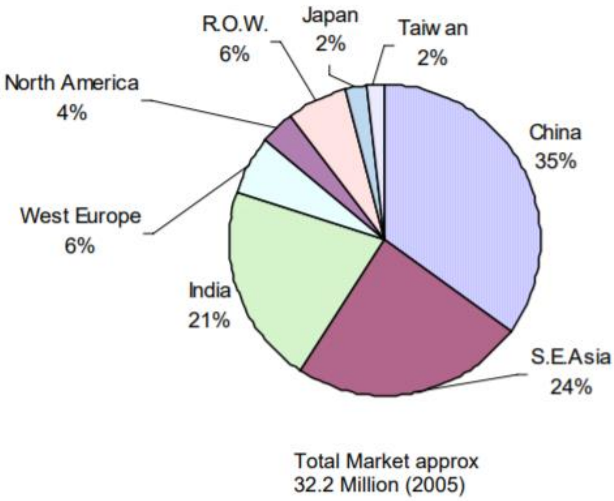

Figure 1: Worldwide Distribution of Two-Wheelers

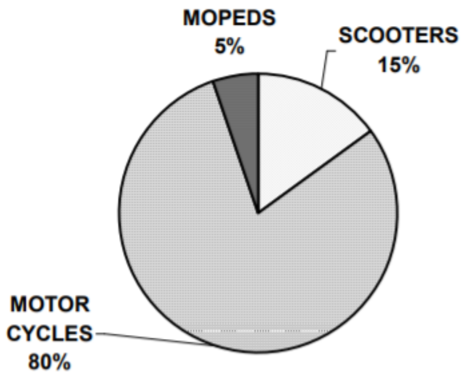

Figure 2a: Two-wheeler distribution in India

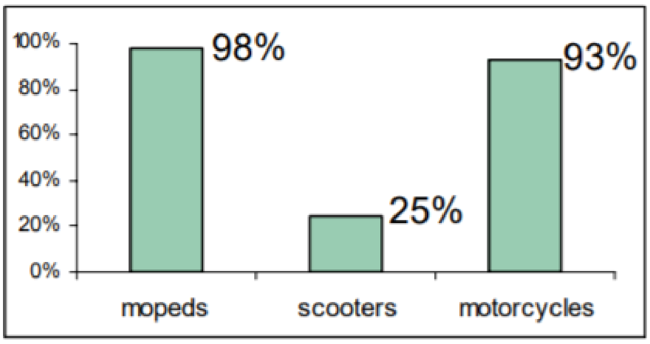

Figure 2b: Distribution of Kick Start Vehicles

Figure 2a shows the distribution of two wheels in India. [1] The Kickstart vehicle distribution between the categories in India is shown in Figure 2b. Motorcycles represent 80 % of the market and 83% of both wheels are of the Kick-Start model, indicating that lower cost is the customer's preference. With a typical two wheel kick, a battery has the function of fulfilling the charged charges as shown in Table 1:

Load	Wattage (W)	Remarks
Horn	18	Safety feature
Direction Indicator	21.7	Safety feature
Brake indicator lamp	10	Safety feature
Dash Board Neutral indicator	1.7	Indication
Total	51.4	

All of the above charges are intermittent. If we try to directly put them on Magneto, the magneto will increase in size and cost and its efficiency will decrease. This battery is therefore placed on these loads. If safety-related loads are to be functional, the battery must be kept working, at all times.

Usually, the electric hybrid vehicles architecture includes two or more energy sources with their associated energy converters as shown in Figure 3.

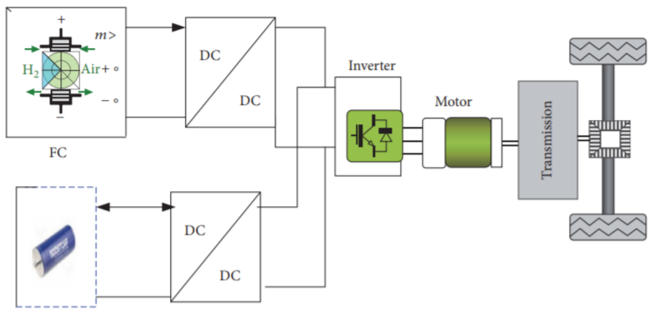

Figure 3. Electric Vehicle System

The main source is a fuel cell, with high-energy storage capability; it is the electrochemical devices that convert chemical energy of a reaction directly into electrical energy. This has slow dynamic to response under load variation and does not allow the recuperation of energy from the load. The second source is the storage system; it produces the lacking power in acceleration and absorbs excess power in braking function. Batteries and ultracapacitors are employed as energy storage system in many hybrid applications. Recently, ultracapacitors have been explored better than batteries in the electrical vehicles because they present considerably higher power densities than those of batteries, and extremely higher energy densities than those of conventional electrolytic capacitors.

Batteries have extreme difficulties in supplying power at low temperatures, whereas super capacitors perform down to −20°C. Super capacitors are thin, light and to a certain extent can be conformal. These are impressive features especially for mobile applications.

A traditional capacitor stores energy in the electric field created by charge separation. The charge separation is created by the polarisation of bound charges in the dielectric. The capacitance is proportional to the permittivity of the dielectric and the area of the plates and inversely proportional to the separation distance of the plates.

Supercapacitors have a much higher capacitance than traditional capacitors because of the large equivalent area of the plates and the small effective separation distance of the plates. One gram of the electrode material can have an equivalent area of 2000m2. The separation distance between an electrode and the layer of ions, the double layer, is in the nanometre range.

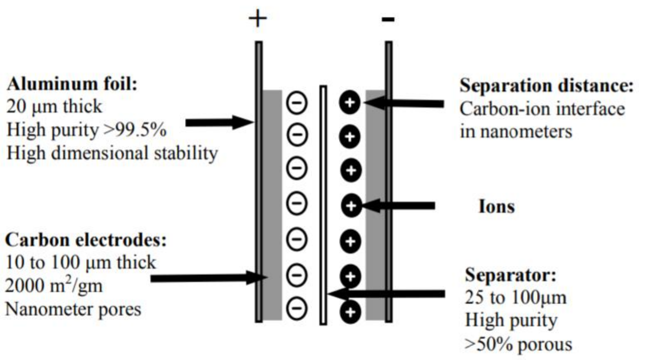

Fig. 4. A carbon double layer super capacitor

Fig. 4 shows the typical construction for one cell of a carbon double layer super capacitor. The physical construction is similar to that of a battery with two electrodes immersed in an electrolyte with a separator between them. However, unlike a battery there is no chemical energy storage. There are effectively two capacitors in series within each supercapacitor. Each has a set of plates consisting of a carbon electrode and an adjacent electrolyte with a layer of ions. The main difference compared with a traditional dielectric is that the charges are not bound, they are free to move anywhere within the electrolyte and into the pores of the carbon particles. The separator insulates the two electrodes whilst allowing the ions to pass through it. The typical maximum voltage permitted on one cell is 2.5V. This voltage determines the ESR rise rate and lifetime of the cell. The supercapacitor in fig. 3 is symmetrical. However, supercapacitors are polarised during manufacture where they are conditioned by an applied DC voltage. It is preferable not to reverse the polarity or there may be some deterioration of the device, reduced capacitance and increased ESR, and the device will have to be reconditioned.

The actual capacitance of a supercapacitor is a complicated function of voltage, current, frequency, temperature and time. There are also parasitic inductances and resistances. An adequate first order model is a series RLC. The typical impedance of a supercapacitor along with a series RLC fitted to the data. This particular supercapacitor is used in notebooks. It is rated at 12.5V and is referred to as a 2.7F/25mΩ device. The model parameters are R = 25mΩ, L = µH and C = 2.7F.

II. Literature Review

The batteries used in renewables are able to undergo a wide range of irregular, partial charging / discharge cycles because of the variables in renewable generation properties. This can also affect battery life and increase the costs of the project. Secondary lead acid batteries can be less than 1000 full-cycle long and often account for a significant proportion of renewable energy's overall cost. [1].

The purpose of this study is to develop a system to extend battery life expectancy and thereby reduce the cost of battery replacement. This could be an important advantage, especially in remote areas that are difficult and expensive to access. In contrast to secondary batteries, super condensers known to have a higher power density and a higher cycle life (around 10 ^ 5 cycles), but have a considerably lower power density, also called electronically-powered double-layer capacitors to deal with (EDLC).

Super condensers are currently used in renewable energy, power systems and transport applications as short-term power buffers or secondary energy storage systems. The combination of two or more power storage systems allows for the use of beneficial features of each device. The [3]-[7] version. The aim of this study is to use the super condenser's inherently high cycle life in a hybrid energy storage system battery / super condenser for battery life improvement.

Lijun et al have shown that the active hybridization of batteries and super capacitors can yield an improvement in the overall energy storage system power handling.[3]. It has been shown theoretically that peak power of the energy storage system can be enhanced, internal losses be reduced and discharge life of the battery be extended with the usage of ultra-capacitors. Wei et al have demonstrated that a battery-super capacitor hybrid has lower battery costs, a general increase in battery life and higher overall system efficiency.[6].

Haihua et al have proposed a composite energy storage system with both high power density and energy density for micro grid applications.[12]. One similarity between these studies and others is that the battery is used to provide the low-frequency component of total power demand whereas the super capacitor provides the short-term or highfrequency component. This has the effect of reducing transient fluctuations in the battery power profile.[8]-[11] .

The work presented here also adopts this approach, and extends previous studies by providing new results, which quantify the potential increase in battery cycle lifetime due to the addition of super capacitor energy storage, and describes a means of system implementation and analysis.

III.Implementation Details

The circuit schematic in Figure 5 represents the simple RC model for a ultra-capacitor. It is comprised of three ideal circuit elements: a series resistor Rs: it is called the equivalent series resistor (ESR) and contributes to the energy loss component of the ultra-capacitor during charging or discharging; a parallel resistor Rp: it is called the leakage resistance, and a capacitance Csc.

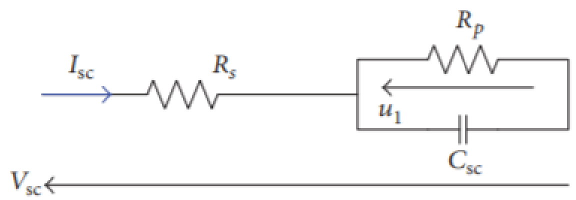

Figure 5: Classical model.

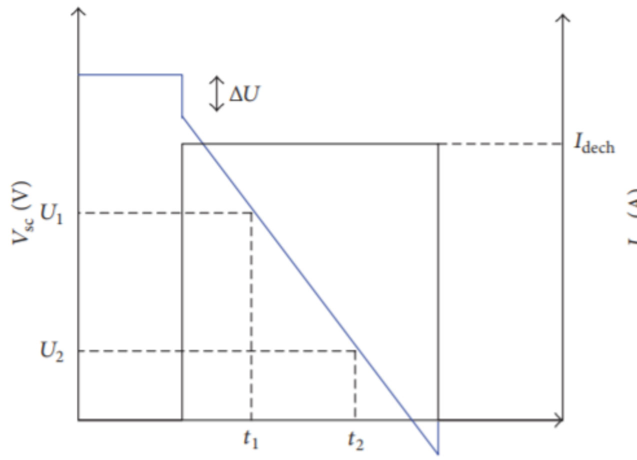

Figure 6: Evolution of voltage discharged with a constant current.

The dynamic can be described as

$$\frac{du_1(t)}{dt} = \frac{-u_1(t)}{R_p C_{sc}} + \frac{I_{sc}}{C_{sc}} \qquad (1)$$

$$V_{sc}(t) = R_s I_{sc} + u_1(t).$$

The ultracapacitor is discharged with a constant current and the result is presented in Figure 6.

The equivalent series resistor is obtained through the following equation:

$$R_s = \frac{\Delta U}{I_{\text{dech}}}, \quad (2)$$

where ΔU and Idech denote, respectively, the voltage drop which is observed at the beginning of the discharge and the discharge current. The capacitor can be expressed by

$$C_{sc} = \frac{I_{\text{dech}}(t_2 - t_1)}{U_1 - U_2}. \quad (3)$$

The parallel resistor is calculated using

$$R_p = \frac{U_1}{I_L}, \quad (4)$$

where $U1$ and IL denote, respectively, the open circuit voltage and the leakage current.

IV.CONCLUSION

On the basis of the field experiments and tests, Ultra cap as a battery replacement meets all entry-level 'Start-Kick' two-wheel drive performance requirements, while eliminating all the battery shortcomings. Without maintenance problems and the cost of periodic battery replacement, users benefit from the safety features that operate constantely throughout the vehicle lifetime. This additional value and the safety aspect justify the higher cost for the Ultra condenser over the Battery of Blei Acid. The product also contributes to the environment without lead. We called on the competent authorities now that a solution is available, to explore the possibility of law-making to ensure safety features function at all times. According to an examination of electric systems across the various car brands, BSU can replace more than 80 percent of existing Kick-Start vehicles directly without any modification.

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