AN INTELLIGENT HYBRID ELECTRIC VEHICLE CONTROL WITH BATTERY AND ULTRA CAPACITOR SYSTEM

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ABSTRACT

In the electric drive vehicles consisting of hybrid electric vehicles, electric vehicles and connect hybrid electric vehicles an advanced battery/ultra-capacitor hybrid energy storage system arrangement (HESS) is implemented. The traditional HESS strategy has a higher and efficient DC/DC converter to interconnect between the battery/DC link and ultra-capacitor to satisfy and maintain the real time peak power demand requirements. The developed design uses a much lower DC/DC converter which performs to operate and regulate energy pump to maintain the voltage of the ultra-capacitor at a larger value compare to the battery voltage for urban areas driving circumstances. The dc-dc converter is controlled by the use of sinusoidal pulse width modulation (SPWM) technique to perform the ultra-capacitor and the dc-dc converter effective manner. In this we are using SPWM technique to produce the firing pulses to the inerter and hence the generation of output voltage is produced required sufficient voltages with reduced harmonics. The battery generates power directly only when the voltage drops of the ultra-capacitor less than the required battery voltage. Consequently, a moderately steady state voltage load profile is produced for the battery. Power developed from the regenerative braking is not triggered directly, thus the battery is switched off from recurrent charges which improves the life span of the battery.

Keywords: DC/DC Converter, Battery, Hybrid Energy Storage System, Ultra Capacitor, Electric Drives Vehicles, SPWM.

I. INTRODUCTION

Electric vehicles and hybrid electric vehicles associated by hybrid electric vehicles (EVs, HEVs, and PHEVs) and they require Energy storage systems (ESS) in which batteries are the majority widely used as energy storage components. Conversely, a battery included ESS has various aspects which requires supplementary solutions. Power thickness of the battery desires to be high adequate to maintain the peak power load demand in battery included energy storage systems.

Batteries of larger power density are naturally priced much more than their lower power density inner parts. Escalating the size of battery is one of the distinctive solutions but this will enhance the cost. Thermal organization is carried for safe functioning of batteries to achieve the preferred power restrictions, to cool down the battery throughout high power load and to heat up the battery in freezing temperatures.

In addition, an issue regarding the life span of the battery is the complementary of the cells in a battery system. Without the balancing system arrangement, the personality cell voltages tend to drift separately over a particular specified period of time. Then the competence of the total pack reduces quickly during operation, ensuing in the failure of the total battery arrangement and also with very high rate of charging and discharging occurs in batteries.

In addition to these problems, applications that need immediate power input and output normally discover batteries suffering from recurrent charge and discharge modes of operations, which have an unpleasant effect on battery life span. Consequently these systems necessitate an extra energy storage system arrangement or a buffer which is very high robust in management surge current.

The above listed troubles can be minimized by using hybrid energy storage systems arrangements (HESS). The HESS consisting the batteries ultra-capacitors (UC) to achieve a better overall performance and reliability. The ultra-capacitors have a low energy density and very high power density compared to batteries. Therefore this arrangement achieves better performance in assessment to the use of either of them alone. Different configurations for HESS models have been developed, which range from simple to composite circuits.

Depended on the use of power electronic designs in the models, HESS can be confidential into two categories of passive or active. Traditional active technologies use one or much full size DC/DC Converter to interconnect the energy storage device arrangement to the DC-Inlet the full size used to the information that the DC/DC converter performs the singular path for the flow of energy in the apparatus.

In the conventional HESS methods, the battery pack is straightly connected to the DC link even though a half bridge converter is situated between the DC link and the Ultra Capacitor bank. Equally, in order to develop the power density advantage of the UC, the half bridge converter be supposed to match the necessary power level of the Uc.

Conversely the half bridge converter operating cost more. Although this design minimizes the trouble of the peak power necessities the battery still faces from persistent charge and discharge modes of operations. To solve all these difficulty an superior HESS is developed in this paper.

II. HYBRID ENERGY STORAGE SYSTEMS

Both batteries and UCs are methods of electrochemical plans. Conversely operating principles of both these arrangements are special making their distinctiveness also different. The batteries have a moderately elevated energy density of 30-200WhlKg, which differ with power density.

Excluding the UC has larger power density and less energy density. The life span of UC is much more than that of batteries and also UCs has higher and low temperature working conditions for the batteries. This distinctiveness allow for an most favorable combination in order to accomplish an improved overall efficiency.

2.1 Basic Passive Parallel

Passive paralleling is the easiest technique in which battery is collective with UC bank devoid of any power electronic converters/inverters in involving. In this scheme, since the two sources are constantly paralleled, V Bau = V uc = V oc. The UC basically performs as a low pass filter.

Compensation of this system includes ease of implementation of design, no necessities for control or luxurious power electronic converters. The main disadvantage is that it cannot successfully operate the UC stored energy.

2.2 Ultra-Capacitor/Battery Configuration

The ultra-capacitor/battery design is the majority extensively deliberate and researched HESS. Fig.2 displays the arrangement of HESS. This technique uses a power electronic bidirectional DC/DC converter which is linked to interconnect to the UC, the developed voltage of UC can be used in a large range.

However the equipment size of the bi-directional converter desires to be larger in order to control the power of the Uc. In adding, the nominal required voltage of the UC bank can be inferior. Because the battery is associated directly to the DC link, the DC link voltage cannot be speckled.

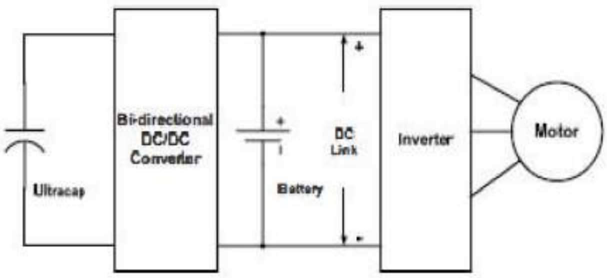

Fig 2. Ultra-Capacitor / Battery Configuration

2.3 Battery/Ultra-Capacitor Configuration

The UC and battery in the UC/battery design is different to get the battery l UC arrangement. Now the voltage of the battery can be controlled higher or lower than the UC voltage.

The UC is associated to the DC link straight which mechanism as a low pass filter. If the organize strategy practical to this technology allows the DC link voltage to differ within a specified range so that the UC energy can be more successfully used.

2.4 Cascaded Configuration

In order to give better operating assortment of the UC of the Battery/UC arrangement, an additional bi-directional DC/DC converter was supplementary between the DC link and the UC bank. This design develops a cascaded converter technology.

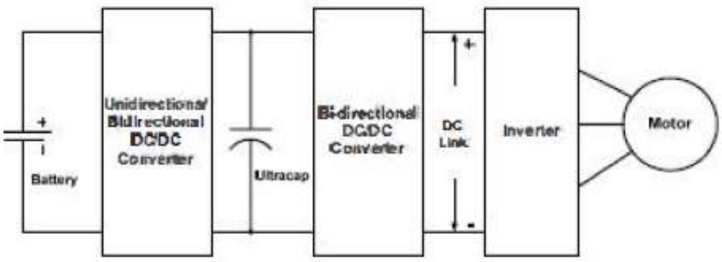

Fig. 3 Cascaded Configuration

2.5 Multiple Converter Configurations

The multiple converter scheme two converters are parallel connected the output also collected from the two converters. Below Figure gives the diagram of the multiple converter methodology. The two converters output are same as the required DC link voltage. In order to get less balancing difficulty the voltage of both the UC and the battery is maintained less than the required DC link voltage.

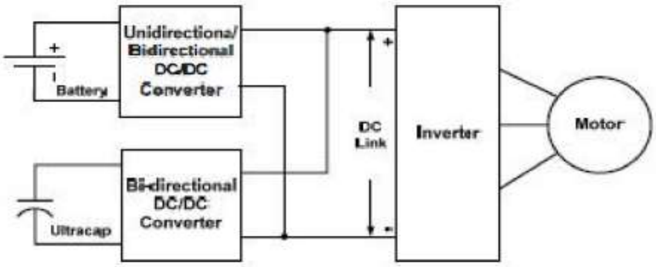

Fig.4. Multiple Converter Configuration

The voltage of the UC can be different in a broad range therefore the capacitor is fully used. The difficulty of this technique is that two full size power electronic converters are essential which enhances the cost.

2.6 Multiple Input Converter Configurations

Multiple input converter technologies are implemented in order to diminish the cost of the total system arrangement. The scheme of diagram of the multiple input converters technique.

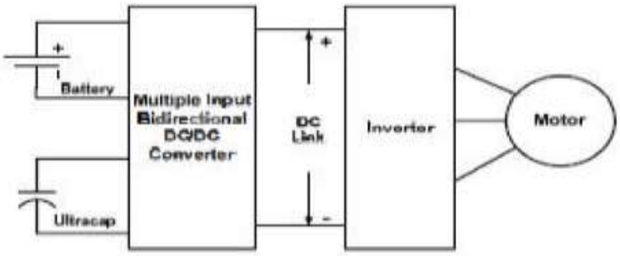

Fig.5. Multiple Input Converter Configuration

III. HYBRID ENERGY STORAGE SYSTEM DESIGN

This division explains with the basic design requirements which are preferred in the progress of battery/UC HESS technology is demonstrated in detail.

3.1 Voltage Strategy of Battery and Ultra capacitor

In implementation a battery/UC HESS, the assortment of the voltage strategy based on the distinctiveness of the battery and UCs preferred. Larger voltage capability for the energy storage device develops a higher requirement for the cell complementary circuit.

As the quantity of cells increases in series the cell cannot control the faults grow problems exponentially. One method to diminish balancing requirements is to use cells with lower performance changes. The matched presentation is produced by cycling a big group of cells and result similar cells that can be grouped collectively.

For a better coordinated performance it requires the necessity for a bigger group of cells to select from resulting in enlarge of the total cost of battery pack. Consequently, depending on the distinctiveness of the battery and UC cells, voltage cut offs between the storage battery elements require to be made. It is also obvious that that in most belongings, UCs are easier to balance with lower supplementary cost.

Technology of a HESS based on the voltage control strategy selected. In the subsequent discussion, Vuc, VBall, and VDC are considered to the voltage of the UC group, voltage of the battery set, and voltage of DC link, correspondingly. If (V uc < V Ball = VDC), it denotes that a battery pack is associated directly to the DC link and a Ultra Capacitor attached to the DC link through a DC/DC converter. The power ratting specifications of the DC/DC converter is required to match that of UC in order to fully make use of its higher power qualifications.

This voltage control strategy has an benefit to use the whole range of the UC where a minor voltage UC bank is wanted. If (V Ball < V uc = V DC), it consider to a switch in places between the battery and the UC with suggestion to the earlier method. The UC bank is linked to the DC link frankly, although the battery is connected throughout a DCDC converter. With this the voltage of the battery can be generate at lower amplitude so that less balancing problems need to be identified.

If V Batt = Vuc = VDC is maintained this means the UC and the battery are directly paralleled and linked to the DC link.

This does not need any DC/DC converter but the operating range of the UC is very less. If VBall i- Vuc i- VDC, then both the battery and UC are associated to the DC link throughout power electronic converters or other devices.

3.2 Effective Energy Utilization of Ultra-Capacitor

In order to transport 75% of the stored energy, the voltage of the UC desires to discharge to half of the preliminary voltage. The major trouble related to HESS arrangement is the capability to use the UC energy storage well. If the UC is linked to the DC bus through a DC/DC converter, then 100% of the energy can be transported theoretically. Nevertheless, in order to protect a reverse charge of disturbed cells a safety scope is permitted. 90% of the UC energy can be transported when a voltage distinction of 66% is allowable. By paralleling passively the UC and battery the voltage of the UC does not change very much. Even in a destructive discharge, the produced voltage of the battery pack can produce drop only up to 20% of the operated required voltage. The actual energy accessible is less than 36% since a margin wants to be permissible for the UC to cover superior voltage of the battery pack for the duration of charging or regenerative braking.

3.3 Protection of the Battery

The HESS develops is used to fully make use of the considerably higher power restrictions of the ultra capacitor to sustain acceleration and fully improve energy by regenerative braking. There are recurrent charging and discharging switching cycles in energy storage mechanisms in automotive impulsion applications which are usually current surge produced by irregular regenerative braking. If this surge is induced directly into a battery without controlling, the battery could die very speedily. This is particularly accurate for lithium-ion batteries. The ordinary engineering explanation for in a battery ESS to this difficulty is to give charging and discharging power restrictions to the regulator. This allows the hybrid system controller to follow power limits in order to keep the battery. The discharging power limit corresponds that no supplementary power is pinched from the battery during destructive acceleration although the charging power limits strength the hybrid regulator to make active mechanical brake before time in order to draw the portion of additional energy that cannot be collected by the battery. In a Battery/UC HESS system implemented, it is significant to make use of the much superior power limit of the UC to not only defend the battery but also amplify the in general reliability of the electric drive arrangement. UC equipment increases the energy compactness. Conversely, UC cost is motionless a major constituent of the overall HESS system charged. Power management capability of the converter is an additional vital factor that influences cost of the HESS. If a superior power DCIDC converter is desirable, this enhanced the cost. Extraordinary thermal supervision is also necessary which adds difficulty and increases total cost of the scheme.

IV. THE PROPOSED HESS

In order to convince the real time peak power difficulty of the power train regulator conservative HESS connects the UC using a DC/DC converter. It require DC/DC converter to have the similar power ability as the UC bank or at least advanced than the maximum promising demand value. The implemented HESS produced this by the feature of the averaging impression which is operated with the principle of sinusoidal pulse width modulation (SPWM) technology. In this the firing pulses are generated by the SPWM for the DC-DC converter to perform the adequate operation of the converter.

In the implemented arrangement the high voltage DC link is permissible to differ in a specified ratio. The motor drive is considered to control the current at the lower voltage. In order to give peak power load demands a superior voltage UC bank is forever straight associated to the DC link where as a poorer voltage battery is related to the DC link through a power diode. A minimized size bi-directional DC/DC converter is associated between the battery and the UC to suggest energy to allow charge the Uc. The DC/DC converter is forever regulated to try to continue the voltage of the UC larger than that of the battery. Consequently in the majority cases, the diode is invalidating biased.

V. CONCLUSION

In this paper, a new HESS development has been implemented. Compared to the conservative HESS, an advanced implementation is able to fully make use of the power capacity of the ultra-capacitors without using a corresponding power DC/DC converter.

The relative analysis gives that the developed HESS needs a lesser size DC-DC converter to suggest energy to charge the UC bank. The dc-dc converter utilizes the sinusoidal pulse width modulation control technique to perform effective response for the consumers. Multiple input converter technologies are implemented in order to diminish the cost of the total system arrangement. The scheme of diagram of the multiple input converters technique. A case revision and simulations results were approved out.

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