A Review On Power Management Optimization of An Experimental Fuel Cell(Or)Super Capacitor(Or)Battery Hybrid System

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Abstract*: In this review, a new hybrid system, which comprises of the fuel cell, battery, and supercapacitor is studied by modeling and power management design and optimization. Each device is given a specific role for the overall Optimized power management system. The operation of supercapacitor contains the peak power demand. The transient power demand, which can be controlled by the state of energy of supercapacitor, is assisted by the battery, which is controlled by the fuel cell by virtue of its slow dynamics. This study's parameters are obtained by an optimized framework, which is done by monitoring the level of hydrogen consumption, loading on battery, and quick performance required.*

Keywords: Fuel hybrid model; Super/Ultracapacitor; Power management schemes

I. INTRODUCTION

Due to the Non-Renewable fuel source is limited in this Global Environment, the World is very interested in going to a hybrid system. The basic advantage of this model is applied to the transportation system. Therefore, the so-called alternative hybrid system, which is Electric Vehicle, will be the most practical path to decrease radiation, apart from which Carbon dioxide Evolution into the environment can be minimized. This can dominantly help to control Global warming. The energy source for this hybrid model is a fuel cell; the drawback with this Fuel cell energy is it will be bounded to some particular fixed electro-mechanical feedback rate [2]. So this system will not have the capability to provide a quick start along with constant power output. To overcome this problem in the system, Super Capacitor will provide a backup supply to maintain the Load's constant output power [2].

II. VEHICLE MODEL

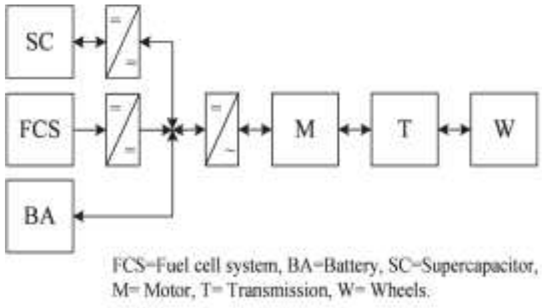

Fig:1 Representation of Supercapacitor/fuel cell Hybrid system.

We can observe that all three components are connected to the individual DC/DC converter from the schematic diagram. Primarily DC/DC bidirectional converter will contribute to Isolation (or) separation between supercapacitor and battery.

All three components are connected to the DC bus. The function of the DC bus is to feed Induction electric motor with the help of an Inverter. The coupling of wheels is done through a motor shaft, an intern connected by a mono speed line, containing a reduction gearbox. Fig: 1we can see that the DC bus's voltage and the battery are equal, due to which there will be no fluctuation in voltage. Two directional DC/DC converter can be placed between the DC bus facilitates the DC bus voltage regulation. Introducing this is advantageous because the traction motor's full power efficiency can be utilized all the time [1]. But the drawback with this network will be there is a chance of an increase in hydrogen utilization. Like the normal systems, the supercapacitor decreases excessive power consumption from the battery, which also includes providing sufficient transient power demand. So that losses in the energy system will be reduced, which ultimately leads to improvement in the system's global efficiency [3].

As we know that when the speed of the

vehicle has to be increased at a particular instant of time, in such cases, the burden will be (or) loading effect will be on battery [1]. To overcome this problem, supercapacitor is placed. By placing supercapacitor at that specified contemporary time, the battery can be protected [4].

III. POWER MANAGEMENT SCENARIO/SYSTEM

The basic advantage over fuel cell implementation is it will produce energy with The use of chemical feedback of hydrogen and oxygen so that electric vehicles can perform With high efficiency will less internal combustion of hydrogen gas[4]. Initially, there are two schemes considered to evaluate the required power output to the hybrid system. The following figures will show power management schemes.

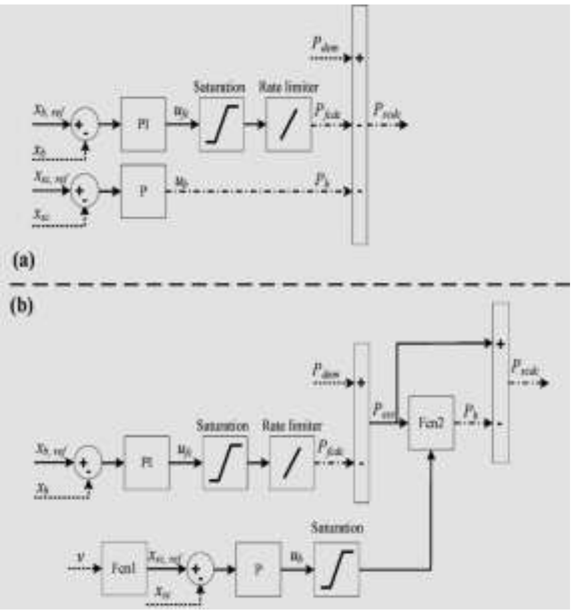

Fig: 2.Illustrative representation of power management schemes (a) Scheme1 ;(b) Scheme2

From the diagram representation shown above, two schemes are implemented to calculate the required power output.

SCHEME 1:

The battery state is controlled within a few limits references, ref 0.6 using a Proportional Integral (PI) controller. The controller output u_{fc} is given to block of saturation that fixes the control parameter between 0 and 700W. The control variable's ramp rate is limited by the rate limiter to a value ±10W/Sec.

The ref. power for the FCS DC/DC Converter is obtained from the output of the rate limiter. The state of the supercapacitor is controlled around fixed reference $x_{ac,}$ refof0.6 using a proportional controller.

$$u_{fc}(t) = K_{p,b}(X_{b,ref} - X_b(t)) + K_{i,b}\int_0^t (x_{b,ref} - x_b(T))\, dT$$

SCHEME 2:

The main difference between scheme 1 and scheme 2 is the control loop of x_{sc}. The reference state for the supercapacitor in scheme 2 is variable rather than fixed and is proportional to the square of the vehicle's speed, $V_{max}$is the maximum speed of the vehicle, that is 80Kmph and K_{ref} SC is the proportional factor. To optimally exploit energy stored in the supercapacitor and the supercapacitor is made State-Of-Energy variable. This is based on the idea that with the increase in the speed of the vehicle, the Kinetic energy increases in proportional to the square of the speed. As such, the expected regenerative breaking energy also increases.

As the amount recovered energy directly depends on the way of vehicle deceleration, a proportionality factor $k_{ref,}$ SC is used as a tuning factor as represented in the below equation. The ratio of P_b to the power required by the hybrid energy storage system is represented as U_b in scheme 2. If U_b is positive, the battery helps the supercapacitor in catering to the demand if it is positive. Another wise battery contribution is zero. if U_b is negative, the supercapacitor needs to be discharged [1]

$$X_{sc,ref}(t) = 0.6 - K_{ref,sc}\left(\frac{v(t)}{v_{max}}\right)^2$$

$$P_b(t) = \begin{cases} +u_b(t)\,P_{ess}(t) & u_b(t) > 0 \;\&\; P_{ess}(t) > 0 \\ -u_b(t)\,P_{ess}(t) & u_b(t) < 0 \;\&\; P_{ess}(t) < 0 \\ 0 & \text{otherwise} \end{cases}$$

IV. EXPERIMENTAL EVALUATION

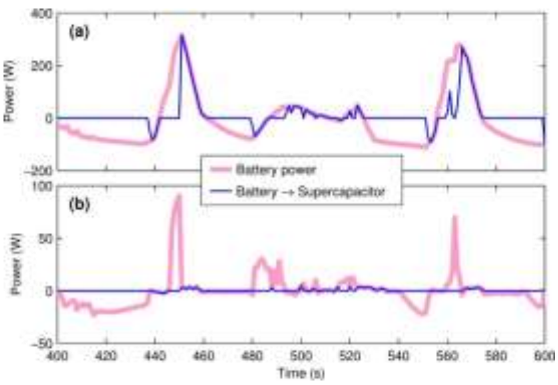

Fig: 3.This fig. represents the observation regarding power exchange between the supercapacitor and battery.

The above figure represents the battery's total power, and parts are aimed at the supercapacitor. The contribution of power can also be represented by comparing the different graphs shown above. The significance of Scheme-1 shows the exchange of Real power between Supercapacitor and battery [4]. And the directions are known to be nothing, but the battery can charge supercapacitor, and supercapacitor can charge the battery. As we discussed, that scheme-2 conclusion is the battery does not have the capacity to charge the supercapacitor and vice-versa.

V. CONCLUSION

In this work, a New optimization technique is proposed for managing the power of a fuel cell(or) Supercapacitor(or)battery hybrid system. In this work, the power management strategy is met by two control loop in a decoupled mode. One of the circles is used to maintain the energy state of the capacitor and other control energy of the battery. For power management, one of the two proposed schemes is seemed to be advantageous. In this strategy, charge exchange will be reduced between supercapacitor and battery. And in this strategy, in addition to the state of supercapacitor the demanded/required power can be consumed by the battery. I t can also contribute to other benefits: Acceleration, battery loading as well.

VI. REFERANCES

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