Hybrid Energy Sources for Hybrid Electric Vehicle Propulsion

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Abstract- *Today, an ever increasing number of issues have been emerged in half and half electric vehicles (HEV). It has been appeared none of any vitality sources can exclusively satisfy every one of the requests of HEV in certain conditions. Cross breed vitality sources end up one elective arrangement. This vitality stockpiling innovation has likewise turned out to be one pattern of HEV impetus sources as of late. In this paper, common hybridization types, the application and the future patterns about half and half vitality sources were talked about*

Keywords- HEV; Hybrid energy storage; Electric vehicle; Ultra capacitor

I. INTRODUCTION

Cross breed electric vehicles are considered as the most encouraging items in the close term. Anyway batteries that work as the optional power sources in HEV are inadmissible because of their lower explicit power. Batteries are restricted in their capacity to catch and give blasts of high power amid brief span occasions, for example, quickening, slope climbing and regenerative braking just as virus beginning, which lessens the proficiency of the half breed electric drive framework plan. Remunerating the power prerequisite by expanding the quantity of vitality stockpiling gadget will build the vehicle's cost definitely. In the meantime, the bigger charging or releasing current will influence control sources' life. So as to get wanted execution of the vehicles, ultra capacitors are seen amid HEV improvement. Since ultra capacitors have inalienably high explicit power and long cycle life for fast and profound release just as amazing low temperature conduct, are considered as progressively potential innovation equipped for improving the vitality stockpiling framework. Along these lines the advancement of ultra capacitors has as of late indicated promising application to HEV. In any case, ultra capacitor can not be utilized as the sole vitality hotspot for HEV, basically in light of the fact that its particular vitality is unreasonably low for such application. Under such foundation, a crossover vitality stockpiling framework comprising of battery and ultra capacitor, which consolidates the two preferences of two gadgets brings new essentialness for vitality stockpiling gadgets of HEV. Costumers want a vehicle claim the accompanying essential exhibitions: speeding up rate, efficiency, dimension of upkeep, wellbeing, and cost. Every one of these necessities should be upheld by an effective, quick reacting and high limit vitality stockpiling framework. Along these lines improved vitality stockpiling gadgets are a key innovation for cutting edge HEV and have increasingly more consideration everywhere throughout the world.

In this paper, for HEV application the normal hybridization types, the application and the future patterns about half breed vitality sources are broke down to give essential choosing establishment to future application.

II. MAIN PROBLEMS HEV FACES

Contrasted with unadulterated electric vehicle (EV), HEV has distinctive prerequisites for vitality sources since the driveline of these vehicles uses both inner burning motor and electric engines as drive sources. Since the motor runs monetarily at most extreme productivity areas, the yield control is steady generally. Fills (gas energizes or diesel powers) give most of vitality sources, while the battery as the auxiliary source handles top power requests for speeding up. What's more, the optional source is utilized for catching regenerative braking vitality and applying regenerative vitality for further speeding up or for the essential vitality needs of valuable electrical frameworks. The vehicles can get better unique and practical execution because of the optional source. For HEV applications, as the capacity of charging or releasing all the more frequently is required, the necessities for the vitality stockpiling is high power instead of substantial measure of vitality. The vitality put away in the HEV stockpiling unit is a lot littler than that in the EV unit. Also, the releasing cycles of the battery (around multiple times) are wanted substantially more. As a result of HEV's distinction, utilizing just batteries to give the electrical power stockpiling has downsides in the half breed application, for example,

(1) The versatility of HEV isn't adequate.

Batteries are constrained in their capacity to catch and give blasts of high power amid brief term occasions, for example, increasing speed, slope climbing and regenerative braking because of their lower explicit power.

(2) Batteries experience issues working in chilly climate.
(3) Batteries have restricted cycle lifetime under extraordinary conditions.

For HEV, batteries are charging and releasing oftentimes, which results in abbreviated battery life and surprising expense substitution all through the vehicle life.

At present, a synopsis of battery attributes for HEV applications is given in Table I [1] [2]. In this segment, the status of battery and ultra capacitor innovation is assessed. On account of batteries, the advances considered are VRLA, nickel metal hydride, lithium-particle, and zinc-air

TABLE I

KEY PARAMETERS OF HEV BATTERIES

Battery Types		Nominal Voltage(V)	Specific energy (Wh/kg)	Specific power (W/kg)	Cycle life (Cycles)	Cost (US$/kWh)
Battey	VRLA	2.0	30~50	200~300	400~600	150
	Ni-MH	1.2	40~90	200~1000	600~1200	200~350
	Li-Ion	4.0	90~150	300~1500	800~2000	1100
	Zn-air	1.4	180~230	80~140	NA[c]	90~120
Ultracapacitor		1.4~3.0	5~10	>1000	>100,000	20000
USABC Long-term battery		NA	200	400	1000	<100

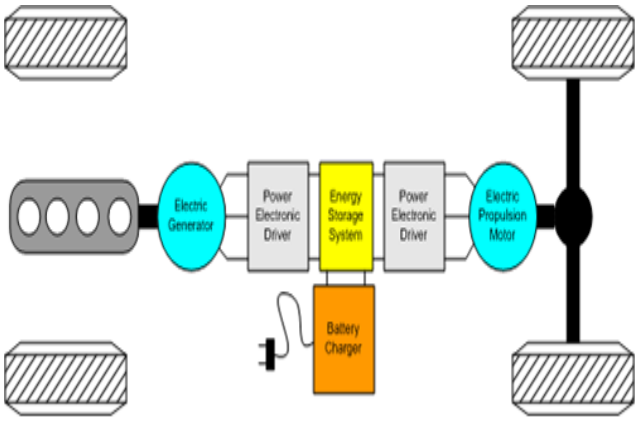


Figure-Repulsion system in electric car

From Table I, we can see that vitality sources, including both vitality stockpiling and vitality age frameworks, have a regular issue—either high explicit vitality or high explicit power, however not both. The tradeoff between explicit vitality and explicit power is a key component in upgrading batteries for specific vehicle applications.

Despite the fact that the ultra capacitor and the ultrahigh-speed flywheel are exhibited in principle to be utilized as the sole vitality hotspot for HEV, because of lower vitality thickness they can not give enough vitality to drive the electric machine for helping the principle control source—motor. To meet the vitality prerequisite, more ultra capacitor cells should be associated in arrangement even a few branches in parallel, which results in immense volume, overweight and unaccepted expense. Therefore the ultra capacitor or the ultrahigh-speed flywheel can be filled in as an associate vitality source to drive the vehicle joined with other vitality stockpiling arrangements, for example, batteries or APU frameworks for the most part.

III. TYPICAL HYBRIDIZATION TYPES

There are three conceivable kinds of hybridization among the accessible HEV vitality sources, to be specific "B+C", "B+UFLY", just as "C+UFLY" (B speaks to the battery, C speaks to the ultra capacitor and UFLY speaks to the ultrahigh-speed flywheel). These half and halves are appropriate for travel transport under complex street cycle, particularly under unpredictable urban driving conditions. Anyway right now, ultra capacitors are more costly than batteries. In certain events, for example, suburb or roadway, the vehicle portion not require quickening and slope climbing all the more regularly. It isn't important to utilize ultra-capacitors. For such case, so as to ensure long driving extent and acknowledge the regenerative vitality productively, the kind of "B+B" or "FC+B" (FC speaks to energy unit) half breed can be considered, which isn't the accentuation of this paper.

TABLE II.: TYPICAL HYBRIDIZATION TYPES

Item	Hybridization types	Main sources	Assistant sources
Near term	B+C	VRLA Ni-MH Li-Ion Zn-air	Ultra capacitor Ultra capacitor Ultra capacitor Ultra capacitor
Long term	B+UFLY	VRLA	Ultrahigh-speed flywheel
	C+UFLY	Ultra-capacitor	Ultrahigh-speed flywheel

The current common hybridization types utilized for HEV are summed up however coordinating the examination of half and half vitality sources at home and abroad, as appeared Table II.

A. B with High Specific Energy and UC Hybrid

This half breed framework has been proposed as of now in the mid nineties, however has not been put into

generation because of the multifaceted nature and, onto now, costly structure. Improvement has, be that as it may, quickened amid the previous decade.

This mix has been utilized in both EV and HEV. Yet, in contrast to unadulterated EV, the prerequisites to vitality hotspots for HEV application are control as opposed to vitality. In this way it all the more frequently shows up in mixture electric vehicles.

Lead-Acid batteries are the most widely recognized batteries being used and have the most develop innovation in vehicles today since they are economical, promptly accessible, and exceptionally solid. The essential issues existed: one is restricted explicit vitality, just 30Wh/kg, witch results in shorter driving extent when the battery is charging one time (practically 30~40 km generally). It is likewise extremely substantial and extensive. Another is short administration life, higher utilizing cost. Also, it is charging in all respects gradually and takes about 4~6 hours notwithstanding amid fast charge. Lead-corrosive batteries ought not be released underneath 80% of their evaluated limit or profundity of release (DOD). Surpassing the 80% DOD abbreviates the life of the battery [3].

Nickel-metal hydride (Ni-MH) batteries have twice explicit vitality and explicit power contrasted with lead-corrosive batteries. These batteries have been utilized effectively in delivering electric vehicles and as of late in low-volume creation HEV. A large portion of the battery controlled and cross breed vehicles tried and promoted to date (2006) have utilized Ni-MH batteries. Ni-MH batteries are reasonable for HEV application on their working standard and attributes and has been recorded as the principal decision driving batteries in the close term and mid-term. Anyway its cost is high. Albeit point of view cost can be lowed down to 150 US$/kWh, the exhaustive utilizing cost is still very

high, for instance the extensive cost is ¥45～ 70/km and the cost of the vehicle is inside ¥30,000~50,000. The primary difficulties with Ni-MH batteries likewise incorporate high self-release, consistency and warmth age at high temperatures.

Zn-air battery, energized precisely, has high vitality very nearly multiple times than that of lead-corrosive battery. At the point when utilized by and by, it has low self-release near zero and the capacity of keeping vitality for quite a while. Charging time is short. It takes twenty to two second to supplant one 20kWh Zn-air battery. What's more, with no consumption, protected and ease, it is promising for electric vehicle application. In America, Mexico, Singapore and some European nations, its tryout on mail vehicle, transport and cruiser has been found. A vehicle can improve drive extend drastically by utilizing this battery which can contend with conventional batteries. Yet, it experiences inability of tolerating regenerative vitality and low explicit power which results in low present and unwanted execution of speeding up.

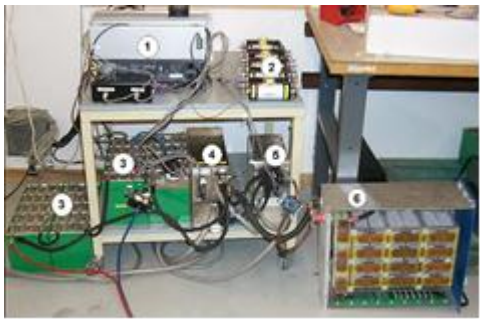
For HEV application, Ni-MH batteries, lead corrosive batteries yet in addition Zinc-air batteries have a similar issue, specifically low explicit capacity to deal with pinnacle loads. Despite the fact that Li-particle batteries have high explicit power, high vitality productivity, long lifetime, great high-temperature execution, low self-release, low memory impact and their segments are likewise recyclable, at present because of the in all respects profoundly cost and perilous issue, it is hard to actualize sooner rather than later.

Ultra capacitor, a promising innovation, has been acquainted that has the potential with improve HEV vitality stockpiling for the necessities of quick power burst, joined the two benefits of batteries and customary capacitors. For tremendous explicit power, the utilization of ultra capacitors is appealing to give abrupt vitality for start-up, increasing speed and slope - climbing. It very well may be utilized as the quickening and start-up power source just as to acknowledge prompt regenerative vitality amid braking and downhill. Undoubtedly, ultra capacitors won't totally supplant batteries in HEV plan. All things considered, their quality lies in giving high power, as opposed to high vitality. For the most part joining different batteries, the power prerequisites of HEV can be fulfilled, yet not decrease the execution of batteries. The utilization of ultra capacitors will diminish the prerequisites of releasing with incredible current to batteries. It fundamentally improves control the board in half and half electric vehicles and broadens battery life. What's more, the battery can be cut back emphatically, which results in a lighter and less exorbitant battery. Research has demonstrated that the vitality using rate of the framework can be expanded above 15% with the half breed framework comprising of "B+UC" cross breed.

Utilizing a ultra capacitor related to a battery joins the power execution of the previous with the more noteworthy vitality stockpiling ability of the last mentioned. It can broaden the life of a battery, save money on substitution and upkeep costs, and empower a battery to be cut back. In the meantime, it can increment accessible vitality by giving high pinnacle control at whatever point important. Be that as it may, the mix of ultra capacitors and batteries requires extra bi-directional DC/DC control electronic converters, which would expand the expense of the vehicle.

A half breed electric vehicle with the cross breed vitality source in term of "B+C" was created by Hyundai Motor
Organization and Seoul National University, Seoul, Korea [4], The half breed control framework comprises of batteries and ultra capacitors, utilizing lead-corrosive batteries as a principle stockpiling in charge of the consistent prerequisite of vitality and super-capacitor as an associate one, in charge of the transient interest of intensity.

In Chalmers University of Technology, Sweden, with help by Volvo Technology Corporation, a downscaled HEV drive train comprising of Ni-MH batteries, electrochemical capacitors, a DC/DC converter and an outside burden, is manufactured and tried. This recreation and tests demonstrate that the absolute load of the vitality stockpiling framework, the battery misfortunes and RMS current could be decreased altogether when batteries are joined with a bank of electrochemical capacitors. The framework is appeared in Fig.1 [5].



(b)The laboratory system used in tests: 1. Power supply 2. EC

Bank with passive balancing 3. NiMH Batteries 4. DC/DC Converter 5. Inductance for the DC/DC Converter 6. EC Bank with active balancing.

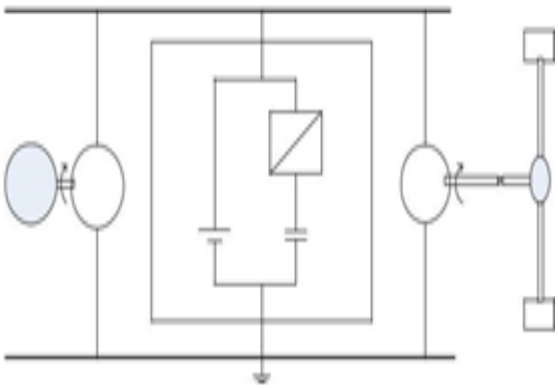
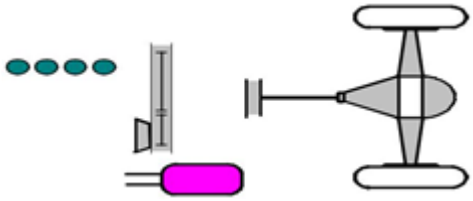


Figure 1. Hybrid energy system in Sweden Simplified drive train of an HEV

IV. CONCLUSIONS

In this paper, we likewise examine the half breed electric vehicle created by First Automobile Works (FAW), in China, appeared as Fig.3 (a). The power train setup of FAW half breed electric vehicle embraces a twofold sha parallel engineering. Fig.3 (b) demonstrates the setup of the power framework [6]. This setup embraces Ni-MH batteries as the sole vitality source, confronting a great deal of issues portrayed to some extent II. A mixture vitality stockpiling framework joining ultracapacitors was considered and examined, appeared in Fig.4. In spite of the fact that this work isn't confirmed by the genuine vehicle tests, the reenactment results demonstrate that the execution of the Ni-MH batteries has been improved in an expansive degree, particularly the present dimension and the cycle life of the batteries. Fig.5 demonstrates the examination of recreation results between the current of the sole Ni-MH batteries and that of the batteries and ultracapacitors consolidated set apart with "2" for improved cross breed vitality stockpiling framework under China urban cycle.

(a) The photo of the hybrid electric vehicle



(b) Powertrain chain with sole energy source

Figure 3. Hybrid electric vehicle in FAW

At present and sooner rather than later, customary batteries have been recognized to be the major HEV vitality source on account of their innovative development and sensible expense. Li-particle batteries, ultra - capacitors and energy units have enough respects and are promising because of their magnificent execution. Cost decrease is the essential issue for HEV innovation. Only hence, it is inconceivable that vitality stockpiling innovation utilized in HEV is substituted clear by ultracapacitors or power modules whose cost is

unsuitable from customary batteries. A progress procedure is vital. Subsequently to consolidate all benefits of batteries with high explicit vitality, power modules and ultra-capacitors to shape half and half vitality control framework, is a developing pattern for driving vitality intensity of HEV in the years future. From long perspective, with respect to ultrahigh-speed flywheel advancement, if the particular vitality levels get improvement further, it is cheerful to supplant batteries to make up of cross breed vitality stockpiling arrangement of "FC+UFLY" or "C+UFLY" .

In a word, whichever hybridization type, it shows up alongside the issues which uncovered in the electric vehicle advancement. We should choose the most suitable mix in perspective on cost, effectiveness, cycle

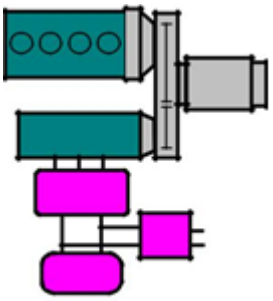


Figure 4. Improved powertrain chain with hybrid energy source

life of vitality stockpiling framework and thought process execution just as efficiency of the vehicle. For the half breed vitality stockpiling framework utilizing ultracapacitor, an extra bidirectional DC/DC converter will be required to control the vitality stream between ultracapacitors, batteries and DC-connect, in light of the fact that the working voltage of the ultracapacitor source is very low even numerous ultracapacitors have just been inside piled up. Nonetheless, how to pick successful driving topology of the converter and sensible control methodology are not included. Them two ought to merit further examination since they are one key factor deciding the execution of the mixture framework.

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