RELATIVE FUEL ECONOMY POTENTIAL OF HYBRID PASSENGER VEHICLE USING HI-PA DRIVE

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ABSTRACT

All Hybrid passenger vehicle have distant types of power sources, but this Hi-Pa drive type of transmission of power to the wheels deals with high fuel economy. This Hi-Pa Drive providing high torque in a lightweight flat motor package and is ideally suited to vehicle in wheel drives impact on suspension dynamics is minimal. The Hi-Fa Drive is powered initially by battery pack. If the battery drains its power, then the generator at front will regenerate the power to the Hi-Pa Drive. The controller and power boosters will regulates the power required to function up the Hi-Pa Drive.The aim of the project is to go beyond electric and hybrid vehicles.

INTRODUCTION

1.1 HYBRID VEHICLES

The petroleum displacement potential of a plug-in hybrid electric vehicle (PHEV). PHEV technology provides the potential to displace a significant portion of transportation petroleum consumption by using electricity for portions of trips. The primary energy carrier is the electricity generated from a diverse mix of domestic resources, including coal, nuclear, natural gas, wind, hydroelectric, and solar energy whereas the secondary energy carrier would be a chemical fuel stored on the vehicle such as gasoline, diesel, ethanol, or even hydrogen. The combination of fuel savings potential, consumer usage patterns, charging scenarios, battery life attributes, and battery costs have to be balanced and optimised to find the best low-cost solution for displacing fuel by using PHEV technology. A recently developed battery life assessment method into sets of PHEV simulations to understand the impacts of charge management scenario options and the potential to reduce battery size while providing equivalent or greater fuel savings is also presented.

1.2 HI-PA DRIVE TRANSMISSION

Hi-Pa Drive is a literal revolution in motor technology.Hi-Pa Drive is an integrated motor and drive electronics in one unit. Hi-Pa Drive is ultra high power density - 20 times more than conventional systems. Hi-Pa Drive is ultra reliable – 20 times more reliable than conventional systems, Providing high torque in a lightweight flat motor package, Hi-Pa Drive is ideally suited to vehicle in wheel drives, where its impact on suspension dynamics is minimal. The motor was incorporated into the wheel without gearing and addressed torque considerations through the use of a new high torque.

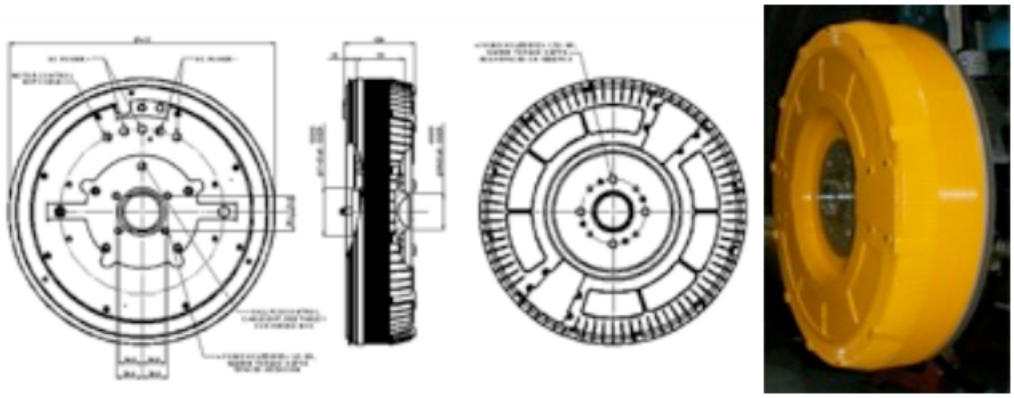

Fig.1.1 Sectional view of HI-PA Drive.

TYPES OF HI-PA DRIVE	HPD40	HPD 35	HPD 30
TORQUE(MAX)	750Nm	500Nm	350Nm
SPEED(MAX)	2000rpm	2000rpm	2000rpm
POWER	120Kw	80Kw	40Kw
MASS	25Kg	21Kg	18Kg

Table.1.1 Specification of various HI-PA Drive.

Eventually the growth in power of the gasoline engine overtook the power of the electric wheel hub motors and this made up for any losses through a transmission. As a result autos moved to gas engines with transmissions, but they were never as efficient as electric wheel hub motors.

1.3 TECHNOLOGY AND CLAIMED BENEFITS

1.In-wheel motor: The propulsion system and development platform acts as an electric motor, generator or brake and is several times lighter, smaller and powerful than the conventional electronic propulsion systems and generators it replaces.

2.Power electronics: The embedded (in the motor) control electronics reliably, efficiently and precisely manages the control of the motors to provide smooth operation when driving at any speed.

3.Energy management: The integrated power management system distributes drive power to the motor and then recaptures and feeds most of that energy back into the battery using a regenerative system.

4.Drive software: The control software helps engineers optimise energy efficiency and vehicle performance while giving drivers more control over the driving experience.

1.4 ADVANTAGES OF USING HI-PA DRIVE IN HYBRID VEHICLES

The following are the unique features of Hi-Pa Drive.

- ❖ Full regenerative braking down to very low speed.
- ❖ Full holding torque at zero speed
- ❖ Wide speed range.
- ❖ Built in brake resistor (for full charge regeneration situations).
- ❖ Hand / parking brake option available.
- ❖ Heavy duty bearing system.

1.5 LITHIUM-ION BATTERY

In hybrid and plug-in hybrid electric vehicles (PHEVs). Several battery chemistries such as nickel–metal hydride (Ni/MH) and lithium ion are either in use or being considered for use in HEVs and PHEVs. The fundamental properties of a pair of electrode materials is related to the size of a battery required for a particular application and the fraction of the capacity in the battery that can be accessed during a given driving cycle is discussed. The three main electrode properties, which include the specific capacity (in mAh/g), the magnitude of the cell equilibrium potential (in V), and the shape of the equilibrium potential, are also discussed. A simple battery model to show the relationships among the major design variables by neglecting the details of an actual battery operation is presented. The combined battery and vehicle model captures the details of the complex relationships between battery chemistry and performance. These models show that a large battery energy and maximum pulse-power capability decrease battery size and increase capacity use, but the influence of the shape of the equilibrium potential is more subtle. In the case of a cell with a flat equilibrium potential, there is no driving force for the relaxation of concentration gradients through the depth of the electrodes and the persistence of concentration gradients can reduce performance by shifting the current distribution, which results in more polarisation for consecutive charge or discharge pulses.

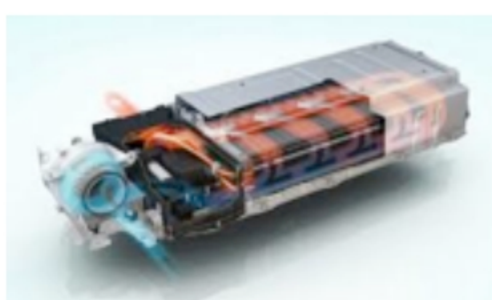

Fig.1.2 lithium-ion battery.

LITERATURE REVIEW

This chapter briefs about the PHEV hybrid vehicle design, Energy consumption, Power trains, Emissions and Batteries.

2.1 PHEV HYBRID VEHICLE DESIGN

Benjamin Geller, Casey Quinn, Thomas H. Bradley[1] concluded that plug-in hybrid electric vehicles (PHEVs) and presents a model of PHEV design to review how the PHEV design studies in literature can fit into the PHEV design model. The PHEV design process is broken up into three components including design objectives, analyses, and design attributes where objectives, analyses, and attributes for the PHEV can exist at system level, vehicle level, and subsystem level. This study investigates and summarises the design tradeoffs that exist among these three levels of the design process for a variety of the PHEV subsystems. The study finds that a majority of PHEV studies to date have used vehicle-level design objectives to guide the design process and system level design attributes can be achieved only by including system-level design objectives and analyses directly into the PHEV design process. It also finds that designs of PHEVs are characterised by strong connections between the characteristics of the vehicles at the subsystem level and the design attributes at the vehicle and system levels. Several case studies are also presented to show how PHEV designers have found compromises among these design tradeoffs to achieve a set of design objectives. Some case studies demonstrate that subsystem-level design objectives can limit design space and thus restricting optimization toward system-level attributes whereas others demonstrate how system-level design objectives may lead a PHEV designer to compromise vehicle-level performance in pursuit of optimised system-level performance.

2.2 ENERGY CONSUMPTION AND EMISSIONS

Carla Silva, , **Tiago Farias [2]** evaluated the energy consumption, emissions, and costs of plug-in hybrid vehicles (PHEVs) and presents a broader methodology of fuel consumption (FC) and emissions determination that can be applied according to US, European, and Japanese legislations. The various factors that affect PHEV FC and emissions are manufacturer power-train management, charging frequency, driving cycle and energy source (fuel and electricity) well-to-tank life cycle. The Society of Automotive Engineers (SAE) J1711 Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles used for US light-duty vehicle technology comparison studies, including PHEVs and HEVs, is described and the disadvantages of the methodology are pointed out. A different methodology based on SAE J1711 is proposed and applied to two PHEVs in US, European, and Japanese driving cycles. CO_2 total emissions are estimated for both fuel life cycle and cradle-to-grave materials cycle and, based on the electricity consumption, the impact of these vehicles on the electric grid and the cost assessment on production and use such as maintenance and fuel price is estimated. The CO_2 impact is maximum for the European cycle as the PHEV is always in CS operation mode, with the battery never recharged.

2.3 LITHIUM-ION BATTERIES FOR PHEV

The usage of lithium-ion batteries are risk factors but they can be handled with certain safety measures as **Ashish Arora , Noshirwan K. Medora, Thomas Livernois , Jan Swart [3]** says the safety concerns related to the use of Lithium–ion (Li–ion) batteries in hybrid vehicles. Lithium–ion (Li–ion) technology as an energy storage chemistry for hybrid and electric vehicles is developing rapidly, although presently the chemistry of choice in commercially available hybrid vehicles is still nickel metal hydride (NiMH). The consequences of a failure in a Li–ion battery tends to be more severe compared to other rechargeable battery chemistries as they have a higher energy density that results in the generation of more heat by the chemical reaction between the positive and negative electrodes. They also use a flammable organic solvent as the electrolyte that ignites and releases additional heat when exposed to the air. Often, a Li–ion cell fails in a manner that makes it inoperable; such a way makes them unable to be charged and/ or discharged. In some instances, a Li–ion cell fails exothermically and the thermal runaway of a Li-ion cell occurs when the heat generated within the cell exceeds the heat dissipation by the cell. The use of adequate safeguards in the form of redundant protection circuits, well designed thermal management systems, and robust manufacturing processes coupled with battery designs can also minimise the risk of safety-related failure modes.

Maria Grahn, James E. Anderson, Timothy J. Wellington [5] says that,The various factors that influence the cost-effective vehicle and fuel technology choices in a carbon-constrained world. It develops an already existing global energy systems model and provides a detailed description of light-duty vehicle technologies. CCS and CSP are the two technological options that can significantly reduce CO_2 emissions associated with electricity and heat generation and can affect cost-effective fuel and vehicle technologies for transport and thus provide options for passenger vehicles to meet the global CO_2 emission target of 450 ppm at the lowest system cost. The introduction of CCS increases the use of coal in the energy system and ICEV for transport and thus extends the time span of conventional petroleum-fuelled ICEVs, and enables the use of liquid biofuels as well as GTL/CTL for transportation. The use of CSP reduces the relative cost of electricity in relation to H_2 and tends to increase the use of electricity for transport. Thus the combined use of both CCS and CSP reduces the cost-effectiveness of shifting away from petroleum and ICEVs for a prolonged period of time and reduces the cost of carbon mitigation. The findings of the model highlight the need to recognise, and account for, the interaction between sectors in policy development and illustrate the importance of pursuing the research and development of multiple fuel and vehicle technology pathways to achieve the desired result of affordable and sustainable personal mobility.

2.4 POWER TRAINS

Fabio Orecchini, Adriano Santiangeli[5] says the evolution of vehicle electrification from various forms of hybrid electric vehicles such as micro, mild-medium, and full hybrid vehicles to plug-in hybrid electric vehicles and battery electric vehicles (BEVs) and from fuel cell hydrogen electric vehicles to multi-purpose electrified traction platforms and architectures. An all-electric traction can be obtained in various ways, with different architectures ranging from full-hybrid configurations that allows driving in electric mode for short ranges, to solutions with electric batteries and motor, up to the adoption of electric systems with the double possibility of supplying onboard electricity from both hydrogen-powered fuel cells and batteries. The fast development of electrified power-trains would not only result in improved fuel consumption but would also enable one to travel for longer distances in a zero emissions vehicle (ZEV) mode. Hydrogen fuel cell-powered vehicles, despite a recent drop in public opinion, are still the subject of continued applied research and testing. The hydrogen architecture could also hybridise the battery-powered electric system with a stack of fuel cells and a tank, which would allow an extension of the range compared to battery-powered electric vehicles. The electricity produced by fuel cells will be supplied to the batteries or the electric motor whose emissions would be water vapour. Voltec Technology proposed by GM is a plug-in technology with an extended range of about 500 km, which is four times that of an electric vehicle. ZEVs presently are undergoing massive testing and will be increasingly available, although at a slow initial pace.

Ibrahim Dincer., Marc A. Rosen, Calin Zamfirescu[6] says that economic and environmental comparison of conventional and alternative vehicles and evaluates, based on actual cost data, the life cycle indicators for vehicle production and utilisation stages. The vehicles analysed include conventional gasoline vehicles, hybrid vehicles, electric vehicles, hydrogen fuel cell vehicles, hydrogen internal combustion vehicles, and ammonia-fuelLed vehicles. Hydrogen internal combustion vehicles and ammonia-fuelLed vehicles use hydrogen as a fuel in an internal combustion engine (ICE) and ammonia as a hydrogen fuel source to drive an ICE, respectively, both of which are zero polluting at fuel utilisation stage during vehicle operation. When electricity is generated from renewable energy sources, the electric car is advantageous to the hybrid vehicle, and when electricity is generated from fossil fuels, the electric car remains competitive when it is generated onboard. The electric car is superior in many respects when the electricity is generated with an efficiency of 50–60% by a gas turbine engine connected to a high-capacity battery and electric motor. The various theoretical developments, consisting of novel economic and environmental criteria for quantifying vehicle sustainability, could prove useful in the design of modern light-duty automobiles, with superior economic and environmental attributes.

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