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Development of Hybrid Two Wheeler Vehicle (Scaled Model)

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Abstract— the development of hybrid electric two wheelers in recent years has targeted the reduction of on road emissions produced by these vehicles. However, added cost and complexity have resulted in the failure of these systems to meet consumer expectations. This report presents a comparative study of the energy economy and development of a hybrid electric two wheeler vehicle (scaled model) so that the efficiency of small two wheelers such as scooters or low capacity motorcycles can be improved. The projected model is modified from a 127cc GenSat Engine combined with 24V, 120A heavy duty DC electric motor to further enhance the overall fuel efficiency of the system, particularly the fuel consumption rate. The 127cc GenSat Engine is controlled via DC servo motor that derives its instruction and commands from Arduino Mega 2560 that in turn is controlled via the human machine interface (HMI) projected on the laptop. The main function/utility of the model is to prove the enhancement in the efficiency of a traditional motor scooter. This may prove to be important milestone for adoption of non-conventional electric vehicle.

Index terms: Hybrid Drive, SWDP, Single Wheel Dual Power Supply, Electric Drive, Non-Conventional Drive train.

1. INTRODUCTION

Motorcycle is a vehicle with the characteristics of being mobile, quick, convenient, economical, and easy to park. It is best suited for short range transport. Since India is densely populated, motorcycle has become a pretty popular means of transport. In recent years, along with fast expansion and rapid industrial development, the number of motorcycles has increased dramatically. The pollutants, such as carbon monoxide (CO) and hydrocarbons (HC), produced by motorcycles account for approximately 10% of the total annual amount of pollution emissions in India. Therefore, how to effectively reduce pollution emissions from motorcycles to improve the quality of the environment has become a critical issue that can no longer be ignored [2].

2. BASICS OF HYBRID TWO WHEELER VEHICLE.

In conventional vehicles the combustion engine must choose operating load point that corresponds to the instantaneous demanded tractive power. Since the ICE does not provide power with high efficiency at all operating points, in particularly not at low loads, and most modern vehicles are significantly over powered, the efficiency at average (=low power) driving conditions is relatively low.

Furthermore, conventional vehicles have no possibilities to avoid load points that have a disadvantageous emission formation. Sudden load increments cause's transients when the engine tries to follow them and it includes also transiently raised emissions due to a sudden increase of injected fuel.

When braking, there are small possibilities to recover energy in a conventional vehicle. Almost all kinetic energy, originating from the fuel energy, will be lost. The electric hybrid vehicles, on the other hand, have the advantage to alter its tractive power sources or even better the possibility to combine them. This leads to the possibility to slow down the changes of load points for the ICE. By utilizing pure electric mode it is possible to avoid low ICE efficiency or load points that forms large amount of emissions, if combining the ICE and electric machine does not solve the problem. Furthermore, the presence of a battery makes it possible to regenerate braking energy. The pure electric vehicles (EV) are still not ready to conquer the market from the conventional vehicles, even though battery performance of both NiHM and LiO technologies have improved significantly during the later years. The main reason for not building pure electric vehicles is still the shortcoming of the batteries. The energy supply is simply not enough for longer trips. On top of this comes that the time needed for recharging the batteries is not negligible. A 6 hour coffee break after 50-80 km might not be efficient at long trips. Therefore a hybrid of today combines the extended range of a conventional vehicle with the environmental

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benefits of an electrical vehicle. This results in a vehicle with improved fuel economy and

Lowered, yet not zero, emissions. The main drawback with a HEV is the price that is higher due to increased complexity [6].

The goal, to minimize the use of non-efficient operating points, is more or less easy to achieve depending on the chosen hybrid topology.

3. TOPOLOGIES

In hybrid vehicles, studied in this thesis, there are one combustion engine and, at least, one electric machine. The engine can be of petrol or diesel type. The hybrid vehicles also include an energy buffer, in this study a chemical battery. It can though be e.g. a. mechanical battery (flywheel), electrostatic (capacitor) or pneumatic (pressurized air).

There are many ways of combining the included components and consequently the number of possible hybrid topologies is large, considering the combinations of electric machines, gearboxes, clutches etc. (Harbolla, 1992). The two main solutions, series and parallel topology, can be supplemented in a numerous amount of combinations, each one with its pros and cons. The other topologies can, strongly simplified, be described as variants of these two basic concepts. The topology efficiency is depending on the chosen vehicle solution with its unique characteristics and the actual working condition [1].

4. TECHNOLOGICAL CHALLENGES

Several technologies to be implemented in the next generations of automobiles are found on the horizon. There are still a lot of technology challenges to overcome, particularly in the area of Hybrid electric vehicles. Hence, the present challenges for researchers are in the development of low weight and high capacity batteries, drives, electronic controls and transmission. Some of these technological challenges are discussed below [4].

4.1ELECTRIC PROPULSION SYSTEM

In the area of propulsion motor and other motor control technologies, methods to eliminate speed/position sensors, inverter current sensors, etc., have been under investigation for several years. These technologies have not yet been proven to be practical for automotive applications. The technology development effort needs to be focused on the sensor less operation of electric machines and the reduction or elimination of current sensors in inverters [2]. Controllers need to be developed for the robust operation of all vehicle subsystems. The development of low cost, high temperature magnets would lead to the widespread use of permanent magnet (PM) motors. PM motors have higher efficiency and need lower current to obtain the same torque as other machines. This would reduce

the cost of power devices as well. This cost reduction is critical for market viability. The future technological challenges for the electric motors will be light weight, wide speed range, high efficiency, maximum torque and long life.

4.2 POWERELECTRONICS

The power switching devices and associated control systems and components play a key role in bringing plug-in hybrid vehicles to market with reliability and affordability. The power electronic system should be efficient to improve the range of the electric operation and fuel economy. The selection of power semiconductor devices, converters/inverters, control and switching strategies, the packaging of the individual units, and the system integration are very crucial to the development of efficient and high performance HEVs. In addition to power devices and controllers, there are several other components such as capacitors, inductors, bus bars, thermal systems that form a major portion of a power electronic unit. The packaging of all these units as one system has significant challenges. To meet the requirements of the automotive environment, several technical challenges need to be overcome and new developments are necessary, from the device level to the system level [6].

The technologies related to device packaging need to be investigated by the semiconductor industry to develop a power switch. Wire bonding, device interconnections, etc., are the barriers to the development of high-current-density power units. Technologies such as topside power connection without wire bonds, minimizing wire bonds, dynamic matching, heat-sinking both sides of the die, direct bond copper on alumina and aluminium-nitride substrates, interconnect solutions for large-scale manufacturing, etc., need to be investigated as well. The reliable operation of power modules and other related packaging technologies needs to be studied. The power electronic systems available in the market are still bulky and difficult to package for automotive applications. The capacitors with high-frequency and high-voltage operations, low equivalent series resistance, high operating temperatures, and high ripple current capabilities need to be further developed [1]. Hence, improved dielectric materials need to be investigated. The technology of laminated bus bars with high isolation voltage and low inductance needs further work to meet the automotive operating environment.

In order to meet the packaging goals, the components must be designed to operate over a much higher temperature range. A novel way of cooling the entire unit needs to be examined to quickly take away the heat from the devices. The current heat management techniques are inadequate to dissipate heat in high-power density systems. In addition, the

impact of current intensiveness in a system on lower efficiency, larger passive components such as inductors and capacitors, and a thicker wiring harness among the components should be properly taken into consideration at the stage of system design. Also there is a need to develop an inverter topology that achieves the performance of a soft-switched inverter but with less components and simplified control. Topologies with two or more integrated functions such as an inverter, a charger, and a dc/dc converter and with minimum use of capacitors need to be developed. In the area of dc–dc converters, further development is needed to obtain 12 V from 42 V and higher voltages [5].

5. EXPERIMENTAL SETUP

Fig.1 Virtual Setup

The main components of hybrid electric two wheeler vehicle (scaled model) are as follows:

- Gensat Engine.
- 24V, 12A DC Motor
- 2x12V batteries.
- Potentiometer
- Servo Motor
- Motor Driver.
- Microcontroller (Arduino Mega 2560)

Fig 2.1: Actual setup

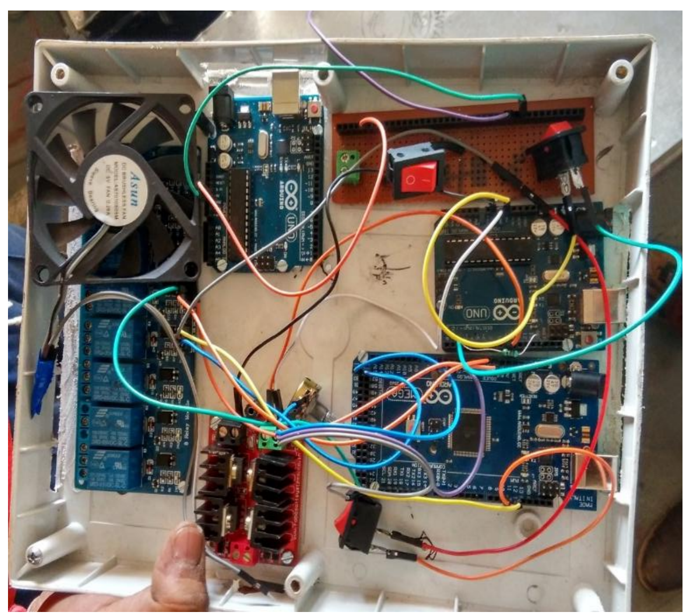


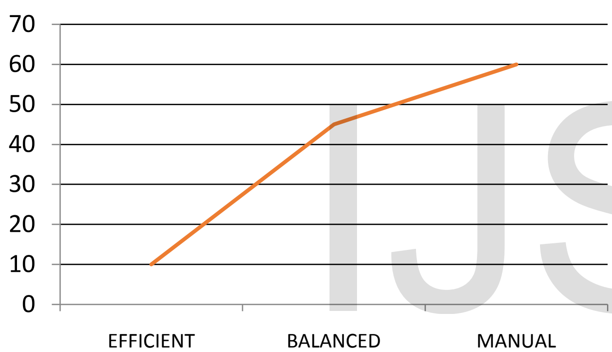
Fig 2.2: Controllers.

6. EXPECTED RESULTS

The resultant of the hybrid setup in this case gives us the saving in the form of Fuel as well as the increased efficiency of the batteries given as follows:-

Table 1: Electrical Energy Conservation.

Drive State/Mode	Wheel RPM	Savings in Watts/hour theoretical	Savings in Watts/hour actual
Manual	1500	60	52.1
Balanced	3000	45	43.8
Efficient	5400	10	8.9



(Note: The above figures are for indicative purposes and are derived from the fact that a 12V and 120A alternator is used)

The above results are derived from the below equation:

$$\iint Ie = \frac{\text{Rated RPM(N)}}{\text{Rated Voltage(V)} * \text{Rated Current(A)}}$$

Where

I*e* = Inductive Output (Faraday's Law of Electromagnetic Induction)

V = Rated Voltage of system

A = Rated Amps of the system

7.CONCLUSION

The fuel consumption decreased and the range of vehicle increased which resulted, better of overall vehicle performance

There is a need to develop batteries for HEVs, whose requirement characteristics like energy density and specific power will be intermediate between those of EVs and HEVs. There is also a need to improve the battery life, number of deep discharge cycles and charging/discharging efficiencies even under cold climatic conditions. A great deal of testing is required to determine its safety in a crash or fire.

For electric propulsion motors, the future challenges were be light weight, wide speed range, high efficiency, maximum torque and long life. Controllers for these motors also need to be developed for the robust vehicle operations.

Reliable and affordablepower switching devices and associated control system were developed. Also technologies related to device packing and large-scale manufacturing were studied.

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