Future Aspects of Four Wheeler Hybrid Vehicles - A Review

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Abstract - *There is a growing acceptance for hybrid and electric cars and more and more manufacturers are entering this segment. The hybrid vehicles have come a long way in the past few years in terms of technology. They have been designed for fuel efficiency and low emissions. Hybrid models relying on a gasoline motor to recharge batteries or power the electric motor can be driven farther than gasoline-powered vehicles, and retain a fuel economy advantage as well. This paper presents the future aspects of four wheeler hybrid vehicles which can be used to maximize fuel economy and vehicle drivability.*

Keywords: Hybrid Electric Vehicle, Design, Internal Combustion Engine, Power Requirement, Regenerative Braking.

1.INTRODUCTION

A hybrid vehicle combines and uses two or more distinct types of power (energy) sources, such as internal combustion engine to drive an electric generator that powers an electric motor. The possible combinations include diesel/electric, gasoline/fly wheel, and fuel cell (FC)/battery. Typically, one energy source is storage, and the other is conversion of a fuel to energy. The combination of two power sources may support two separate propulsion systems. Thus to be a true hybrid, the vehicle must have more than one mode of propulsion. The two power sources may be paired in series, meaning that the gas engine charges the batteries of an electric motor that powers the car, or in parallel, with both mechanisms driving the vehicle directly. The hybrid electric vehicle (HEV) combines a gasoline engine with an electric motor.

The operating principles of a hybrid vehicle revolve around the interaction between the energy sources. For example, when the hybrid is not moving, neither are either engines-- this includes the gasoline engine which shuts off when stopping at a red light, which saves energy. The start-up of the vehicle depends upon the electric motor, and it continues to power the vehicle up to a certain speed, at which time the gasoline engine takes over operation. Anytime there exists a need for sudden acceleration the gasoline power is available, in addition to handling the power at extended high speeds. This continual interaction saves energy and occurs automatically.

2.HISTORY AND BACKGROUND

While it may seem that hybrids are a recent phenomenon, the technology has been around since the creation of the automobile. In fact, auto manufacturers have been developing and building hybrids since the beginning of the auto industry. The first hybrid car was built in the year 1899 by engineer Ferdinand Porsche. Called the System Lohner-Porsche Mixte, it used a gasoline engine to supply power to an electric motor that drove the car's front wheels. The Mixte was well-received, and over 300 were produced.

In 1999, the Honda Insight became the first mass-production hybrid electric vehicle released in the United States. The two-door, two-seat Insight may have been first, but it was the Toyota Prius sedan, released in the United States in 2000, that gave hybrid technology the foothold it was looking for. In the years since its United States introduction, the Prius has become synonymous with the term "hybrid." It is the most popular HEV ever produced, and auto manufacturers around the world have used its technology as a basis for countless other vehicles.

2.1HYBRIDS TODAY

Along with the Prius, two other well-known hybrids are the Honda Insight, which was introduced in 1999, and the Honda Civic Hybrid. Ford introduced the first hybrid sport-utility vehicle (SUV), the Ford Escape. Many other car manufacturers have developed their own version of the hybrid, including Volvo, Volkswagen, Nissan and Lexus. Here are some examples of modern hybrid cars: Nissan Altima, Ford Fusion, Lexus Hybrids.

3.WORKING OF HYBRID VEHICLES

Hybrid electric vehicles (HEVs) as shown in fig.1 combine the benefits of gasoline engines and electric motors. They can be designed to meet different goals, such as better fuel economy or more power.

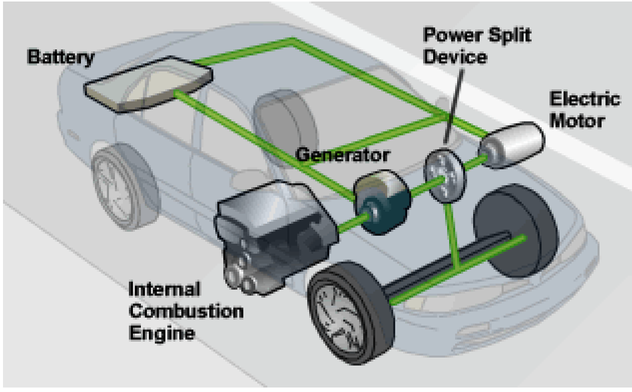

Fig-1: Main Components of a Hybrid Electric Vehicle [3]

Most hybrids use several advanced technologies:

- Regenerative Braking. It recaptures energy normally lost during coasting or braking. It uses the forward motion of the wheels to turn the motor. This generates electricity and helps slow the vehicle.
- Electric Motor Drive/Assist. The electric motor provides power to assist the engine in accelerating, passing, or hill climbing. This allows a smaller, more-efficient engine to be used. In some hybrids, the electric motor alone propels the vehicle at low speeds, where gasoline engines are least efficient.
- Automatic Start/Stop. Automatically shuts off the engine when the vehicle comes to a stop and restarts it when the accelerator is pressed. This reduces wasted energy from idling.

4.DESIGN

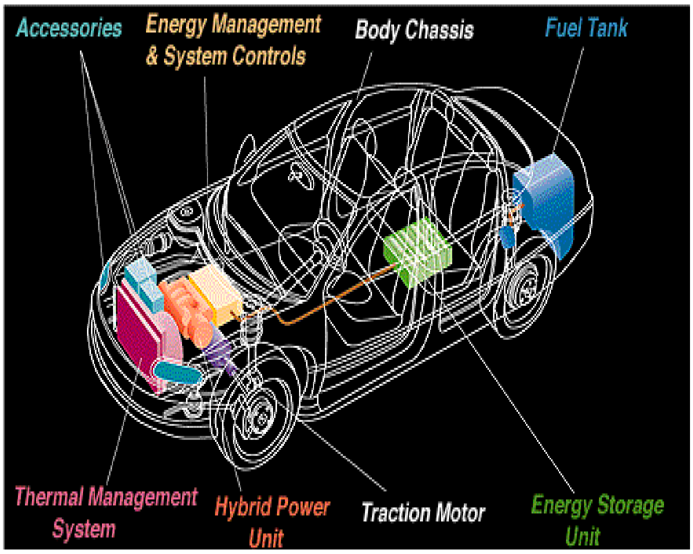

Fig-2: Design of a Hybrid Electric Vehicle [5]

As shown in Fig.2, the Hybrid Power Unit could be Any Internal Combustion Engine (diesel, petrol, hydrogen, biogas, biodiesel etc.) or a Fuel Cell. The Traction Motor can be electric and driven directly by the Hybrid Power Unit or the Traction Motor can be hydraulic or a mechanical drive driven indirectly by the Hybrid Power Unit via an electric motor. When designers are free of the mechanical coupling and the mechanical constraints inherent in most of our current Automobiles, Power Units can be mounted low (Center of gravity) and out of the way, Wheels can be placed at the extreme corners of a vehicle. Their location in reality is only constrained by the available suspension technology.

5.FUTURE INTERNAL COMBUSTION ENGINE DRIVETRAINS

The internal combustion engine (and any other heat engine) functions best under constant load. If the engine can constantly work near its optimal operating point, efficiency and longevity increase dramatically, complexity and costs reduce, and emissions control becomes much easier and cheaper. Electric drive, on the other hand, is great for variable loads. Efficiency remains high, maximum torque is available even at low power output and mechanical energy can be efficiently recovered to electrical energy under braking. Hybrid drive trains aim to synergistically combine the internal combustion engine and the electric motor to fully capitalize on these fundamental characteristics. Even though hybrid drive has been around for about two decades, great room for further improvement exists. Continued cost reductions in electric drive trains and battery technology combined with further development of Internal Combustion Engines especially designed for hybrid drive can lead to higher efficiency, lower costs and a better driving experience.

6.POWER REQUIREMENTS DURING DRIVING

To better understand the potential of hybrid drive, it is important to realize just how little power it takes to maintain constant speed (the role of the Internal Combustion Engine) and how much power it takes to accelerate (the role of the electric motor). To illustrate this, three simple graphs in fig.3, fig.4 and fig.5 are presented below.

The first graph in fig.3 shows the horsepower (hp) required to maintain a given constant speed for a car weighing 3050 lbs with a frontal area of 22 ft for different drag coefficients. Even at a speed of 60 miles per hour, only 11-15 horsepower is required.

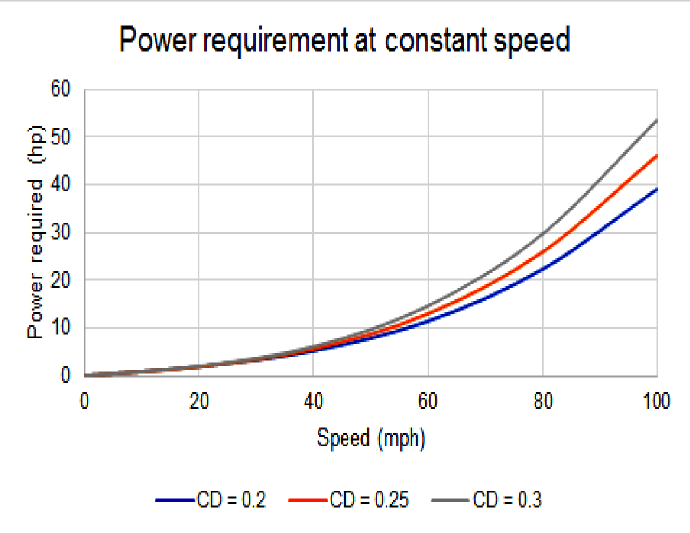

Fig-3: Power Requirement during Driving at Constant Speed [9]

As shown in the fig.4 graph below, accelerating even at a fairly modest rate equivalent to a 10 seconds 0-60 miles per hour time takes almost an order of magnitude more power than maintaining speed at 60 miles per hour.

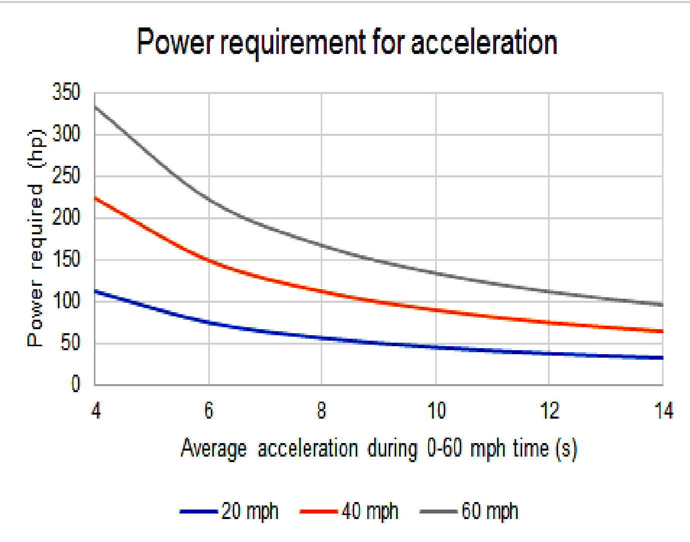

Fig-4: Power Requirement during Driving for Acceleration [9]

As shown in fig.5 below, hills also require quite a lot of power depending on the gradient.

For these simple reasons, the hybrid of the future will have an engine that has substantially less power than the electric motor. The engine will be responsible for most constant speed driving, while the electric motor will provide the short bursts of larger power required by acceleration and steep hills.

Fig-5: Power Requirement during Driving for Hill-climbing [9]

7.CONCLUSION

The future hybrid configuration with a greatly downsized internal combustion engine will bring at least two significant side-benefits.

Firstly, the hybrid configuration with a large electric motor will be more fun to drive than a pure internal combustion engine car. Currently, the hybrid image is still linked to the old Toyota Prius, which was very sluggish to drive. According to the vast majority of professional reviews, this stigma is already being altered by the new Prius and the Hyundai Ioniq. Future models will certainly continue this positive trend. As a result, people will start to buy efficient cars, not as a grudging compromise to help the environment, but simply because they are both cheaper and better to drive. Hybridization is already being used to increase performance in sports cars, the pinnacle of which is Mercedes' 50% efficient F1 engine.

Secondly, the moderately sized battery pack (~5 kilowatt hour) in the future hybrid configuration can also be charged from a regular plug overnight. Even though, on average, fuel costs for gasoline and electricity will not differ much for such an efficient hybrid vehicle, adding a plug provides fuel flexibility in the case of high oil prices. Even just a moderate number of such flex-fuel vehicles can provide enough demand elasticity to prevent fuel price spikes. For example, if oil prices start to rise outside of the normal range, everyone with these vehicles can instantly start displacing some of their gasoline consumption with electricity, thus reducing demand for oil and lowering the price.

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