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A REVIEW ON HYBRID VEHICLES

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ABSTRACT

Automobile hybridization is considered as an important step in reducing greenhouse gases and related automotive emissions. However, current hybrid electric vehicles are a temporary solution on the way to zero emission road vehicles. This paper discusses the use of hybrid electric vehicle power train. This vehicle allows a control strategy which includes both fuel-economy and performance modes.

Recently there has been a lot of interest in the concept of hybrid electric vehicles, which have great potential to attain higher fuel economy and efficiency.

How does a hybrid automobile work? What goes on under the hood to give you 20 or 30 more miles per gallon than the standard automobile? And does it pollute less just because it gets better gas mileage? This paper helps us to understand the technology behind these hybrid vehicles. A brief review of design considerations and selection of major components for hybrid electric vehicles is provided.

KEYWORDS: Hybrid Vehicles, Energy Saving, Regenerative Braking, Eco Friendly

INTRODUCTION

An alternative fuel vehicle is a vehicle that runs on a fuel other than "traditional" petroleum fuels (petrol or diesel) and also refers to any technology of powering an engine that does not involve solely petroleum (e.g. electric car, hybrid electric vehicles, solar powered). Because of a combination of factors, such as environmental concerns, high oil prices and the potential for peak oil, development of cleaner alternative fuels and advanced power systems for vehicles has become a high priority for many governments and vehicle manufacturers around the world.

A hybrid vehicle is a vehicle that uses two or more distinct power sources to move the vehicle. The term most commonly refers to hybrid electric vehicles (HEVs), which combine an internal combustion engine and one or more electric motors.

A hybrid vehicle uses multiple propulsion systems to provide motive power. The most common type of hybrid vehicle is the gasoline-electric hybrid vehicles, which use gasoline (petrol) and electric batteries for the energy used to power internal-combustion engines (ICEs) and electric motors. These motors are usually relatively small and would be considered "underpowered" by themselves, but they can provide a normal driving experience when used in combination during acceleration and other maneuvers that require greater power. The presence of the electric powertrain is intended to achieve either better fuel economy than a conventional vehicle or better performance.

History of Hybrid Vehicles

Henri Pieper in 1899 developed the first petro-electric hybrid automobile in the world. In 1901 Ferdinand Porsche

developed the Lohner-Porsche Mixte Hybrid, the first gasoline-electric hybrid automobile in the world using two motor-in-wheel-hub arrangements with a combustion generator set providing the electric power, setting two speed records While liquid fuel/electric hybrids date back to the late 19th century, the braking regenerative hybrid was invented by David Arthurs, an electrical engineer from Springdale, Arkansas in 1978–79. [1]

In 1905, Henri Pieper of Germany/Belgium introduced a hybrid vehicle with an electric motor/generator, batteries, and a small gasoline engine. It used the electric motor to charge its batteries at cruise speed and used both motors to accelerate or climb a hill.

In 1931 Erich Gaichen invented and drove from Altenburg to Berlin a 1/2 horsepower electric car containing features later incorporated into hybrid cars.

Automotive hybrid technology became widespread beginning in the late 1990s. The first mass-produced hybrid vehicle was the Toyota Prius, launched in Japan in 1997, and followed by the Honda Insight, launched in 1999 in the United States and Japan. The Prius was launched in Europe, North America and the rest of the world in 2000. [1]

How Does a Hybrid Car Work?

In a traditional hybrid vehicle, we have a complete electric car. It includes an electric motor to provide all of the power to the wheels, as well as batteries to supply the motor with electricity and a completely separate gasoline engine powering a generator. The engine is very small (10 to 20 horsepower) and it are designed to run at just one speed for maximum efficiency. The purpose of this small, efficient engine is to provide enough power for the car at its cruising speed. During times of acceleration, the batteries provide the extra power necessary. When the car is decelerating or standing still, the batteries recharge. This sort of hybrid car is essentially an electric car with a built-in recharger for longer range. The advantage is that the small, efficient gasoline engine gets great mileage. [2]

- **Design Considerations of Hybrid Vehicles**

In some cases, manufacturers are producing HEVs that use the added energy provided by the hybrid systems to give vehicles a power boost, rather than significantly improved fuel efficiency compared to their traditional counterparts. The trade-off between added performance and improved fuel efficiency is partly controlled by the software within the hybrid system and partly the result of the engine, battery and motor size. In the future, manufacturers may provide HEV owners with the ability to partially control this balance (fuel efficiency vs. added performance) as they wish, through a user-controlled setting. Toyota announced in January, 2006 that it was considering a "high-efficiency" button. [3]

Hybrid Vehicle Power Train Configurations

- **Parallel Hybrid:** In a parallel hybrid vehicle, the single electric motor and the internal combustion engine are installed such that they can power the vehicle either individually or together. Most commonly the internal combustion engine, the electric motor and gear box are coupled by automatically controlled clutches. For electric driving the clutch between the internal combustion engine is open while the clutch to the gear box is engaged. While in combustion mode the engine and motor run at the same speed.
- **Mild Parallel Hybrid:** Mild hybrid, is a vehicle that cannot be driven solely on its electric motor, because the electric motor does not have enough power to propel the vehicle on its own. Mild hybrids only include some of

the features found in hybrid technology, and usually achieve limited fuel consumption savings, up to 15 percent in urban driving and 8 to 10 percent overall cycle. These types use a generally compact electric motor (usually <20 kW) to provide auto-stop/start features and to provide extra power assist during the acceleration, and to generate on the deceleration phase.

- **Power-Split or Series-Parallel Hybrid:** In a power-split hybrid electric drive train there are two motors: An electric motor and an internal combustion engine. The power from these two motors can be shared to drive the wheels via a power splitter, which is a simple planetary gear set. The ratio can be from 0–100% for the combustion engine, or 0–100% for the electric motor, or anything in between, such as 40% for the electric motor and 60% for the combustion engine. The combustion engine can act as a generator charging the batteries. Power-split hybrids have the benefits of a combination of series and parallel characteristics. As a result, they are more efficient overall, because series hybrids tend to be more efficient at lower speeds and parallel tend to be more efficient at high speeds; however, the cost of power-split the hybrid is higher than a pure parallel.

- **Series Hybrid:** Series-hybrid vehicles are driven by the electric motor with no mechanical connection to the engine. Instead there is an engine tuned for running a generator when the battery pack energy supply isn't sufficient for demands. In series hybrids, only the electric motor drives the drivetrain, and a smaller ICE works as a generator to power the electric motor or to recharge the batteries. They also usually have a larger battery pack than parallel hybrids, making them more expensive. Once the batteries are low, the small combustion engine can generate power at its optimum settings at all times, making them more efficient in extensive city driving.

- **Plug-in Hybrids (PHEVs):** A plug-in hybrid electric vehicle (PHEV), also known as a plug-in hybrid, is a hybrid electric vehicle with rechargeable batteries that can be restored to full charge by connecting a plug to an external electric power source. A PHEV shares the characteristics of both a conventional hybrid electric vehicle, having an electric motor and an internal combustion engine; and of an all-electric vehicle, also having a plug to connect to the electrical grid. PHEVs have a much larger all-electric range as compared to conventional gasoline-electric hybrids, and also eliminate the "range anxiety" associated with all-electric vehicles, because the combustion engine works as a backup when the batteries are depleted. [4]

Technology Used in Hybrid Vehicles

The varieties of hybrid electric designs can be differentiated by the structure of the hybrid vehicle drivetrain, the fuel type, and the mode of operation.

In 2007, several automobile manufacturers announced that future vehicles will use aspects of hybrid electric technology to reduce fuel consumption without the use of the hybrid drivetrain. Regenerative braking can be used to recapture energy and stored to power electrical accessories, such as air conditioning. Shutting down the engine at idle can also be used to reduce fuel consumption and reduce emissions without the addition of a hybrid drivetrain. In both cases, some of the advantages of hybrid electric technology are gained while additional cost and weight may be limited to the addition of larger batteries and starter motors. [5]

Some of the advanced technologies typically used by hybrids include

- **Regenerative Braking:** The electric motor applies resistance to the drivetrain causing the wheels to slow down. In return, the energy from the wheels turns the motor, which functions as a generator, converting energy normally wasted during coasting and braking into electricity, which is stored in a battery until needed by the electric motor.
- **Electric Motor Drive/Assist:** The electric motor provides additional power to assist the engine in accelerating, passing, or hill climbing. This allows a smaller, more efficient engine to be used. In some vehicles, the motor alone provides power for low-speed driving conditions where internal combustion engines are least efficient.
- **Automatic Start/Shutoff:** Automatically shuts off the engine when the vehicle comes to a stop and restarts it when the accelerator is pressed. This prevents wasted energy from idling. [6]

Environmental Impact by HEV's

- **Fuel Consumption and Emissions Reductions**

The hybrid vehicle typically achieves greater fuel economy and lower emissions than conventional internal combustion engine vehicles (ICEVs), resulting in fewer emissions being generated. These savings are primarily achieved by three elements of a typical hybrid design:

- Relying on both the engine and the electric motors for peak power needs, resulting in a smaller engine sized more for average usage rather than peak power usage. A smaller engine can have less internal losses and lower weight.
- Having significant battery storage capacity to store and reuse recaptured energy, especially in stop-and-go traffic typical of the city driving cycle.
- Recapturing significant amounts of energy during braking that are normally wasted as heat. This regenerative braking reduces vehicle speed by converting some of its kinetic energy into electricity, depending upon the power rating of the motor/generator.

Any combination of these three primary hybrid advantages may be used in different vehicles to realize different fuel usage, power, emissions, and weight and cost profiles. The ICE in an HEV can be smaller, lighter, and more efficient than the one in a conventional vehicle, because the combustion engine can be sized for slightly above average power demand rather than peak power demand. The greater fuel economy of HEVs has implication for reduced petroleum consumption and vehicle air pollution emissions worldwide. [7]

- **Noise**

Reduced noise emissions resulting from substantial use of the electric motor at idling and low speeds, leading to roadway noise reduction with comparison to conventional gasoline or diesel powered engine vehicles.

The reduced noise may not be beneficial for all road users, as blind people or the visually impaired use the noise of combustion engines a helpful aid while crossing streets and feel quiet hybrids could pose a negative impact.

- **Pollution**

Hybrid vehicles are eco-friendly, as hybrids use NiMH batteries which can be recycled and that disposal will pose no toxic hazards and also does not release any harmful gases that help to give green earth. [8]

CONCLUSIONS

Hybrid-electric vehicles (HEVs) combine the benefits of gasoline engines and electric motors and can be configured to obtain different objectives, such as improved fuel economy, increased power, or additional auxiliary power for electronic devices and power tools.

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