HYBRID ELECTRIC VEHICLES

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ABSTRACT

A hybrid electric vehicle is a hybrid vehicle that combines a conventional propulsion system with a rechargeable energy storage system to achieve better fuel economy than a conventional vehicle. Its secondary propulsion system, additional to the electric motor, means that it does not require regular visits to a charging unit as a battery electric vehicle does. Modern mass-produced HEVs prolong the charge in their batteries by capturing kinetic energy by means of regenerative braking, and some HEVs can use internal combustion engines (ICE) to generate electricity by spinning an electrical generator to either recharge the battery or directly feed power to an electric motor that drives the vehicle. Many HEVs reduce idle emissions by shutting down the internal combustion engine at idle and restarting it when needed. An HEVs engine is smaller than a non-hybrid fossil fuel vehicle and may be run at various speeds, providing greater efficiency.

Have you pulled your car up to the gas pump lately and been shocked by the high price of gasoline? As the pump clicked past $20 or $30, maybe you thought about trading in that SUV for something that gets better mileage. Or maybe you are worried that your car is contributing to the greenhouse effect. Or maybe you just want to have the coolest car on the block. Currently, there is a solution for all this problems; it's the hybrid electric vehicle. The vehicle is lighter and roomier than a purely electric vehicle, because there is less need to carry as many heavy batteries. The internal combustion engine in hybrid-electric is much smaller and lighter and more efficient than the engine in a conventional vehicle. In fact, most automobile manufacturers have announced plans to manufacture their own hybrid versions.

Hybrid electric vehicles are all around us. Most of the locomotives we see pulling trains are diesel-electric hybrids. Cities like Seattle have diesel-electric buses -- these can draw electric power from overhead wires or run on diesel when they are away from the wires. Giant mining trucks are often diesel-electric hybrids. Submarines are also hybrid vehicles -- some are nuclear-electric and some are diesel-electric. Any vehicle that combines two or more sources of power that can directly or indirectly provide propulsion power is a hybrid.
INTRODUCTION

The world started down a new road in 1997 when the first modern hybrid electric car, the Toyota Prius, was sold in Japan. Two years later, the United States saw its first sale of a hybrid, the Honda Insight. These two Vehicles, followed by the Honda Civic Hybrid, marked a radial change in the type of car being offered to the public: vehicles that bring some of the benefits of battery electric vehicles into the conventional gasoline powered cars and trucks we have been using for more than 100 years. In the coming years, hybrids can play a significant role in addressing several of the major problems faced by the United States and the whole world today: climate change, air pollution and oil dependence. Whether this new technology delivers on its promise hinges on the choices automakers, consumers and policymakers make over the coming years. Poor choices could result in hybrids that fall short even of what conventional technology could deliver on fuel economy, emission or both. If they designed well, these hybrids can equal or better the utility, comfort, performance and safety we’ve come to expect, while saving us thousand of dollars at the gas pump.
Definition

A hybrid electric (HEV) is a type of hybrid vehicle and electric vehicle which combines a conventional internal combustion engine (ICE) propulsion system with an electric propulsion system.

What is HEV?

The combination of an internal combustion engine (ICE) with one or more electric motor or generators and a battery pack.

Combines propulsion system with RESS and gets better fuel economy.

An HEV uses less gasoline because the electric motor does some of the work.

How HEV works

Hybrid-electric vehicles (HEVs) combines 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. Some of the advanced technologies typically used by hybrid include.

REGenerative Breaking: The electric motor applies resistance to the drive train 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 breaking 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 condition where internal combustion engines are least efficient.

Automatic Start/Shutdown: 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.
Power

Power sources for hybrid vehicles include:

- On-board or out-board rechargeable energy storage system (RESS)
- Compressed air
- Coal, wood or other solid combustibles
- Electricity
- Electromagnetic fields, Radio waves
- Compressed or liquefied natural gas
- Human powered e.g. pedaling or rowing
- Hydrogen
- Liquid nitrogen
- Petrol or Diesel fuel
- Solar
- Wind
- Waste heat from internal combustion engine.

Process of Working

Overview

Full hybrids use a gasoline engine as the primary source of power and an electric motor provides additional power when needed.

In addition, full hybrids can use the electric motor as the sole source of propulsion for low-speed, low-acceleration driving, such as in stop-and-go traffic or for breaking up.

This electric-only driving mode can further increase fuel efficiency under some driving conditions.

Starting

When a full hybrid vehicle is initially started, the battery typically powers all accessories.

The gasoline engine only starts if the battery needs to be charged or the accessories require more power than available from the battery.

The battery stores energy generated from the gasoline engine or during regenerative
braking from the electric motor. Since the battery powers the vehicle at low speeds, it is larger and holds much more energy than battery used to start conventional vehicles

Low speed
For initial acceleration and low-speed driving, as well as reverse, the electric motor uses electricity from the battery to power the vehicle
If the battery needs to be recharged, the generator starts the engine and converts energy from the engine into electricity. This is stored in the battery.

Cruising
At speeds above mid-range, both the engine and electric motor are used to propel the vehicle
The gasoline engine provides power to the drive-train directly and to the electric motor via the generator
During heavy accelerating or when additional power is needed, the gasoline engine and electric motor are both use to propel the vehicle

Braking part
Regenerative braking converts otherwise wasted energy from baking into electricity and stores it in battery
In regenerative braking, the electric motor is reversed so that, instead of using electricity to run the wheels, the rotating wheels turn the motor and create electricity. Using energy from the wheels turn the motor slows the vehicle down

Stopped
When the vehicle is stopped, such as at a red light, the gasoline engine and electric motor shut off automatically so that energy is not wasted I idling
All other systems, including the electric air conditioning, continue to run

Rollover area: Battery: The battery stores energy generated from the gasoline engine or, during regenerative braking, from the electric motor. Since the battery powers the vehicle at low speeds, it is larger and holds much energy than batteries used to start conventional vehicles.
Technology

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. There is no standard terminology for such vehicles, although they may be termed mild hybrids.

Engines and fuel sources

Fossil fuels

Main article: Fossil fuel

Free-piston engines could be used to generate electricity as efficiently as, and less expensively than, fuel cells

Gasoline

Gasoline engines are used in most hybrid electric designs, and will likely remain dominant for the foreseeable future. While petroleum-derived gasoline is the primary fuel, it is possible to mix in varying levels of ethanol created from renewable energy sources. Like most modern ICE powered vehicles, HEVs can typically use up to about 15% bioethanol. Manufacturers may move to flexible fuel engines, which would increase allowable ratios, but no plans are in place at present.

Diesel

Diesel-electric HEVs use a diesel engine for power generation. Diesels have advantages when delivering constant power for long periods of time, suffering less wear while operating at higher efficiency. The diesel engine's high torque, combined with hybrid technology, may offer substantially improved mileage. Most diesel vehicles can use 100% pure biofuels (biodiesel), so they can use but do not need petroleum at all for fuel (although mixes of biofuel and petroleum are more common, and petroleum may be needed for lubrication). If diesel-electric HEVs were in use, this benefit would likely also apply. Diesel-electric hybrid drivetrains have begun to appear in commercial vehicles (particularly buses); as of 2007, no light duty diesel-electric hybrid passenger cars are currently available, although prototypes exist. Peugeot is expected to produce a diesel-electric hybrid version of its 308 in late 2008 for the European market.
**Hydrogen**

Hydrogen can be used in cars in two ways: a source of combustible heat, or a source of electrons for an electric motor. The burning of hydrogen is not being developed in practical terms; it is the hydrogen fuel-cell electric vehicle (HFEV) which is garnering all the attention. Hydrogen fuel cells create electricity fed into an electric motor to drives the wheels. Hydrogen is not burned, but it is consumed. This means molecular hydrogen, $H_2$, is combined with oxygen to form water. $2H_2 (4e^-) + O_2 \rightarrow 2H_2O (4e^-)$. The molecular hydrogen and oxygen's mutual affinity drives the fuel cell to separate the electrons from the hydrogen, to use them to power the electric motor, and to return them to the ionized water molecules that were formed when the electron-depleted hydrogen combined with the oxygen in the fuel cell. Recalling that a hydrogen atom is nothing more than a proton and an electron; in essence, the motor is driven by the proton's atomic attraction to the oxygen nucleus, and the electron's attraction to the ionized water molecule.

An HFEV is an all-electric car featuring an open-source battery in the form of a hydrogen tank and the atmosphere. HFEV's may also comprise closed-cell batteries for the purpose of power storage from regenerative braking, but this does not change the source of the motivation. It implies the HFEV is an electric car with two types of batteries. Since HFEV's are purely electric, and do not contain any type of heat engine, they are not hybrids.

**Electric machines**

In split path vehicles (Toyota, Ford, GM, Chrysler) there are two electrical machines, one of which functions as a motor primarily, and the other functions as a generator primarily. One of the primary requirements of these machines is that they are very efficient, as the electrical portion of the energy must be converted from the engine to the generator, through two inverters, through the motor again and then to the wheels.

Most of the electric machines used in hybrid vehicles are brushless DC motors (BLDC). Specifically, they are of a type called an interior permanent magnet (IPM) machine (or motor). These machines are wound similarly to the induction motors found in a typical home, but (for high efficiency) use very strong rare earth magnets in the rotor. These magnets contain neodymium, iron and boron, and are therefore called Neodymium magnets. The magnet material is expensive, and its cost is one of the limiting factors in the use of these machines.
Hybrid Reliability

The cost of maintenance is reduced due to operation of hybrid technology
Regenerative braking reduces wear on brakes
Idle stop extends battery life
Electric accessories reduce load on engine
Battery charge is computer controlled which extends battery life

USE OF HEV

When it comes to purchasing a car many of us used to only think about how it looked and how fast we could go in it. But that was before gas prices skyrocketed and we were forced to think more about convenience rather than what we really wanted. People who are trying to purchase new cars are not in search of a car that receives good gas mileage. Many manufacturers are designing their cars around this one feature to make them more appealing for people. One of the most common cars that people feel can save them the most money are hybrids. These cars combine the use of two different types of engines in order to produce low measures of pollution.

Thanks to the uniqueness of the engine it is one of the quietest types of cars that you will ever see. They are designed with a fuel tank that is connected to the gasoline engine - but it is smaller and more efficient than in the average vehicle. It is also designed with an electric motor that uses batteries to function.

These hybrids have many features that include being able to travel long distances without using large amounts of fuel. When the car is idling or when it is traveling at low speeds it will switch to battery power. These batteries can be recharged at home.

When stopping the car it uses the electric motor and what is commonly known as regenerative braking. In the standard car they used friction to stop the car - but in a hybrid car kinetic energy will charge up the battery and use the energy to stop it. One of the best features that it has is the ability to shut itself off. When the car is idling it will automatically shut off and save fuel.

The Cash For Clunkers program is used to help people save money and purchase a car they
can afford. Some of the most popular types are the Hybrids - which help to save people in gas money

**Latest developments**

**2011-2012**

*Volkswagen* announced at the *2010 Geneva Motor Show* the launch of the 2012 *Touareg Hybrid*, scheduled for 2011 VW also announced plans to introduce *diesel*-electric hybrid versions of its most popular models in 2012, beginning with the new Jetta, followed by the *Golf Hybrid* in 2013 together with hybrid versions of the *Passat*. The *Peugeot 3008 HYbrid4* will be launched in the European market in early 2011 and is expected to become the world's first *production diesel*-electric hybrid. According to *Peugeot* the new hybrid delivers a *fuel economy* of up to 62 miles per US gallon (3.8 L/100 km; 74 mpg-imp) and CO₂ emissions of 99g/km on the European test cycle.

The *Toyota Prius V*, the first spinoff from the *Prius* family, was unveiled at the January 2011 u and is scheduled to be released to the U.S. market by mid 2011. Other gasoline-electric hybrids already scheduled for commercial sales in 2011 are the *Lexus CT 200h*, the *Infiniti M35 Hybrid*, the *Hyundai Sonata Hybrid* and its siblling the *Kia Optima Hybrid*
ADVANTAGES OF HEV

- Mechanical
- Environmental
- Energy resilience
- Energy efficiency
- Cost of recharge
- Stabilization of the grid
- Use less fuel
- Lighter batteries
- Mobility
- System Integration
- Value Added Features
CONCLUSION

A Cooler, Cleaner and Secure Future

A technology exists to build a future with a significant lower dependence on oil and a cleaner, cooler atmosphere. With sufficient political will and automaker participation, this future can arrive in time to address these significant and growing problems. Hybrids can play an important role in realizing this future, filling the gap between immediate improvements through conventional technology; hybrids can help drive passengers vehicle oil consumption and global warming emulsions from cars and trucks below 1990 levels.

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