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# Efficient Hybrid vehicle

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***Abstract*- 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. However, other mechanisms to capture and use energy may also be included.**

## I. INTRODUCTION

Different types of Hybrid vehicles are invented till now, which are discussed here under.

Two-wheeled and cycle-type vehicles

Mopeds, electric bicycles, and even electric kick scooters are a simple form of a hybrid, as power is delivered both via an internal combustion engine or electric motor and the rider's muscles. Early prototypes of motorcycles in the late 19th century used the same principles to power it up.

In a parallel hybrid bicycle human and motor power are mechanically coupled at the pedal drive train or at the rear or the front wheel, e.g. using a hub motor, a roller pressing onto a tire, or a connection to a wheel using a transmission element. Human and motor torques are added together. Almost all manufactured Motorized bicycles, Mopeds are of this type.

In a series hybrid bicycle (SH) the user powers a generator using the pedals. This is converted into electricity and can be fed directly to the motor giving a chainless bicycle but also to charge a battery. The motor draws power from the battery and must be able to deliver the full mechanical torque required because none is available from the pedals. SH bicycles are commercially available, because they are very simple in theory and manufacturing.

The first known prototype and publication of an SH bicycle is by Augustus Kinzel (US Patent 3'884'317) in 1975. In 1994 Bernie Macdonalds conceived the Electrolyte SH lightweight vehicle which used power electronics allowing regenerative braking and pedaling while stationary. In 1996 Jürg Blatter and Andreas Fuchs of Berne University of Applied Sciences built an SH bicycle and in 1998 mounted the system onto a Leitra tricycle (European patent EP 1165188). In 1999 Harald Kutzke described his concept of the "active bicycle": the aim is to approach the ideal bicycle weighing nothing and having no drag by electronic compensation. Until 2005 Fuchs and colleagues built several prototype SH tricycles.

Fig1, Diesel-Electric hybrid vehicle

Hybrid power trains use diesel-electric or turbo-electric to power railway locomotives, buses, heavy goods vehicles, mobile hydraulic machinery, and ships. Typically some form of heat engine (usually diesel) drives an electric generator or hydraulic pump which powers one or more electric or hydraulic motors. There are advantages in distributing power through wires or pipes rather than mechanical elements especially when multiple drives—e.g. driven wheels or propellers—are required. There is power lost in the double conversion from typically diesel fuel to electricity to power an electric or hydraulic motor. With large vehicles the advantages often outweigh the disadvantages especially as the conversion losses typically decrease with size. With the exception of non-nuclear submarines, presently there is no or relatively little secondary energy storage capacity on most heavy vehicles, e.g. auxiliary batteries and hydraulic accumulators—although this is now changing. Submarines are one of the oldest widespread applications of hybrid technology, running on diesel engines while surfaced and switching to battery power when submerged.

Both series-hybrid and parallel hybrid drive trains were used in the Second World War.

## II. HYBRID ELECTRIC-PETROLEUM VEHICLES

When the term hybrid vehicle is used, it most often refers to a Hybrid electric vehicle. These encompass such vehicles as the Saturn Vue, Toyota Prius, Toyota Yaris, Toyota Camry Hybrid, Ford Escape Hybrid, Toyota Highlander Hybrid, Honda Insight, Honda Civic Hybrid, Lexus RX 400h and 450h and others. A petroleum-electric hybrid most commonly uses internal combustion engines (generally gasoline or Diesel engines, powered by a variety of fuels) and electric batteries to power the vehicle. There are many types of petroleum-electric hybrid drivetrains, from Full hybrid to Mild hybrid, which offer varying advantages and disadvantages.

Henri Pieper in 1899 developed the first petro-electric hybrid automobile in the world. In 1900, Ferdinand Porsche developed a series-hybrid using two motor-in-wheel-hub arrangements with a combustion generator set providing the electric power, setting two speed records.[citation needed] 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. His home-converted Opel GT was reported to return as much as 75MPG with plans still sold to this original design, and the "Mother Earth News" modified version on their website.

The plug-in-electric-vehicle (PEV) is becoming more and more common. It has the range needed in locations where there are wide gaps with no services. The batteries can be plugged into house (mains) electricity for charging, as well being charged while the engine is running.

Continuously outboard recharged electric vehicle (COREV)

Given suitable infrastructure, permissions and vehicles, BEVs can be recharged while the user drives. The BEV establishes contact with an electrified rail, plate or overhead wires on the highway via an attached conducting wheel or other similar mechanism. The BEV's batteries are recharged by this process—on the highway—and can then be used normally on other roads until the battery is discharged. Some of battery-electric locomotives used for maintenance trains on the London Underground are capable of this mode of operation. Power is picked up from the electrified rails where possible, switching to battery power where the electricity supply is disconnected.

This provides the advantage, in principle, of virtually unrestricted highway range as long as you stay where you have BEV infrastructure access. Since many destinations are within 100 km of a major highway, this may reduce the need for expensive battery systems. Unfortunately private use of the existing electrical system is nearly universally prohibited.

The technology for such electrical infrastructure is old and, outside of some cities, is not widely distributed. Updating the required electrical and infrastructure costs can be funded, in principle, by toll revenue, gasoline or other taxes.

## III. HYBRID FUEL (DUAL MODE)

In addition to vehicles that use two or more different devices for propulsion, some also consider vehicles that use distinct energy sources or input types ("fuels") using the same engine to be hybrids, although to avoid confusion with hybrids as described above and to use correctly the terms, these are perhaps more correctly described as dual mode vehicles:

Some electric trolleybuses can switch between an on board diesel engine and overhead electrical power depending on conditions (seedual mode bus). In principle, this could be combined with a battery subsystem to create a true plug-in hybrid trolleybus, although as of 2006, no such design seems to have been announced.

Flexible-fuel vehicles can use a mixture of input fuels mixed in one tank typically gasoline and ethanol, or methanol, or bio butanol.

Bi-fuel vehicle: Liquefied petroleum gas and natural gas are very different from petroleum or diesel and cannot be used in the same tanks, so it would be impossible to build an (LPG or NG) flexible fuel system. Instead vehicles are built with two, parallel, fuel systems feeding one engine. For example Chevys Silverado 2500 HD, which is now on the road, can effortlessly switch between petroleum and natural gas, and offers a range of over 650 miles. While the duplicated tanks cost space in some applications, the increased range, decreased cost of fuel and flexibility where (LPG or NG) infrastructure is incomplete may be a significant incentive to purchase. While the US Natural gas infrastructure is partially incomplete, it is increasing at a fast pace, and already has 2600 CNG stations in place. With a growing fueling station infrastructure, a large scale adoption of these bi-fuel vehicles could be seen in the near future. Rising gas prices may also push consumers to purchase these vehicles. When gas prices trade around $4.00, the price per MMBTU of gasoline is $28.00, compared to natural gas's $4.00 per MMBTU. On a per unit of energy comparative basis, this makes natural gas much cheaper than gasoline. All of these factors are making CNG-Gasoline bi-fuel vehicles very attractive.

- Some vehicles have been modified to use another fuel source if it is available, such as cars modified to run on auto gas (LPG) and diesels modified to run on waste vegetable oil that has not been processed into biodiesel.
- Power-assist mechanisms for bicycles and other human-powered vehicles are also included (see Motorized bicycle).

Fluid power hybrid

Fig2, petro-electric hybrid vehicle

Hydraulic and pneumatic hybrid vehicles use an engine to charge a pressure accumulator to drive the wheels via hydraulic (liquid) or pneumatic (compressed air) drive units. In most cases the engine is detached from the drive train, serving solely to charge the energy accumulator. The transmission is seamless. Regenerative breaking can be used to recover some of the supplied drive energy back into the accumulator.

## IV. PETRO-AIR HYBRID

A French company, MDI, has designed and has running models of a petro-air hybrid engine car. The system does not use air motors to drive the vehicle, being directly driven by a hybrid engine. The engine uses a mixture of compressed air and gasoline injected into the cylinders. A key aspect of the hybrid engine is the "active chamber", which is a compartment heating air via fuel doubling the energy output. Tata Motors of India assessed the design phase towards full production for the Indian market and moved into "completing detailed development of the compressed air engine into specific vehicle and stationary applications".

## V. PETRO-HYDRAULIC HYBRID

Petro-hydraulic configurations have been common in trains and heavy vehicles for decades. The auto industry recently focused on this hybrid configuration as it now shows promise for introduction into smaller vehicles.

In petro-hydraulic hybrids, the energy recovery rate is high and therefore the system is more efficient than battery charged hybrids using the current battery technology, demonstrating a 60% to 70% increase in energy economy in US Environmental Protection Agency (EPA) testing. The charging engine needs only to be sized for average usage with acceleration bursts using the stored energy in the hydraulic accumulator, which is charged when in low energy demanding vehicle operation. The charging engine runs at optimum speed and load for efficiency and longevity. Under tests undertaken by the US Environmental Protection Agency (EPA), a hydraulic hybrid Ford Expedition returned 32 miles per US gallon (7.4 L/100 km; 38 $mpg_{-imp}$) City, and 22 miles per US gallon (11 L/100 km; 26 $mpg_{-imp}$) highway. UP currently has two trucks in service with this technology.

Although petro-hybrid technology has been known for decades, and used in trains and very large construction vehicles, heavy costs of the equipment precluded the systems from lighter trucks and cars. In the modern sense an experiment proved the viability of small petro-hybrid road vehicles in 1978. A group of students at Minneapolis, Minnesota's Hennepin Vocational Technical Center, converted a Volkswagen Beetle car to run as a petro-hydraulic hybrid using off-the shelf components. A car rated at 32mpg was returning.

In the 1990s, a team of engineers working at EPA’s National Vehicle and Fuel Emissions Laboratory succeeded in developing a revolutionary type of petro-hydraulic hybrid power train that would propel a typical American sedan car. The test car achieved over 80 mpg on combined EPA city/highway driving cycles. Acceleration was 0-60 mph in 8 seconds, using a 1.9 liter diesel engine. No lightweight materials were used. The EPA estimated that produced in high volumes the hydraulic components would add only $700 to the base cost of the vehicle.

While the petro-hydraulic system has faster and more efficient charge/discharge cycling and is cheaper than petro-electric hybrids, the accumulator size dictates total energy storage capacity and may require more space than a battery set.

Research is underway in large corporations and small companies. Focus has now switched to smaller vehicles. The system components were expensive which precluded installation in smaller trucks and cars. A drawback was that the power driving motors were not efficient enough at part load. A British company (Artemis Intelligent Power) has made a breakthrough by introducing an electronically controlled hydraulic motor/pump, the Digital Displacement motor/pump, that is highly efficient at all speed ranges and loads, making small applications of petro-hydraulic hybrids feasible. The company converted a BMW car as a test bed to prove viability. The BMW 530i, gave double the mpg in city driving compared to the standard car. This test was using the standard 3,000cc engine. The design of petro-hydraulic hybrids using well sized accumulators entails downsizing an engine to average power usage, not peak power usage. Peak power is provided by the energy stored in the accumulator. A smaller more efficient constant speed engine reduces weight and liberates space for a larger accumulator.

Current vehicle bodies are designed around the mechanicals of existing engine/transmission setups. It is restrictive and far from ideal to install petro-hydraulic mechanicals into existing bodies not designed for hydraulic setups. One research project's goal is to create a blank paper design new car, to maximize the packaging of petro-hydraulic hybrid components in the vehicle. All bulky hydraulic components are integrated into the chassis of the car. One design has claimed to return 130mpg in tests by using a large hydraulic accumulator which is also the structural chassis of the car. The small hydraulic driving motors are incorporated within the wheel hubs driving the wheels and reversing to claw-back kinetic braking energy. The hub motors eliminates the need for friction brakes, mechanical transmissions, drive shafts and U joints, reducing costs and weight. Hydrostatic drive with no friction brakes are used in industrial vehicles. The aim is 170mpg in average driving conditions. Energy created by shock absorbers and kinetic braking energy that normally would be wasted assists in charging the accumulator. A small fossil fuelled piston engine sized for average power use charges the accumulator. The accumulator is sized at running the car for 15 minutes when fully charged. The aim is a fully charged accumulator which will produce a 0-60 mph acceleration speed of under 5 seconds using four wheel drive.

In January 2011 industry giant Chrysler announced a partnership with the US Environmental Protection Agency (EPA) to design and develop an experimental petro-hydraulic hybrid power train suitable for use in large passenger cars. In 2012 an existing production minivan will be adapted to the new hydraulic power train.

PSA Peugeot Citroën exhibited an experimental "Hybrid Air" engine at the 2013 Geneva Motor Show. The vehicle uses nitrogen gas compressed by energy harvested from braking or deceleration to power a hydraulic drive which supplements power from its conventional gasoline engine. The hydraulic and electronic components were supplied by Robert Bosch GmbH. Production versions priced at about $25,000, £17,000, are scheduled for 2015 or 2016. Mileage was estimated to be about 80 miles per gallon for city driving if installed in a Citroën C3.

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