AN INVESTIGATION ON A NEW ROAD BY HYBRID TECHNOLOGY

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ABSTRACT

Hybrid technology has blossomed over the last several years to become one of the most advanced heavy-duty vehicle technologies available today. These vehicles combine the latest advances in hybrid vehicle technology with the inherent efficiency and reduced emissions of modern clean technology to produce dramatic reductions in both emissions and fuel consumption while offering superior vehicle performance and the benefit of using existing fueling infrastructures. The combination of high oil costs, concerns about oil security and availability, and air quality issues related to vehicle emissions are driving interest in “hybrid electric vehicles (HEVs)”. HEVs are similar to conventional hybrid electric vehicles, but feature a larger battery and electric motors.

Keywords: Hybrid technology, heavy-duty vehicle technologies, hybrid electric vehicles (HEVs)

1. INTRODUCTION TO HYBRID TECHNOLOGY

The term “hybrid vehicle” refers to a vehicle with at least two sources of power. A “hybrid electric vehicle” indicates that one source of power is provided by an electric motor. The other source of motive power can come from a number of different technologies, but is typically provided by an internal combustion engine designed to run on either gasoline or diesel fuel. The term “diesel-electric hybrid” describes an HEV that combines the power of a diesel engine with an electric motor. The diesel engine in a diesel electric hybrid vehicle generates electricity for the electric motor, and in some cases can also power the vehicle directly. HEVs are fueled just like their more traditional counterparts with conventional diesel fuel. HEVs generate all electricity they need on-board and never need to be recharged before use. The diesel fuel powers an internal combustion engine that is usually smaller (and thus more efficient) than a conventional engine, which works along with an electric motor to provide the same power as a larger engine. The electric motor derives its power from an alternator or generator that is coupled with an energy storage device (such as a set of batteries or a super capacitor).
1.1 TYPES OF HEV

Series HEVs

In a series hybrid, the engine is not directly linked to the transmission for mechanical driving power. Rather, all of the energy produced from the engine is converted to electric power by the generator which re-charges the energy storage device in order to provide power to one or more electric motors. The electric motor system – by itself – provides torque to turn the wheels of the vehicle. Because the combustion engine is not directly connected to the wheels, it can operate at a more optimum rate and can be automatically (or sometimes manually) switched off for temporary all-electric, zero-emission operation. Series hybrids are well-suited for lightweight commuting vehicles and stop-and-go transit buses.

Parallel HEVs

In a parallel hybrid, both the combustion engine and the electric motor have direct, independent connections to the transmission. Either power source or both of them together-can be used to turn the vehicle’s wheels. These vehicles are often designed so that the combustion engine provides power at high, constant speeds; the electric motor provides power during stops and at low speeds; and both power sources work together during accelerations. Parallel hybrids are well-suited to improve the fuel economy of higher performing vehicles.

Fig. 2

2. HYBRID VEHICLE CONTROL SYSTEM

Hybrid Vehicle control system monitors and adjust all the aspects of power train.

- It regulates the engines MG1 & MG2 to meet the driving demands signalled by shift positions, accelerator pedal position and vehicle speed.
- It controls the operation of the hybrid transaxle.
- It oversees the operation of the inverter and converter as they balance the power requirements of the vehicle’s many 12-volt components and the high voltage components of the hybrid system Powertrain.
- MG means motor and generator engines.
2.1. MG1 and MG2

Both MG1 and MG2 function as both highly efficient alternating current synchronous generators and electric motors. MG1 and MG2 serve as the source for supplemental motive force that provides power assistance to the engine as needed.

MG1 recharges the HV battery and supplies electrical power to drive MG2. In addition, by regulating the amount of electrical power generated (thus varying generator’s rpm), MG1 effectively controls the continuously variable transmission function of the transaxle. MG1 also serves as the engine starter.

MG2 serves as the supplemental motive force that provides power assist to the engine output. It helps achieve excellent dynamic performance that includes smooth start-off and acceleration. During regenerative braking, MG2 converts kinetic energy into electrical energy which is then stored by the HV battery.

2.2. Power splitting device

The planetary gear unit is used as a power splitting device. The sun gear is connected to MG1, the ring gear is connected to MG2, and the planetary carrier is connected to the engine output shaft. The motive force is transmitted from the chain drive sprocket drive to the reduction unit via a silent chain.

2.3 Permanent magnet motors

When three-phase alternating current is passed through the three phase windings of the stator coil, a rotating magnetic field is created in the electric motor. By controlling this rotating magnetic field according to the rotor’s rotational position and speed, the permanent magnets in the rotor become attracted by the rotating magnetic field, thus generating torque. The generated torque is for all practical purposes proportionate to the amount of current and the rotational speed is controlled by the frequency of the alternating current. A high level of torque can be generated efficiently at all road speeds by properly controlling the rotating magnetic field and the angles of the rotor magnets.

2.4 Speed sensors

Sensor precisely detects the magnetic pole position, which is indispensable for ensuring the efficient control of MG1 and MG2. The sensor’s stator contains three coils. Since the rotor is oval, the gap between the stator and the rotor varies with the rotation of the rotor. In addition, the HV ECU uses this sensor as an rpm sensor calculating the amount of positional variance within a predetermined time interval.
2.5 Shift position assembly

The shift position sensors consist of a select sensor that detects the lateral movement of the selector lever and a shift sensor that detects the longitudinal movement. A combination of these signals is used to detect the shift position.

2.6 Shift control actuator

The motor in the actuator rotates to move the parking lock rod, which slides into the parking lock pawl, causing it to engage with the parking gear. This actuator detects its own position when a battery is reinstalled, so it does not require initialization.

The Shift Control Actuator includes a cycloid gear reduction mechanism that increases the actuator’s torque, ensuring that the parking lock will release when the vehicle is parked on a slope. This mechanism consists of an eccentric plate mounted on the motor’s output shaft, a 61-tooth fixed gear that is secured to the motor housing and a 60-tooth driven gear. As the output shaft rotates, the eccentric plate presses the driven gear against the fixed gear. The driven gear, which has one tooth less than the fixed gear rotates one tooth for every complete rotation of the eccentric plate. The result is a gear reduction ratio of 61:1, along with an equivalent increase in torque.
2.7 Inverter

The Inverter converts the high voltage direct current of the HV battery into three-phase alternating current of MG1 and MG2. The activation of the power transistors is controlled by the HV ECU. In addition, the inverter transmits information that is needed to control current such as the output amperage or voltage, to the HV ECU.

The inverter, MG1, and MG2 are cooled by a dedicated radiator and coolant system that is separate from the engine coolant system. The HV ECU controls the electric water pump for this system. An A/C inverter, which supplies power for driving the electric inverter compressor of the A/C system, has been included in the inverter assembly. This inverter converts the HV battery’s nominal voltage of DC 201.6V into AC 201.6V and supplies power to operate the compressor of the A/C system.

2.8 Boost converter

The boost converter boosts the nominal voltage of DC 201.6V that is output by the HV battery to the maximum voltage of DC 500V. The converter consists of the boost Integrated Power Module (IPM) with a built-in Insulated Gate Bipolar Transistor (IGBT) which performs the switching control and the reactor which stores energy. By using these components the converter boosts the voltage. When MG1 or MG2 acts as a generator the inverter converts the alternating current (range of 201.6V to 500V) generated by either of them into direct current. The boost converter then drops it to DC 201.6V to charge the HV battery.

2.9 Fuel economy

Current HEVs reduce petroleum consumption under certain circumstances, compared to otherwise similar conventional vehicles, primarily by using three mechanisms.

1. Reducing wasted energy during idle/low output, generally by turning the ICE off
2. Recapturing waste energy (i.e. regenerative braking)
3. Reducing the size and power of the ICE, and hence inefficiencies from under-utilization, by using the added power from the electric motor to compensate for the loss in peak power output from the smaller ICE.

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 drive system in a vehicle is required to operate over a range of speed and power, but an ICE’s highest efficiency is in a narrow range of operation, making conventional vehicles inefficient. On the contrary, in most HEV designs, the ICE operates closer to its range of highest efficiency more frequently. The power curve of electric motors is better suited to variable speeds and can provide substantially greater torque at low speeds compared with internal-combustion engines. The greater fuel economy of HEVs has implication for reduced petroleum consumption and vehicle air pollution emissions worldwide.

Fig.8
3. A VISION FOR THE FUTURE

By the end of the next decade, most new passenger cars and trucks could be full hybrid electric vehicles. This fleet of new passenger cars and trucks could get close to 60 mpg, saving consumers more than $5,000 on gasoline over the lifetime of their vehicles and cutting their contribution to global warming and oil dependence by nearly 60%.

Making this vision a reality means taking a new road as automakers tap into technologies they are developing today. The route would start with the use of cost-effective conventional technology over the next ten years, while hybrids enter the market in larger and larger numbers. By the middle of the next decade, hybrids can take over the market at the point where the energy and environmental gains from improved conventional vehicles start to lag and before hydrogen fuel cells are ready to take us into a gasoline-free future.

4. CONCLUSION

The technology exists to build a future with a significantly 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 and the long-term promise of hydrogen fuel cells and alternative fuels. Building on a 40-mpg fleet that relies on existing conventional technology, hybrids can help drive passenger vehicle oil consumption and global warming emissions from cars and trucks below 1990 levels.

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