

Hydraulic hybrids thrive in stop-and-go conditions

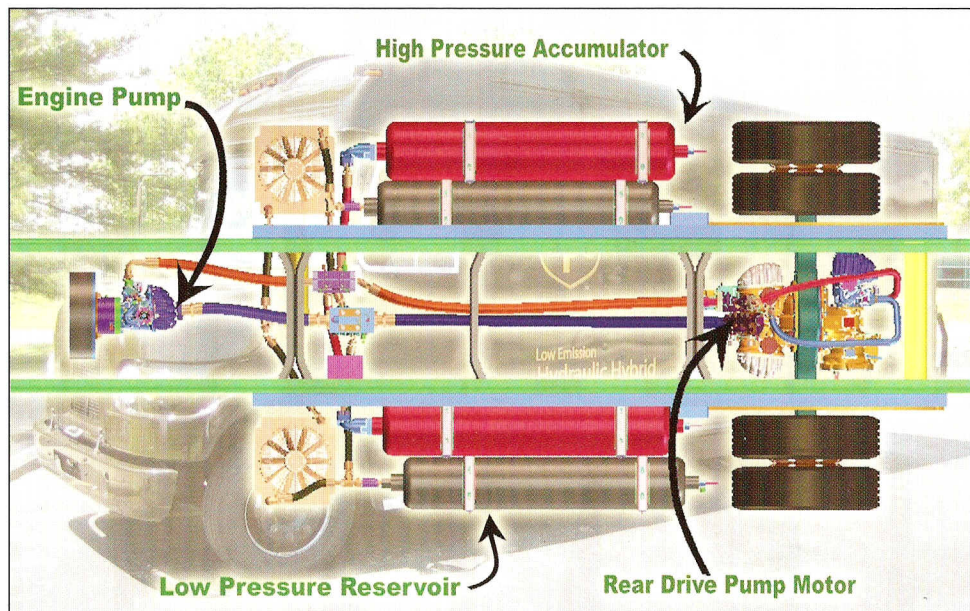
By Bill Vance

Hybrids are the current rage in automotive propulsion – interpreted as an internal combustion engine combined with an electric motor/battery system. They come as series types in which the engine drives the car with assistance from the battery, but the battery does not drive the car alone (e.g. Chevrolet Malibu Hybrid) – or parallel, in which either the battery/electric motor or the engine can propel the car (e.g. Toyota Prius).

But the U.S. Environmental Protection Agency (EPA) is exploring another type of hybrid, the engine-hydraulic system that uses an internal combustion engine, but not in conjunction with batteries and electric motors. Instead, the engine drives a hydraulic pump that pressurizes a hydraulic accumulator which, along with hydraulic motors and associated plumbing, takes the place of the motor/batteries of an engine-electric hybrid.

For close to 20 years the EPA has been interested in hydraulic hybrid vehicles (HHV) because of their potential for improved fuel economy, lower emissions and elimination of environmentally sensitive batteries. EPA has been working with United Parcel Service, Eaton Corp, Navistar International Corp. and others on the project.

As with electrics, hydraulic hybrids come in series and parallel configurations. In a parallel type the hydraulic



Schematic shows EPA's hydraulic circuit currently installed in a UPS demonstration courier vehicle. Fuel saving of up to 70% have been claimed for heavy vehicles using engine-hydraulics.

system assists and/or alternates with the engine in propelling a vehicle with a conventional drive train. In a series hydraulic hybrid the engine does not drive the vehicle directly; it is propelled by a pressurized hydraulic accumulator.

The series type is intriguing because its closed (always pressurized) hydraulic system replaces the conventional transmission, driveshaft and differential, and also promises the most improvement in fuel economy.

In the series system the engine-driven hydraulic pump pressurizes fluid in a high

strength, high pressure, usually carbon fibre cylindrical accumulator containing a nitrogen-filled bladder. Pumping pressurized fluid into this tank compresses the nitrogen, which keeps the fluid pressurized at up to 5,000 pounds per square inch (345 bar). Higher pressures are being researched.

To propel the vehicle, the pressurized fluid flows to a rear-drive hydraulic pump/motor that converts the pressure into rotary motion to turn the wheels. The fluid then flows back into a low pressure storage tank for re-use by the engine

pressure pump.

During braking and deceleration the hydraulic motor converts to a pump and performs a regeneration function by pumping fluid back into the high pressure accumulator. Because a hydraulic system can quickly absorb and release larger amounts of energy than a battery, regeneration is up to three times more efficient.

Since the engine's role is to keep the high pressure tank sufficiently charged, not propel the vehicle, it can operate in rpm and load ranges optimized for economy and emissions. A stop-start feature shuts the engine off when the vehicle is coasting, braking or stationary. The vehicle can travel for short distances with the engine off, using only energy from the hydraulic accumulator.

Because a hydraulic hybrid is most efficient in stop-and-go driving, it is particularly attractive for such applications as delivery services, garbage collection and transit buses. Companies like UPS, American Express, FedEx and Waste Management Corp. are keenly interested. UPS has run diesel HHV prototypes for 18 months in real world conditions around Detroit, and in October, 2008 took the plunge and ordered a fleet of seven HHVs to begin service in 2009.

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