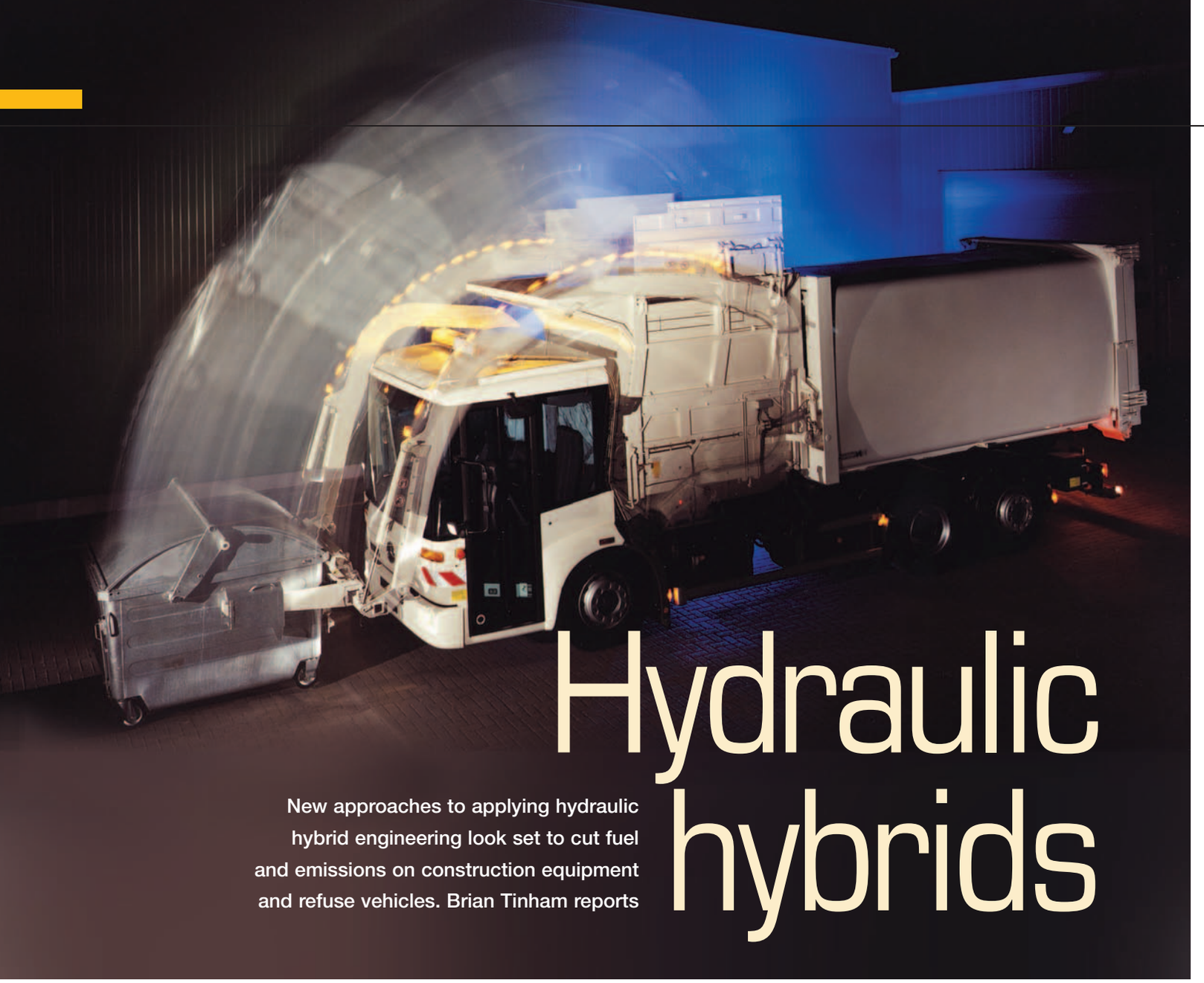


Hydraulic hybrids

New approaches to applying hydraulic hybrid engineering look set to cut fuel and emissions on construction equipment and refuse vehicles. Brian Tinham reports

Hydraulic hybrid equipment that takes advantage of the stop-start activities of, for example, RCVs (refuse collection vehicles), home delivery vehicles and construction equipment, to reduce typically heavy fuel consumption and emissions, are looking increasingly attractive.

Several such systems have been developed. One is Parker Hannifin's stored energy management system (SEMS). Another is Bosch Rexroth's hydrostatic regenerative braking (HRB) system. Both operate essentially by storing kinetic energy, created during braking, in a hydraulic accumulator, and then releasing it to assist with acceleration. And both offer intrinsically high power density, maintaining efficiency during energy conversion and allowing braking energy to be captured and re-used.

SEMS incorporates a conventional Parker hydraulic accumulator, which is automatically charged every time the vehicle brakes. Alternatively, the accumulator can be powered via an electronically controlled pump attached to a PTO (power take-off). The accumulator is linked to a hydraulic converter that reduces the high pressure energy to that required by ancillary equipment on each vehicle. Overall system management is then achieved by Parker's IQAN software-based hydraulic control technology, which combines in-cab screens and joysticks with sensors and interfaces linked to the trucks' ECUs.

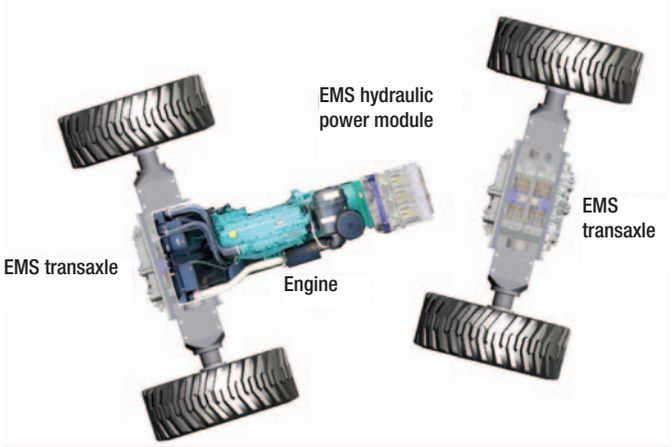
As for Bosch Rexroth's HRB, this system goes into action when the vehicle's driver depresses the brake pedal, causing a hydraulic unit to push hydraulic fluid into the high-pressure reservoir. Each time the driver brakes, energy that would usually be lost, is stored in this way. Then, when accelerating, the electronically-controlled hydraulic pressure reservoir releases the pressure, so relieving some of the demand on the diesel engine. As a result, the engine consumes less fuel and generates fewer exhaust gases.

HRB functions through the use of a hydraulic axial piston unit integrated into the mechanical drivetrain by means of a gearbox. Upon braking, this unit acts as a pump and so harnesses the released braking energy by charging its bladder accumulator with hydraulic oil. Electronics control the process, via a hydraulic valve control block, and give the signal to reverse it when the vehicle begins to move. The pressurised oil is then released from the accumulator in a controlled manner

and flows back through the axial piston unit, which then functions as a motor – delivering its power to the drivetrain, while a pressure relief valve ensures safety. Rexroth's HRB can be retrofitted in the chassis, as an add-on, without major modifications – even in vehicles without hydraulics.

Last year saw the start of 12 months of HRB field trials on New York City Department of Sanitation (DSNY) refuse trucks, as an alternative drive system – the goal being to obtain real-world operating data to help DSNY rule on its viability for large-scale deployment on in-service and new vehicles. The HRB system was installed onto a Crane Carrier LET2 truck and integrated with a Heil Environmental refuse body – with two such vehicles provided for the evaluation.

Bosch Rexroth accepts that the trials – which



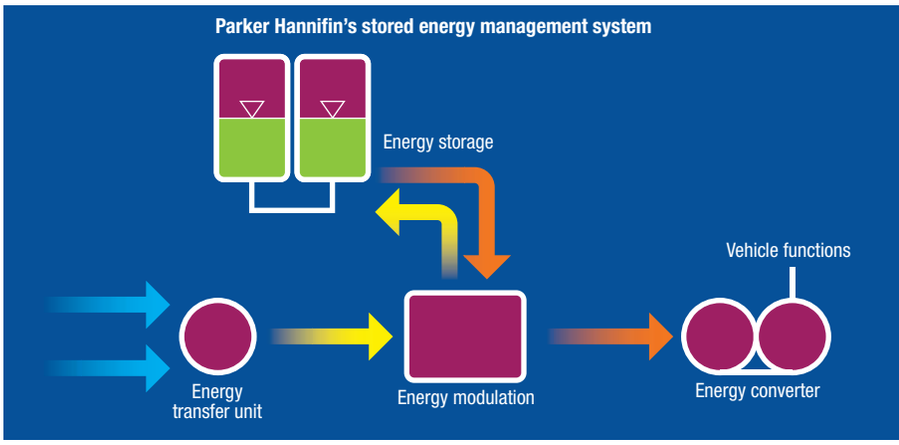
involve braking tests, acceleration tests, route collection tests and dynamometer testing – mark an important step towards achieving commercialisation of heavy-duty hybrid hydraulic vehicles.

50% fuel saving

Meanwhile, the latest development of this type, comes from Haldex Hydraulics, whose equipment is able to take the energy from a descending loader bucket – and use it to help propel the truck. Combined with energy storage in an accumulator, full-scale laboratory tests suggest that in-service, in a vehicle, it should be able to achieve fuel savings in excess of a staggering 50%.

While other hydraulic hybrids capture braking energy, store it and redeploy it for propulsion, the Haldex Energy Management System is the only one to provide energy management – and so aims to integrate all functions on, for example, construction equipment, using hydraulics throughout.

Says Jeff Maney, director of advanced solutions engineering at Haldex Hydraulics in Rockford, Illinois, USA: "Our system is strictly series [hydraulic] and, unlike a conventional hydrostatic swash plate



transmission system, the high pressure port is always the high pressure port. It's the flow that changes direction." Additionally, this system is open loop – also unlike a conventional hydrostatic transmission, which is closed loop with pressure dictated by load, rather than system control.

The energy management system aims to maintain a constant supply pressure and some load on the engine at all times. Even when the machine is stationary, the swash plate in the unit attached to the engine is kept at a shallow angle, while the swash plates in the motors attached to the wheels are at zero angle and the units are at full pressure.

Surplus high pressure oil is then used to add charge slowly to the accumulator. Movement is initiated by controlling the swash plates at the wheels, which leads to the pump swash plate angle being increased to deliver more high pressure oil. As Maney puts it, this means they "draw torque, rather than torque being pushed towards them". This should mean that the system is very quick to respond and thus easier to control – which is useful, given that hydraulic systems have to be pressurised before anything happens and so have a tendency to oscillate, if demand changes quickly.

Throughout, the overall goal of the control system is to avoid energy waste. Hence, energy from a descending bucket on a loader can be stored or delivered to help accelerate the vehicle. Surplus energy is then delivered to the hydraulic accumulator during braking events and released when extra energy is required for acceleration or lifting.

This accumulator is sized at six US gallons on the 180bhp powered system currently on the test bed. Maney believes the test system can absorb up to 550bhp – more than three times the engine input. Compared to parallel hybrid systems, component sizes will be larger, but complexity is reduced. TE

Above: Parker Hannifin's stored energy management system (SEMS) Left: Key elements of the EMS