

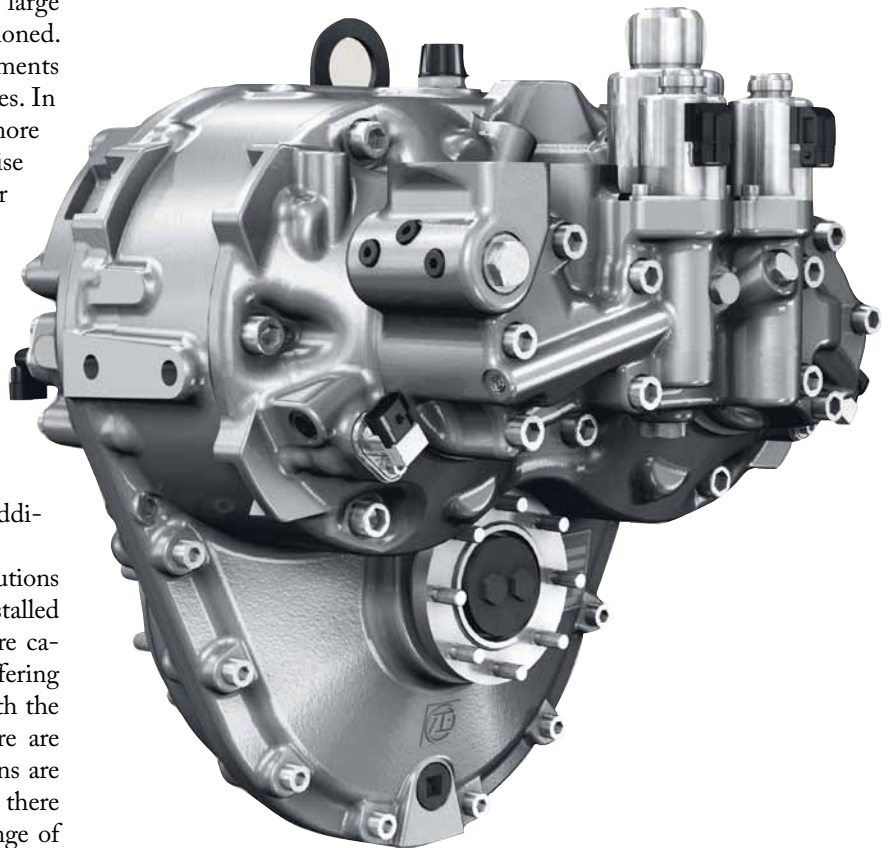
# Compact Loaders for Compact Spaces

## HYDROSTATIC DRIVE OFFERS FLEXIBILITY IN OFF-HIGHWAY APPLICATIONS

Matthew Jaster, Associate Editor

Compact loaders are employed where large machines have no access or are over dimensioned. Apart from the amount of load, the requirements on the vehicles are similar to large machines. In addition to the known requirements for more compact drive systems with reduced noise level, there is an ever increasing demand for a reduction of fuel consumption. At the same time, however, vehicle speed should be increased. The new hydrostatic drives of the HC-range meet these requirements of the off-highway market. ZF's 2 HC 85 transmission systems with incorporated actuators and sensors for construction machinery up to 10 tons enable continuously variable vehicle speeds up to 50 km/h and do not require any additional shifting devices.

Unlike other hydrostatic driveline solutions with bent axis axial piston motors, ZF installed two crankshaft radial piston motors that are capable of running up to 2,500 rpm while offering constant output torque characteristics. "With the crankshaft radial piston motor design there are fewer leakages thanks to piston seals. Pistons are guided in pivoted cylinders, and as a result there are no lateral forces. This allows a wide range of displacement variation, speeds up to 2,500 rpm with high pressure, high starting torque, high efficiency and low noise," says Alexander Eisner, marketing communications product manager at ZF.



**ZF's 2 HC 85 transmission systems with incorporated actuators and sensors for construction machinery up to 10 tons enable continuously variable vehicle speeds up to 50 km/h and do not require any additional shifting devices (courtesy of ZF).**

Other advantages to the 2 HC 85 transmission system include increased riding comfort; continuously variable transmission without gear shifts; no interruption of traction (therefore improved handling performance); low start speed due to electronically controlled driveline management; better performance (no interruption of tractive effort); an electronic propulsion control that ensures a low starting speed; an output control (limit load control) that also adjusts the diesel engine to the optimum speed when driving at full throttle; enhanced efficiency and reduced fuel consumption up to 15 percent by crankshaft radial piston motors; and noise reduction by lower hydrostatic motor speeds.

Thanks to its compact design there's an increased degree of freedom regarding vehicle construction. The integration of hydrostatic motors into the transmission system reduces the number of external hose pipes and valves, leading to a reduction of interfaces to the vehicle and one-source supply of the complete driveline: i.e., transmission, axles and driveline control.

"Highly precise maneuvering during loading and unloading plays a key role in any off-road machinery application," Eisner adds. "This is possible at full traction through the entire speed range thanks to the hydrostatic 2 HC 85 drive. The whole accelerator pedal play can be used to position the vehicle exactly by selecting the desired driving range."

ZF rigid axles MT-L 3010/15/20/25 feature a particularly slim design. The high ratio in the wheel heads' final drive provides increased ground clearance. The system comprises a directly mounted transfer box for hydrostatic drive suitable for 55 to 160 ccm engines. A service and parking brake are offered as a drum brake, plus the series offers a low-wear multi-disc brake at the axle input. The MT-L 3045/55 axles provided by ZF are optimally suited for the on-site operation of compact loaders. Their durability and robustness have been tested at the in-house test bench, both alone and in connection with the relating compact loader transmissions. In addition, the axles are characterized by the direct mounting of the HC 85 to rear axle MT-L 3045/55, an above cen-



**ZF is now profiting from its established hybrid solutions in vehicle transmissions in the construction, material handling and agricultural machinery markets (courtesy of ZF).**

ter pivot mount of rear axle, front with parking brake (disc brake) on the drive, as well as integrated wet multi-disc brakes and differential options.

ZF also offers a hydrodynamic axle configuration. The power shift transmission from the range 4WG 98 with torque converter in this case is arranged as a separate unit between these two axles. For this driveline a central oscillation of the rear axle is available.

"ZF has also identified the 2 HC 85 as a technological solution for use in telescopic handlers. Based on the experience with the already existing driveline solutions from ZF, this is the next step for applications that are used both in construction and agricultural," Eisner says.

Precise maneuvering when loading and unloading plays a key role in all fields of a telescopic handler application. This is possible at full traction throughout the entire speed range thanks to the hydrostatic transmission 2 HC 85. The complete accelerator pedal play can be used for exactly positioning the vehicle by

selecting the desired driving range. Flexibility and maneuverability become the system's calling card thanks in part to the intelligent driveline technology by ZF.

Easy handling is ensured by transmissions and axles offered by ZF as a complete driveline. The telescopic handler can be quickly fitted with shovel, fork, grab, working platform and other mounted implements for doing the most varied jobs. This variety of possible applications is highly appreciated, particularly by users in the agricultural sector, and becomes even more valuable with ZF's enhanced driveline technology.

ZF Optisteer, for example, is an innovative steering kinematics optionally available for telescopic handler steering axles. It optimizes steering geometry by a variable length tie rod, improves steering and reduces tire wear. The steering angle error can be reduced by more than 50 percent and it reduces the tire side force by a minimum of 40 percent and contributes to fuel efficiency.

ZF offers heavy-duty transmissions, axles and electronic systems that combine for a driveline package that provides flexibility and precision for construction equipment. These driveline components are matched more precisely to the relevant vehicle requirements in cooperation with the various manufacturers. Additionally, attention is paid to the requirements of the fleet operator and the driver, both in their work with the machine, as well as with upkeep and maintenance.

Today, ZF is focused on reducing fuel consumption, lowering wear and emissions, increasing productivity, extending service intervals and providing better handling and more automation services. The 2 HC 85 drive system is just one example of ZF's efforts in off-highway transmission technology. Here are a few other transmission systems developed by ZF for the off-highway market:

**ZF-Ergopower:** This tried and tested transmission system has been optimized for different construction machinery types and offers the optional feature of five instead of four gears. Therefore, the noise-optimized transmission allows even more comfortable and easier handling, high shifting quality and flexibility. Moreover, the operating costs can be further reduced. The ZF-Ergopower provides additional possibilities for connecting an electronic driveline thus en-

abling vehicle-specific controls. With the modular construction and optimized design operating costs are kept as low as possible. Helical gears with high tooth contact reduce the noise level. Extremely short shafts reduce deflection and tooth contact faults. The vertical arrangement of the spur gear ratios bridges the height difference between the input and output shafts. Consequently, the axle differential can be integrated into the housing. An additional transfer box is then unnecessary.

**ZF-Ergopower LII:** This transmission is a complete new countershaft design for the application especially in dump trucks, motor graders and heavy wheel loaders. The main features for this new development are high efficiency, higher speed, higher tractive effort and less noise emissions. Well known and accepted design criteria like rotational pressure compensation, set right bearings or short and stiff shafts are combined now with a remarkably reduced internal speed which results in less fuel consumption. The new transmission features onboard electronics, and can optionally be mounted to the axle drive.

**ZF Hydrostar HL:** This transmission mainly used in wheel excavators is produced in three capacity ranges and can be mounted directly to the ZF rigid axle MT-E 3000 range or mounted separately to the chassis. It can be used for

an input torque from 550 Nm up to 950 Nm and an empty vehicle weight from 15 to 25 tons.

**ZF 4 WG 94/98:** This powershift transmission is specially designed for the application backhoe loader up to an engine power of approx. 80 kW and a gross vehicle weight of up to 9,000 kg. Engineered by ZF in Germany, this transmission is produced in the United States by ZF Gainesville, Georgia.

**ZF WG 160-310:** Graders are specialists for flat terrain. In rough conditions, for construction-site roadways or laser controlled leveling of large areas, a grader is suitable. ZF develops system transmissions representing a high added value for any construction machine. Maximum power utilization, optimum shifting quality without tractive effort interruption, easy maintenance and diagnostics combined with low noise emission delivers transmission technology being of equal benefit to the vehicle owner and the driver. For mobile cranes ZF-Ergopower transmissions are used in various dimensions according to the necessary performance of the individual vehicles. ZF-Ergopower transmissions offer completely new standards to the market. Helical gears with high tooth contact area. Vertical arrangements of spur gear ratios bridge the difference in height between input and output shaft, allowing the axle differential to be integrated into the housing. No additional transfer box is required.

**ZF WG 98 TC/WG 98 TSC:** ZF transmissions in telescopic handlers are designed for a maximum engine power of 90 kW. These transmissions in connection with the MS-T 3000 series allow the installation of different mountings of the boom (low and high, middle and center mounted boom up to a payload of 5.6 tons). More than 15 years of experience and a production of more than 42,000 transmissions have solidified ZF's design and quality success in this field.

**ZF-Ecomix II:** This transmission is the new generation for concrete mixers up to 10 m<sup>3</sup> (13 yd<sup>3</sup>) drum capacity and an output torque up to 62,000 Nm (45,700 lb-ft). The compact lightweight construction makes Ecomix II 20 percent lighter and 50 percent shorter in comparison to previous models. The



**ZF has met the increasing demands of lower fuel consumption in compact loaders with its hydrostatic drive technology (courtesy of ZF).**





**ZF-Ergopower transmissions offer completely new standards to the construction and machinery markets (courtesy of ZF).**

use of patented elastomer units allow an increase of the axial run-out at drum bottom and an increase of misalignment of the drum. The acoustic and mechanical decoupling of the drum and vehicle frame leads to considerable noise reduction during operation and improved driving comfort. Serviceability has been improved thanks to separate oil for transmission and hydrostatic system as well as an improved accessibility.

*ZF WG 90-311:* ZF fully automatic powershift transmissions are specially designed as a short drop version and are used mainly in IC (internal combustion) lift trucks and reach stacker applications up to 60 tons lifting capacity (140 tons gross vehicle weight) but also in terminal Trucks, yard tractors and aircraft tow tractors. These transmissions are used in the range of 65 to 330 kW.

ZF is one of the few independent automotive suppliers, whose hybrid technology is being used as a standard. The Group has adjusted its product program to the increasing demand for hybrid technology and thus covers the entire range: components, modules, and complete hybrid systems based on the parallel hybrid design. They can be used as a basis for all hybrid designs, from the micro and mild hybrid to the full hybrid, which leads to roughly 30 percent fuel savings compared to a conventional driveline.

With these and other system developments, ZF follows a trend to market continuous variable transmissions in the construction- and agricultural machinery market. Hydrostatic technology is more and more displacing hydrody-

namic (torque converter) transmissions especially in construction machinery systems. Lowering engine speed and slowdown of the engine through a continuous drive concept is the main focus.



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