

# Traversing Steep Slopes

## Hydrostatic Drive Concept Gives LinsiTrak Flexibility and Versatility

Bosch Rexroth

**“In landscape gardening you will find special-purpose vehicles for almost every task – from the riding lawn mower to the equipment trailer. And anyone confronted with steep slopes faces a real challenge, since these vehicles are normally designed for relatively flat and level fields,”** says Werner Müller, owner and operator of LinsiTrak. **“When we launched development for the LinsiTrak, the target was clear: A versatile tractor for landscape gardening that maintains its maneuverability even on steep grades. Only a hydraulic drive concept could master this challenge. But initial trials came to nothing. The project actually didn’t pick up speed until 2006, when we were able to recruit Rexroth as a partner. There was no concept available that we could have simply taken ‘off the shelf.’”**

The major challenge, according to Müller, was to apply the appropriate



The LinsiTrak’s operator sits vertically in the seat even on a 45 degree slope (all photos courtesy of Bosch Rexroth).

amount of driving power to each of the four wheels at all times. That is simply impossible using conventional differentials, since on a slope the wheels that are not in contact with the ground will always spin. And the locking differential offers no real help, either. “The wheels would rotate at identical

speeds in every curve, thus causing unnecessary slip and that would ultimately plow up the ground. Travelling in circles or evading obstacles would be very critical,” says Müller.

Rexroth offered a hydrostatic drive concept with its High-Efficiency Traction Control (HET). But even that design did not exactly match the requirements for the LinsiTrak. In the normal case a HET drive, with one adjustable-displacement pump each in two circuits, will drive two hydraulic motors connected in series. Power distribution in this concept is entirely dependent on the torque, which means that pressure splitting depends on the traction at each wheel. The consequence is that the uphill wheels would always spin.

### Ready for the Slopes

To modify the HET concept for operation at an angle, Müller pursued a new path for the LinsiTrak. There are now two separate HET circuits in the vehicle, comprising one each A10VG adjustable-displacement pump, two MCR wheel motors and an HET con-



All three A10VG adjustable pumps used in the LinsiTrak are at a common location.

trol block. One circuit drives the left side, one the right side of the vehicle. What might at first glance seem like a step backwards is in fact the decisive feature. In this way the differential can balance power distribution on the two sides of the vehicle. The BODAS RC 36-20 control unit made by Rexroth automatically regulates the outputs of both pumps, in dependency on the steering radius, to deliver the exact volume of fluid required by the hydraulic motors. When traveling around a curve, the pump for the motors at the outside of the curve will always provide proportionately more fluid than to the inside wheels and thus forms a perfect basis for the motion. The electronics control not only these features, but all the vehicle's other functions, too. The LinsiTrak has no mechanical levers, no clutch and no chain.

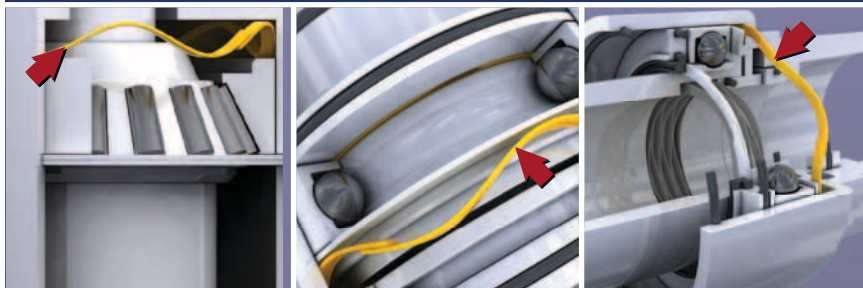
### Thrifty Both on Slopes and on the Road

A vehicle like the LinsiTrak will be used above all by municipal road maintenance departments. And efficiency plays a major role, for simple cost reasons, particularly in towns and cities. The LinsiTrak runs for ten hours with a single tank of fuel, which means that large areas can be worked without interruption. Although its power output exceeds that of comparable vehicles, it is more efficient in operation. On the road, with the series connection active, fuel consumption would jump when speed tops the 40 km/h mark. This is because each wheel traces a slightly different curve during travel, which would result in continuous application of pressure without a load actually being applied. In order to avoid this needless consumption, the user can select from several operating modes for the hydrostatic drive system. In on-road operations the series connection is disabled. Only one wheel motor in each circuit is involved in locomotion. Just like a rear-wheel-drive passenger car, in this mode the drive power for

forward travel is applied entirely at the rear wheels, making for optimal traction during acceleration.

"By contrast, the hydrostatic braking acts almost exclusively on the front wheels. This is all the more important when travelling downhill, since the

weight shift to the front axle enhances the braking effect at the front wheels," Müller adds. "When travelling forward on flat surfaces, those wheels simply 'idle' in the hydraulic circuit. Driving wheels individually in this way saves fuel."



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A special HET valve made by Rexroth thus disables the series connections and applies only the required pressure level to the front wheels. The “series connection active or inactive” option makes sure that the drive is easy on the environment at all times and under all circumstances. A third mode, the so-called “offset mode” is interesting especially when traveling over soils sensitive to compaction. In this mode the tracks of the front and rear wheels at the LinsiTrak are offset and thus help to protect the substrate.

### Many Functions, No Tools

But even the very best drive concept will be of no use to the landscape gardener without the right implements. That is why – adjacent to the two adjustable-displacement pumps for the drive motors at the rear of the vehicle – there is an additional axial piston pump to power implements such as the lawn mower, mulcher or sweeper. Several attachment points on the vehicle, between the axles at the front and rear, match a variety of implements, which can be attached without tools. Just like the HET drives, the power take-off guarantees maximum energy



Adjustments are easily made using the D13 color display.

efficiency thanks to its stepless speed control and since the diesel engine is regulated to the most efficient speed. And in spite of its many functions and elaborate technology, the LinsiTrak is a compact and easy-to-steer unit. Even on 45-degree slopes, the driver's seat is always horizontal, thanks to the automatic tilt feature. The slope sensors used here work something like an electronic spirit level. They continuously transmit the tilt angle to the electronics, which then regulate the seat hydraulically. The complex functions for

the various work tools are implemented in the electronic controls. At market launch any fine adjustments can be made conveniently, using a color display and from the driver's seat. By the time these functions are programmed, the LinsiTrak will also have adopted its final form – the roll bar has to be slightly higher, the vehicle is to be a total of about twenty centimeters shorter and an optional cab will be available. The bulk of the work has been completed, however: developing an innovative drive concept that will also provide valuable impetus for future solutions.

### PTE

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The major challenge was to apply the appropriate amount of driving power to each of the four wheels at all times.