

Liebherr Pactronic® - Hybrid Power Booster

Energy Recovery and Increased Performance with Hybrid Power

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Abstract

The world leader in mobile harbour crane technology offers the industry's first hydraulic hybrid drive for mobile harbour cranes. The new Pactronic® - hybrid drive system addresses two critical issues: increasing handling performance and reducing fuel consumption.

The Liebherr Pactronic® is a revolutionary new hydraulic hybrid drive system and based on an additional energy storage device (accumulator). It is charged by recuperation of reverse power and by the surplus power of the prime mover. The energy, which is stored in the compressed gas, can be released upon demand and provides additional power for the drive system.

KEYWORDS: Pactronic®, hydraulic hybrid drive, increased performance, reduction of emissions, fuel-savings, hybrid power booster

1. Introduction

With the globalization, the global networking of national markets and the increasing liberalisation of world trade, the volume of worldwide trade flows has been rising steadily. Nowadays more than 5 billion tons of goods are transported via seaborne trade. Following the drastic downturn in the previous years, the volume of trade grew exceptionally strong in 2010 and 2011. This led to further increasing rates of growth in global container and bulk handling, an area closely linked to this development. These economic circumstances are a challenge for all types of logistics and require optimised processes for the handling of cargoes. The performance of a crane in loading/unloading is a crucial factor for the total cost of ownership, in addition it may have an influence on the port infrastructure.

The primary focus of Pactronic® is increasing turnover performance. In addition fuel consumption is significantly reduced. In-line with the fuel consumption, CO₂ emissions are also decreased. Thus the crane's efficiency reaches new levels.



Figure 1: Liebherr mobile harbour crane in container operation /1/

2. How to increase handling performance

To increase turnover with a crane, the three main drives slewing, luffing and hoisting can be changed. Due to centripetal- and coriolis-forces while slewing, the movements of luffing and slewing cannot be accelerated at any amount. In contrast, the hoisting gear offers potential for significant optimisation.

While increasing the hoisting speed without load seems to be very simple, maximum output power of hoisting gear and the primary mover is reached immediately when moving the crane with loads.

Conventional approach

Figure 2 shows the conventional, hydrostatic hoist system of a Liebherr mobile harbour crane, which is driven by a hydraulic motor, a pump and the prime mover (diesel or electric engine).

Up to now, enhanced drive power was achieved by further increasing the power of the prime mover and all associated components. This solution is on the one hand very cost-intensive, on the other hand it leads to an increased fuel consumption.

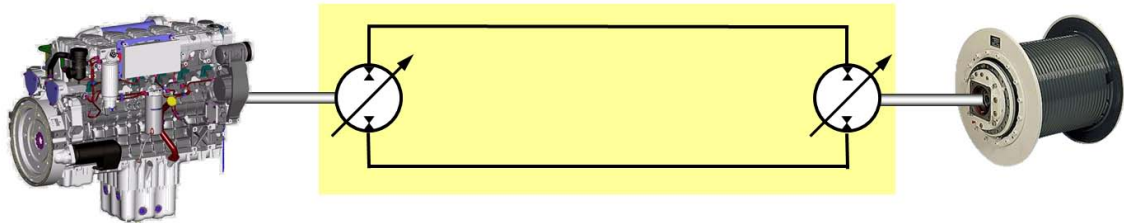


Figure 2: Conventional hydrostatic drive system

3. Boosting performance with hybrid drive system Pactronic®

3.1. Pactronic® concept

As an alternative to the conventional approach, the Pactronic®-drive system, pictured in **Figure 3**, can be used [2],[3]. The name Liebherr Pactronic® is derived from Power by Accumulator and Electronics and is an innovative drive system on a hybrid basis. Instead of increasing the primary power, boosting power is done by adding a secondary energy source to the system. Thereby, the energy storage is connected to the primary mover via a loading pump. In order to reach an optimal efficiency, a hydraulic motor is directly coupled to the hoisting winch.

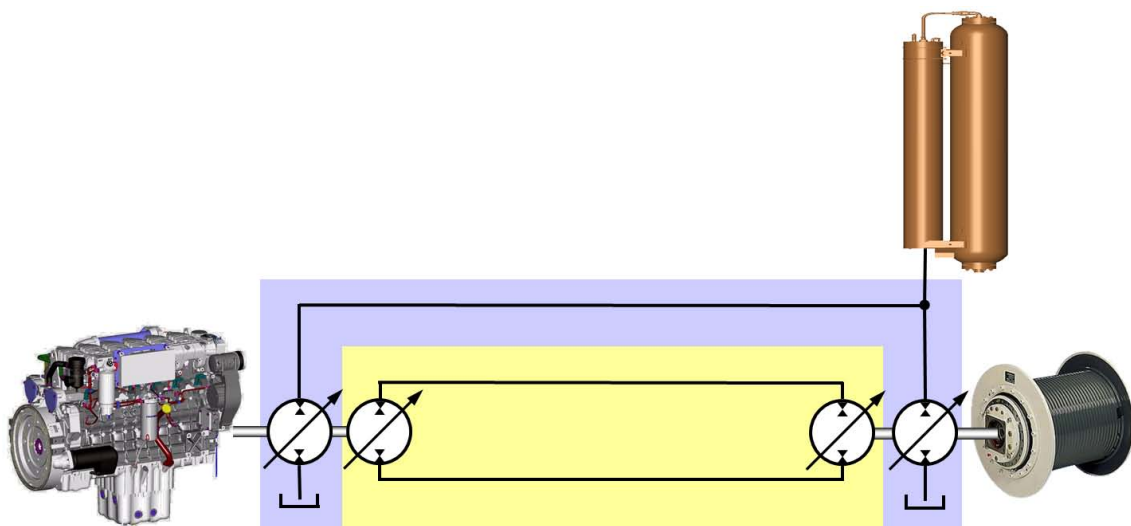
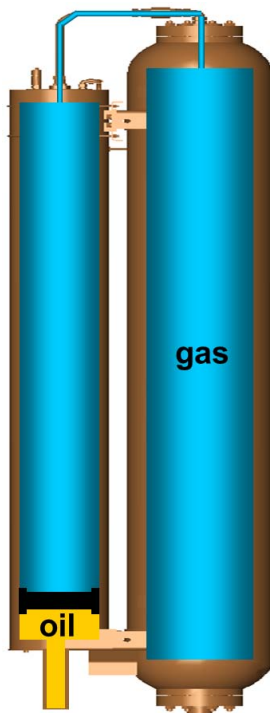


Figure 3: Pactronic® hybrid drive system

The storage of energy is done by a hydraulic accumulator, which can be charged and discharged during normal operation. The accumulated energy can be used while hoisting a load.

3.2. Hydraulic accumulator

The energy storage of the Pactronic®-system is carried out by a hydraulic accumulator (see **Figure 4**). Energy is stored in this compressed gas to be released upon demand very fast. The hydraulic energy storage technology offers a lot of significant advantages in comparison to electrical energy storage:



- Proven energy storage technology
- Designed service life is equal to the crane
- Virtually maintenance free
- Fast charging and discharging
- Performance not affected by ambient temperature (no cooling, conditioning or isolation needed)
- 100% recyclable

Figure 4: Hydraulic accumulator

3.3. Management of hydraulic accumulator

Figure 5 shows a typical load cycle during bulk handling operation. It is obvious, that the primary mover is subject to enormous fluctuations in primary power. The maximum power during hoisting is needed only for a short time and reaches values up to 1340 kW. In contrast, only 500 kW are needed on average. With an installed power of 670 kW it is possible to power the hoisting gear during the complete load cycle. Power peaks are bridged by using the stored energy from the accumulator.

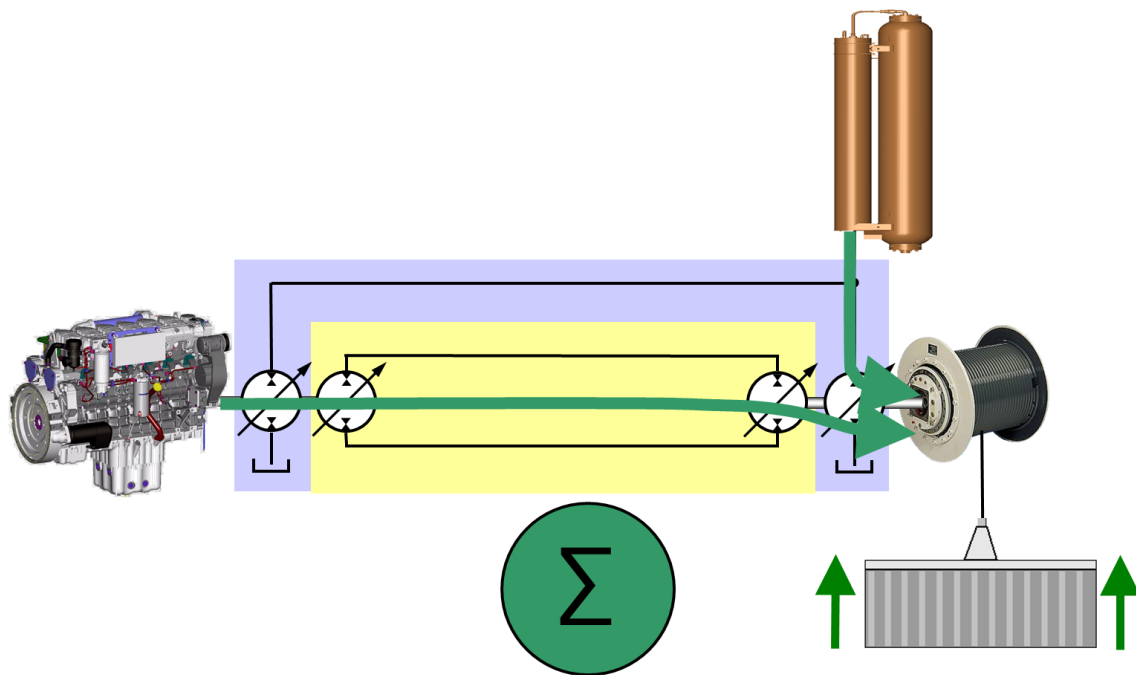


Figure 7: Power flow while hoisting a load: maximum hoisting power is the sum of the diesel engine and the accumulator

The stored energy is transferred back to the system, when the crane requires peak power during hoisting. Consequently, the total hoisting power is the sum of the conventional hydrostatic power and the secondary energy, provided by the accumulator (see **Figure 7**).

In this way, an enormous power boost is possible with the Pactronic®-system. Both, hoisting as well as lowering speeds are increased significantly despite of unchanged primary power. When comparing the Pactronic® drive system with a conventional Liebherr mobile harbour crane with identical prime mover (diesel or electric engine) installed, hoisting power is doubled resulting in an increased hoisting and lowering with up to 100% higher speeds. With a focus on turnover (tonnes/hour), the end user benefits from an increase in performance of 30% on average depending on the crane's operation mode (see **Figure 8**).

Example: A Liebherr mobile harbour crane type LHM 550 with Pactronic® has recently been delivered to Port of Odense in Denmark. The crane has now passed the trial period and demonstrated that substantial benefits for the port could be achieved. With this new crane, unloading times for the port's operations have been reduced by a third (application: handling of 30,000 tons scraps metals).

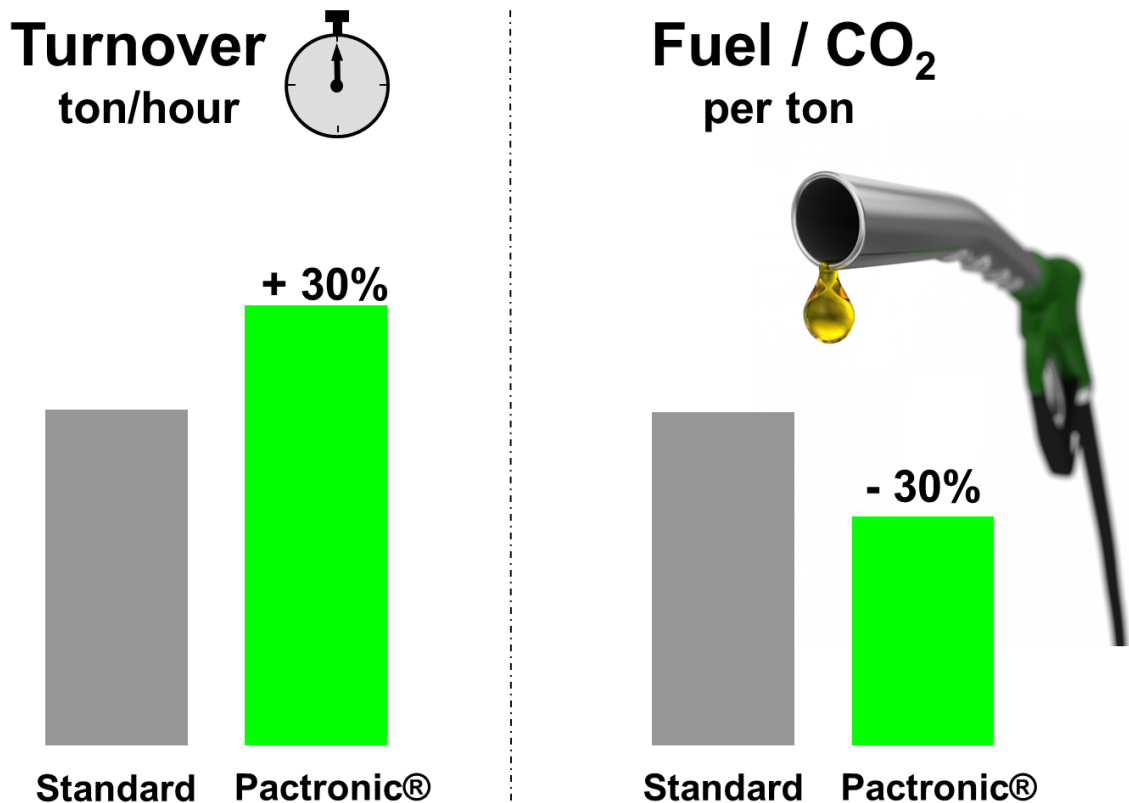


Figure 8: Comparison of power and fuel consumption

In addition to the performance boost, a considerable reduction of fuel consumption is achieved. This is obtained by using reverse energy of load and surplus power of the system.

In comparison to Liebherr mobile harbour cranes with a conventional drive system and identical turnover (tonnes/hour) the Pactronic® hybrid version needs 30% less fuel (litre/ton) depending on the crane's operation mode.

In the current challenging economic times, it is important that large hybrid energy developments such as the Liebherr Pactronic® continue for sustainable carbon emission reductions. In-line with the fuel consumption, CO₂ emissions are also decreased by 30%.

4. Summary and outlook

The pioneering drive concept of the Pactronic®-system reaches an enormous increase of power and efficiency. By doubling the hoisting power via hydraulic accumulator, turnover performance can be increased by 30% without changing the primary power. Fuel consumption and exhaust-emissions are reduced by 30%.

The Pactronic® concept is already available in the mobile harbour cranes of type LHM 420, LHM 550 and LHM 600 and will be gradually rolled out on more models within the broad Liebherr machinery range.

Bibliography

/1/ LHM 550 Data sheet: www.liebherr.com

/2/ Liebherr Pactronic® hybrid power booster: www.liebherr.com

/3/ Product video Liebherr Pactronic®