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Technical article

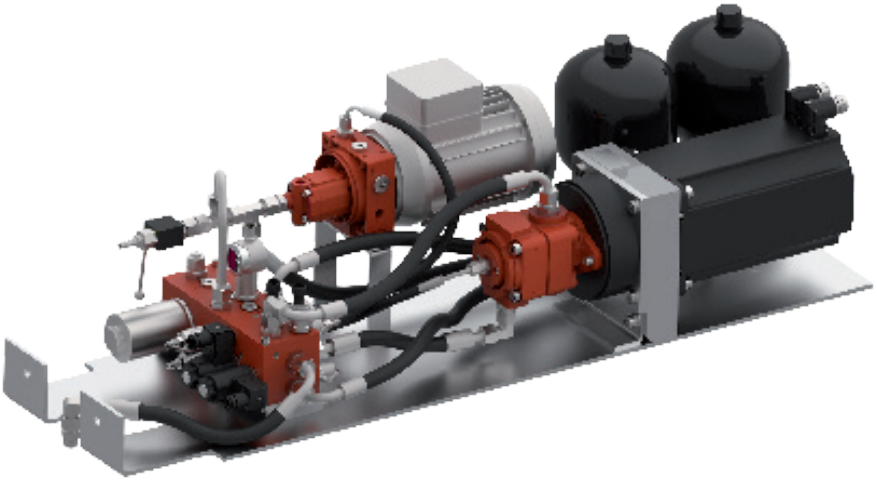
Add Value Systematically

With smarter systems architecture, Bucher Hydraulics redefines the term “savings potential”

Using energy more efficiently and reducing total operating costs are ambitious goals, but goals that can seldom be achieved by simply changing components. Successful positioning in ever-changing markets therefore requires new approaches to these problems. But innovative systems, which need hydraulics, software, control systems, and networking to Industry 4.0 levels, also need combined know-how in those same fields. Based on their extensive experience, Bucher Hydraulics offers cross-technology system solutions from a single source and in this way creates intelligent architectures with new and obvious benefits for the user.

Conventional hydraulics remains the standard in numerous applications. In particular, throttling control systems are still frequently used despite their very high losses, and due to their operating principle – using throttling to control the supply of energy – they offer enormous potential for improving energy efficiency. Often, the better solution is “Pump Control – Power on Demand”, where only as much pressure and flow is generated as the drive needs at the time. Instead of a centrally positioned power unit that involves long pipe runs, the drives are now arranged in a decentralised fashion, right at the actuators. Pipeline losses, installation space, as well as installation time and costs, are therefore significantly reduced. This results in a worthwhile investment in terms of Total Cost of Ownership.

Implementing quiet, compact self-contained axes such as these requires extensive expertise in various disciplines, however. Bucher Hydraulics has continuously expanded this multi-technology know-how over many years of product and application experience. As a result, the innovative hydraulic drive and control technology for mobile and industrial applications is being systematically enhanced, and the range of products needed to meet customer requirements is being widened.



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Bundled know-how for new projects and ongoing development

With this expertise as a foundation, the company is far more than just a component manufacturer: it also engineers, plans and builds complete, turnkey systems. Together with the company Jetter, also a part of the Swiss technology group Bucher Industries, Bucher Hydraulics offers its customers access to comprehensive, in-house automation know-how, enabling users to benefit from valuable support from the planning phase right through to the manufacture and assembly of their machinery and equipment.

Both for new projects and for enhancing existing machines, this combined know-how is the best starting point from which to identify savings potential in the existing application and implement new solutions using cutting-edge technology. Where the hydraulics are concerned, users can make the changeover from lossy throttling control to a servo-hydraulic pump-control system. Bucher Hydraulics integrates it into a comprehensively smart system architecture. In this way, significant energy savings of up to 70 % can be achieved. At the same time, a solution like this can be built to be Industry 4.0-compatible.

Fig. 1: Hans Borer, Nencki AG

Hans Borer, Technical Director of the Railway Engineering division of the Swiss company Nencki AG, summarises the benefits of the smart system architecture from Bucher Hydraulics:
"*We are seeing better energy efficiency and optimised life-cycle cost. Acoustically, the new system is in a different league from the unpleasant sound of the old hydraulic or ball-screw drives.*"

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Nencki: Successful transition to Power on Demand

One example of an innovation of this type is the direct servo-hydraulic drive for two double-rod cylinders, such as the one that the specialists from Bucher Hydraulics have incorporated in a test rig in the Railway Engineering division of Nencki AG. This Swiss company is active in the most important railway markets worldwide. Hans Borer, Technical Director, cites the decisive reasons behind the cooperation with Bucher Hydraulics: "*We needed a reliable partner with experience in hybrid technology, who knew how to combine the implementation of the highly energy-efficient servo drives with hydraulics. Bucher Hydraulics identified what we needed to happen after the components were delivered, highlighted opportunities and, in close cooperation with us, developed a professional, state-of-the-art solution. We also consider it important that this new system is capable of being enhanced and optimised to meet future requirements in the areas of efficiency and costs.*"
(Fig. 1: Hans Borer, Nencki AG)

The bogie test rig is a typical application for a linear drive technology involving control of force, displacement and speed. The drive technology needs to have a sufficiently high power density and be convincingly robust. The technology previously used was a conventional hydraulic system, consisting of a power unit with an E-motor/pump assembly, cylinders and proportional valves. In short: a throttling control system, as is often still used for implementing translational movements.
(Fig. 2: Nencki_Former test rig)

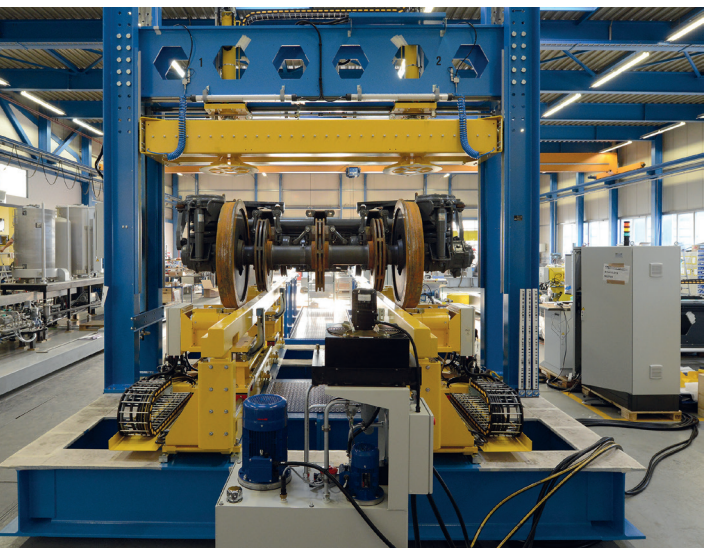

Fig. 2: Nencki_Former test rig

The bogie test rig is a typical application for a linear drive technology involving control of force, displacement and speed, and whose high power density and robustness need to be convincing.

Conventional hydraulics in the form of a throttling control is still often used for this purpose, but this in turn offers great potential for savings in the areas of energy, costs and the space required for the power unit.

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70 percent energy savings

By switching to servo-hydraulic axes, users can save up to 70 percent of the energy. In the conventional throttling control system, there are two significant drawbacks. The system's intrinsic throttling losses have a negative impact in themselves, and the removal of the resulting heat can lead to problems. Typical power units, together with cooling equipment, can therefore reach a considerable size. Hans Borer talks of the 250 litre volume that the previous power unit had. "Thanks to the new axis, just 30 litres of oil is required for the hydraulic component today. In addition, the unit had to be freely accessible from all sides, and its footprint has now been eliminated."
(Fig. 3: Nencki_New test rig)

For larger installations, such as six-axis flight simulators like the hexapod, the power unit for a conventional hydraulic system can easily fill a separate room. In an application of this type, Bucher Hydraulics succeeded in reducing the energy demand by around 70% and the oil requirement by about 90 percent, because only the actual pendulum volume had to be provided for.
(Fig. 4: Comparison of energy demand)

Reducing the volume of oil, and having a smaller space requirement, are by no means the only criteria that speak for modernisation in the case of a conventional hydraulic system. Rather, it is an overall consideration of the system, including noise levels, installation and commissioning work, operating costs, user know-how required, as well as operating safety and the system's degree of future-proofing.

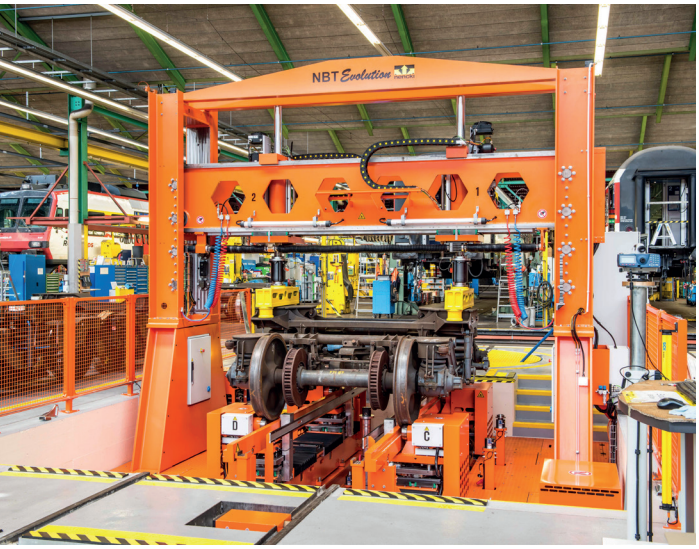

Fig. 3: Nencki_New test rig

Thanks to the smart system architecture that Bucher Hydraulics engineered and built for the Nencki bogie test rig, the new axis requires only 30 litres of oil instead of the previous 250 litres. One result is that the large footprint occupied by the previous power unit can be put to a different use today.

Greater benefits in numerous applications

Hans Borer summarises the benefits of the smart system architecture that Bucher Hydraulics has implemented: "*We are seeing better energy efficiency and optimised life-cycle cost. Acoustically, the new system is in a different league from the unpleasant sound of the old hydraulic or ball-screw drives.*" There are additional technical features on the plus side, as he adds: "*We can run up to the specified loads with greater accuracy and keep them within the resolution range of the load cells. The quality of the control is similar to the position or force control of an electromechanical servo drive, but without the frictional losses.*"

The system is also overload-proof, precise and robust, even when external forces act on it. These features make servo-hydraulic axes suitable not only for test rigs but also for presses (Fig. 5: Press brake), where long life is a very important factor, or injection moulding machines, where the bulk of the product manufacturing cost consists of energy costs, which means that Total Cost of Ownership plays a prominent role. The range of potential applications extends all the way to lifting systems, which need to be capable of precision movement under large loads and with the lowest possible level of jerks and oscillations.

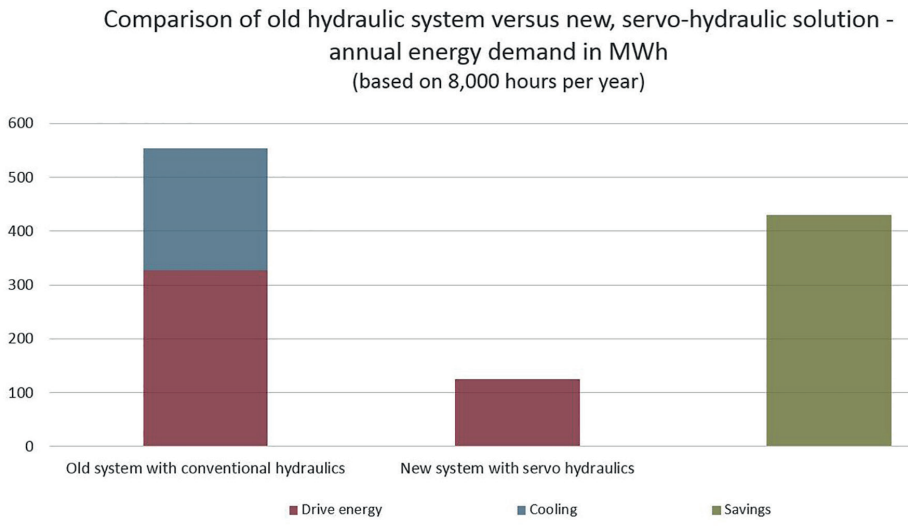

Fig. 4: Comparison of energy demand

The drive solution for a flight simulator clearly shows the advantages of the Bucher system.

Compared with conventional throttling control, the direct, servo-hydraulic 4-quadrant drive for six differential cylinders delivers convincing energy savings of up to 70 percent and works with an oil tank that has been reduced in size by an impressive 90 percent.

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Fusion of technologies

Merging the technology worlds of hydraulics and automation gives rise to intelligent systems that, thanks to their system design and simplified integration into the overall plant concept, offer the user new and significant advantages.
Unlike electromechanical servo drives, servo-hydraulic actuators offer the advantages of a hydraulic drive, as this direct comparison shows: while a classic worm-gear transmission, with the frictional losses inherent in its function, displays a maximum efficiency of 50 percent in the bogie test rig, the hydraulic transmission, consisting of 4-quadrant drive unit, cylinders and auxiliary valves, usually achieves an efficiency of around 80 percent.

Another plus is that the servo-hydraulic axis behaves essentially like an electromechanical drive. Installation and operation therefore require no special hydraulic expertise. This is supported by the plug and play solutions from Bucher Hydraulics, which can be easily connected with the user's industrial computer via fieldbus.

To implement its solutions, Bucher Hydraulics uses specially developed software (firmware), which is optimised for the customer's application and is programmed in a subsystem controller. This subsystem controller then communicates via fieldbus with the industrial computer operated by the customer, who can keep using the familiar user interface and database. In this way, the user gets a complete system, saving time and resources for the otherwise time-consuming programming. That programming also requires an in-depth knowledge of the hydraulic characteristics, because a hydraulic transmission behaves fundamentally differently from a mechanical one. Here, too, Hans Borer sees an important advantage: "*For our part, we input an acceleration ramp and a set point for the bogie test rig. The Bucher system takes care of everything else.*"

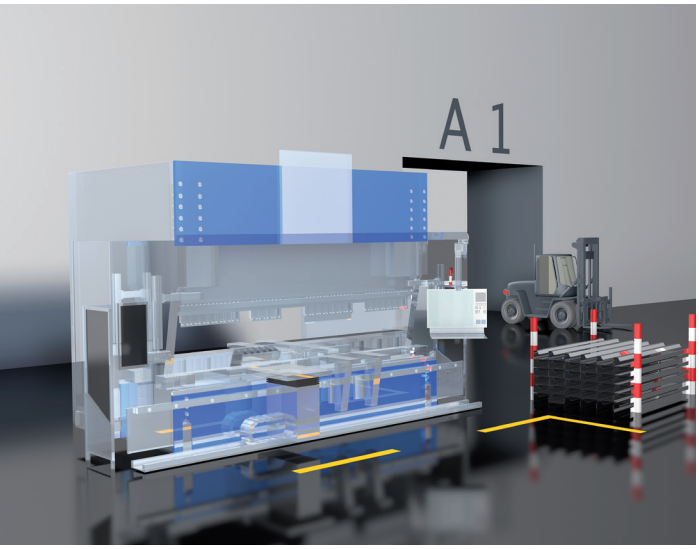

Fig. 5: Press brake

Press brakes are among the typical applications that offer a very high savings potential due to their continued use of throttling controls. By using an intelligent servo-hydraulic axis, their energy efficiency can be significantly raised.

With the fieldbus to Industry 4.0

Thanks to microcontrollers and the associated sensors, the distributed intelligence of the system offers the opportunity to exercise complete control of all characteristics via fieldbus. This is the precondition for preventive maintenance planning. The fact that the entire system now speaks the same language via fieldbus also enables successful integration into industry 4.0 concepts, so that machines such as presses, or even entire factory locations, can be networked globally.

The clever combination of the respective advantages of different technologies thus makes the difference that allows systems designed by Bucher Hydraulics and implemented using their proven components to be referred to as “smart”. Hans Borer sums up: “*The important thing is know-how in the fields of electromechanical drives, industrial hydraulics, automation technology, and the combination of these disciplines. Bucher Hydraulics proved this know-how in our project, just as they demonstrated their flexibility regarding new ideas.*” (Fig. 6: Servo-hydraulic axis)

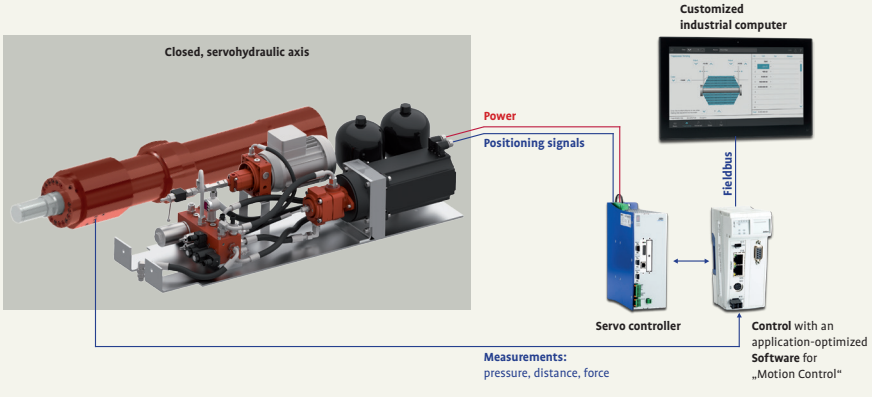

Fig. 6: Servo-hydraulic axis

Using the proven QXM 4-quadrant internal gear drive unit as the foundation, Bucher Hydraulics created a self-contained servo-hydraulic drive that is mounted directly on the cylinder. The complete linear drive is integrated into the rig‘s steel structure.

The control of position and force is done by means of displacement and force sensors together with application-optimised software on the subsystem controller, which communicates with the customer‘s industrial computer via fieldbus.

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