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Versatile working machines thanks to electronic control of open-circuit pumps

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With the eOC (electronic Open Circuit) hydraulic architecture, machine manufacturers can take full advantage of the potential offered by their mobile machines

- Marketable hydraulic architecture for mobile machines
- Software and components optimize the potential of machines
- In the future, travel and working hydraulics systems can be in a single circuit



Electronically controlling hydraulic pumps in open circuits with Rexroth eOC opens up new possibilities in the area of working hydraulics. Shifting complexity from the hardware to the software makes mobile machines even more flexible and productive. (Image source: Bosch Rexroth AG)

Manufacturers of mobile machines must decide whether to control their pumps using pressure, torque or the swivel angle – and always have to accept compromises as a result. The same applies to numerous other parameters which are defined once for the hardware and stay the same throughout the machine's service life. The new electrohydraulic solution from Bosch Rexroth counters this problem by moving control functions from the hydromechanical controller to the software. This makes machines even more versatile and flexible. At the same time, they benefit from increased productivity and lower energy consumption.

The eOC pump – the central component

The electrohydraulic eOC pump with swivel angle sensor and pressure sensors is the central component in the eOC architecture. It ensures the proper control of the necessary setpoint values for torque, pressure or flow. The pump provides highly dynamic control with millisecond accuracy in order to modulate the pressure for example. In combination with the eOC software, characteristics such as dynamics and power control can be set, changed and combined.

eOC software for machine optimization

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Controlled via a CAN interface, the eOC software makes it possible to set various control parameters flexibly during operation. With hydromechanical control functions and interfaces moved to the software, control modes can be individually changed and combined during operation and the pump dynamics can be set variably. Pressure, torque, flow and the swivel angle are thus controlled independently of each other in an electronically closed control circuit. With predefined parameters, the pump behaves optimally as part of the hydraulic system whatever the function is. Via the CAN bus interface, setpoint values and parameters can also be adjusted dynamically in order to allow additional functions and to adapt machines to cope with specific customer requirements and various work tasks.

The eOC software can be installed on a Rexroth BODAS controller or a controller from a third-party manufacturer. It constantly adapts the hydraulic power to the available engine torque and thus allows dynamic, precise work functions which ultimately increase the overall productivity of the working machine. The energy consumption of the entire hydraulic system is optimized, resulting in lower fuel consumption or better battery use.

Marketable machine concept

Mass-produced machines already benefit from the new hydraulic architecture. They include a compact excavator which entered mass production in the first half of 2021. A power mode for demanding excavation work was developed for this purpose. This operating mode allows maximum pressure and torque as well as maximum pressure gradient dynamics, for example when emptying the shovel. At the same time, the machine has a fine mode allowing jerk-free, smooth operation, for example when laying pipes.

The eOC architecture is also ideal for use in wheeled excavators. In order to adjust the power in these multifunctional machines to suit the particular task, numerous valves were needed in the past. The switchover to the eOC architecture significantly reduces the hardware outlay, minimizes costs and avoids potential sources of error in valve switching.

Ongoing further development

As a scalable solution, the Rexroth eOC portfolio allows step-by-step implementation – from the electrohydraulic eOC pump with swivel angle sensor and pressure sensors to the option to cover the entire hydraulic system. An eOC main control block and an electric joystick are provided for this.

Bosch Rexroth has now upgraded a wide range of axial piston pumps and added numerous new functions to the existing basic concept. For example, the eOC architecture now allows the dynamic control of pressure, swivel angle and torque gradients. This means that the pump not only reaches a specific target value – the pressure gradients that are needed to achieve this pressure are also determined. This allows much smoother and gentler motion, especially at the start of a movement.

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Auto-calibration, where the component is calibrated within the machine itself, is another new eOC function. Calibration therefore no longer takes place statically at the OEM's end of production line – it is instead carried out cyclically while the machine is operating. The eOC software records specific calibration data every time the machine starts. Other data are recorded whenever the machine's operating conditions allow this. In this case, up-to-date data which take into account aging effects or temperature differences for example are recorded and the parameters are automatically adjusted accordingly. This increases the reproducibility of behavior, full use is made of pump power at all times and the pump status information for further processing on the machine level is as precise as possible.

Travel drive in focus

The Rexroth eOC architecture not only opens up new possibilities in the area of working hydraulics – it also allows a new approach when it comes to the travel drive systems of compact machines in particular. Travel in the eOC functions in accordance with the secondary control concept. This combines the functionality of a closed-circuit travel drive with the physical layout of an open-circuit drive which only requires one pump for travel and working functions.

As a result, all travel and working hydraulics functions in compact machines can be combined in one hydraulic circuit – all rotating consumers are connected directly to the pressure line. A secondary logic system with no additional directional valves controls the hydraulic motors' displacement and output torque in order to achieve the desired rotational speed. The eOC travel concept requires fewer components in the machine and simplifies the hydraulic architecture. Complexity in the hydraulic system is moved into the software. Travel direction valves and brake valves are no longer needed. In addition, the combination of working and travel functions in one hydraulic circuit allows the recovery of hydraulic energy during braking or lowering and thus ensures that the optimum use is made of the drive power.

Basic Information Bosch Rexroth

As one of the world's leading suppliers of drive and control technologies, Bosch Rexroth ensures efficient, powerful and safe movement in machines and systems of any size. The company bundles global application experience in the market segments of Mobile Applications, Machinery Applications and Engineering, and Factory Automation. With its intelligent components, customized system solutions and services, Bosch Rexroth is creating the necessary environment for fully connected applications. Bosch Rexroth offers its customers hydraulics, electric drive and control technology, gear technology and linear motion and assembly technology, including software and interfaces to the Internet of Things. With locations in over 80 countries, more than 29,600 associates generated sales revenue of around 5.2 billion euros in 2020.

Basic Information Bosch

The Bosch Group is a leading global supplier of technology and services. It employs roughly 395,000 associates worldwide (as of December 31, 2020). The company generated sales of 71.5 billion euros in 2020. Its operations are divided into four business sectors: Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. As a leading IoT provider, Bosch offers innovative solutions for smart homes, Industry 4.0, and connected mobility. Bosch is pursuing a vision of mobility that is sustainable, safe, and exciting. It uses its expertise in sensor technology, software, and services, as well as its own IoT cloud, to offer its customers connected, cross-domain solutions from a single source. The Bosch Group's strategic objective is to facilitate connected living with products and solutions that either contain artificial

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intelligence (AI) or have been developed or manufactured with its help. Bosch improves quality of life worldwide with products and services that are innovative and spark enthusiasm. In short, Bosch creates technology that is “Invented for life.” The Bosch Group comprises Robert Bosch GmbH and its roughly 440 subsidiary and regional companies in some 60 countries. Including sales and service partners, Bosch’s global manufacturing, engineering, and sales network covers nearly every country in the world. With its more than 400 locations worldwide, the Bosch Group has been carbon neutral since the first quarter of 2020. The basis for the company’s future growth is its innovative strength. At 129 locations across the globe, Bosch employs some 73,000 associates in research and development, of which nearly 34,000 are software engineers.

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