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A Bosch Company

Machine tools: Integrated hydraulic power units save space

Optimum power, less installation space: Thanks to new intellectual and design approaches, compact hydraulic power units increase the economic efficiency of machine tools.

POWERFUL FORCE IN A VERY CONFINED SPACE

In the production world, hydraulics are firmly established. Machine tool manufacturers appreciate hydraulics for their high power density, toughness and modular design. In the lower performance range up to 4 kW, however, there are also some challenges. Since the installation space is often limited, designers and technical purchasers are constantly looking for increasingly compact solutions.

INSTALLATION SPACE IS VALUABLE

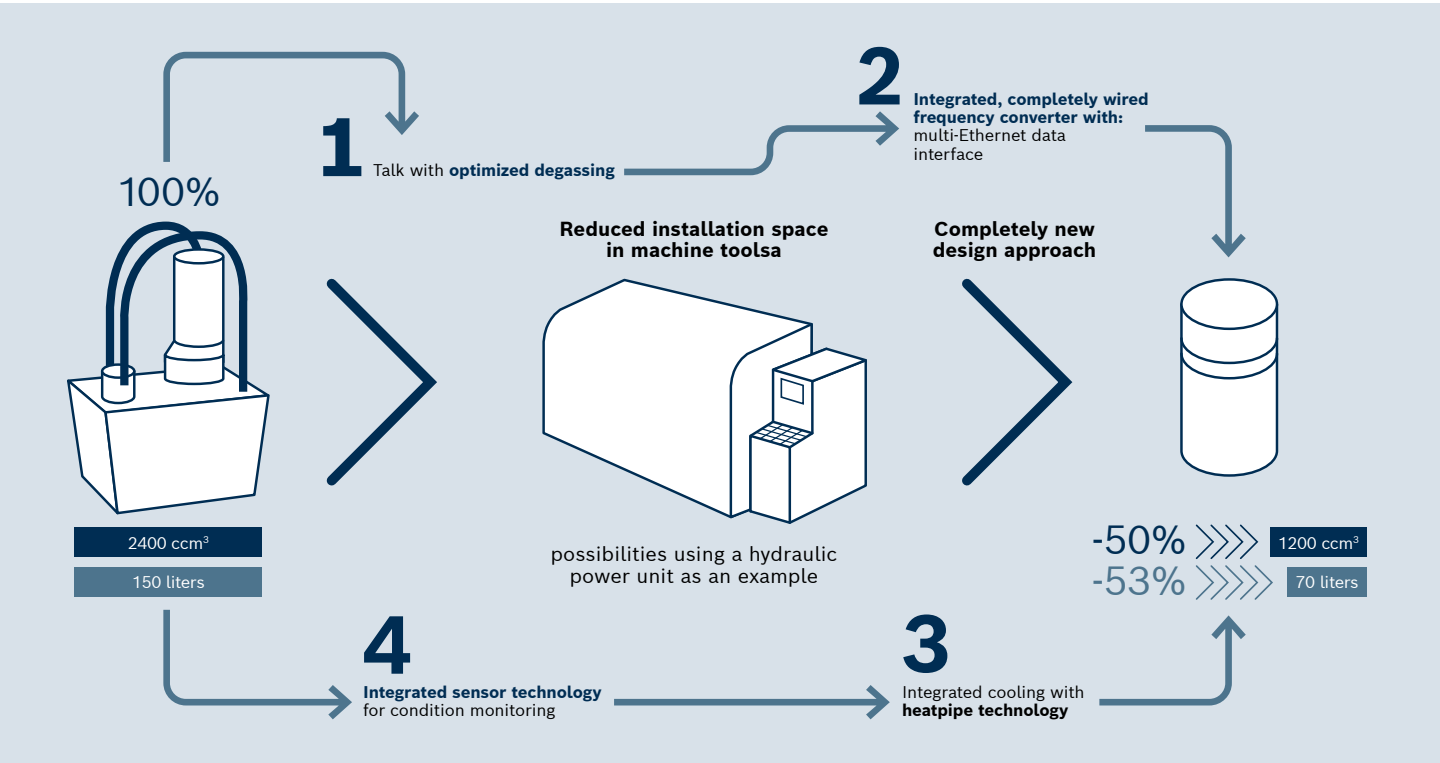
The demand for compact hydraulic drives is not only due to the structurally limited flexibility regarding extensions, modernization measures and refittings but also due to the requirements regarding acquisition costs and assembly times or structural extensions of the working space with given machine dimensions. In addition to the level of integration of the functions, energy efficiency often plays an important role as well. Last but not least, many manufacturers are following the miniaturization trend. If workpieces become increasingly smaller, the moved mass of the machine tool has to be decreased accordingly.

"INSTALLATION SPACE EATERS"

To reduce the installation space, solution manufacturers can start mainly with the following components: hydraulic power unit and control cabinet. When considering this split, it becomes evident that compact power units which are also easy to integrate require completely new design approaches to eliminate all features which waste unnecessary space in the performance spectrum up to 4 kW and to ensure that the units are still compatible with many different machine designs.

HIGHLY INTEGRATED DESIGN APPROACHES

The features of such innovative design concepts according to the EU Eco-Design Directive 2009/125/EC for example include a tank which is optimized for efficient degassing and reduces the oil volume by up to 80 percent. A much more decisive factor for gaining space is, however, that all functions can actually be integrated in one small power unit – from an economic variable-speed drive for demand-based power output to sensor technology with filling level, temperature, pressure and filter contamination sensors to a completely wired frequency converter.



▲ Revolution compact: With four key innovations integrated hydraulic aggregates gaining installation space.

COMPACT AND READY FOR INDUSTRY 4.0

For the future viability of this approach with regard to Industry 4.0, a data interface is essential as well. Only with permanent condition monitoring can the operating conditions be optimized comfortably and relevant faults be detected early on. With this equipment, the user only has to connect the electric power, the data interface and the hydraulic supply during installation and the hydraulic power unit is ready for operation.

NEW COOLING WITH HEATPIPE

So-called “heatpipes” are considered to be a space-saving innovation regarding the cooling of hydraulic power units. Their high-performance passive thermal conduction allows for a further reduction of the frame size. The heatpipes absorb the thermal energy of frequency converter, motor, and hydraulic oil and efficiently transfer it to a central heat sink such as e.g. cooling water. This ensures an intelligently optimized thermal management within the hydraulic power unit and optimally utilizes the cooling power of the cooling water. There is no need for a separate hydraulic circuit for oil cooling. This reduces installation space, noise emissions, energy consumption and possibilities for leakage.

PLUG & PLAY: NO CONTROL CABINET

The frequency converter has a high potential for gaining installation space as well. If it has already been equipped with Multi-Ethernet interface for Sercos, Profinet, and other standards by the manufacturer, machine and plant manufacturers are able to reduce the control cabinet requirement for the hydraulic unit by up to 100 percent. As a precondition, however, the sensor technology and the motor in the power unit have to be wired to the frequency converter in such a way that the frequency converter can control the hydraulic pressure autonomously. This means that the control cabinet can not only be designed with smaller dimensions; sometimes it can even be completely omitted altogether with the corresponding installation effort and related sources of error.

CONCLUSION

Fully integrated small power units based on a completely innovative design approach for the performance range up to 4 kW provide machine and plant manufacturers with the advantages of hydraulic drives with very little space requirements. As an alternative to purely electrical solutions, the required energy can be converted into a linear movement in a precise and cost-effective manner directly at the working area using a simple hydraulic cylinder. If sensor technology, frequency converter and data interface are integrated as well, users not only benefit from comprehensive condition monitoring but also from a significantly reduced control cabinet footprint or even from a design without control cabinet.

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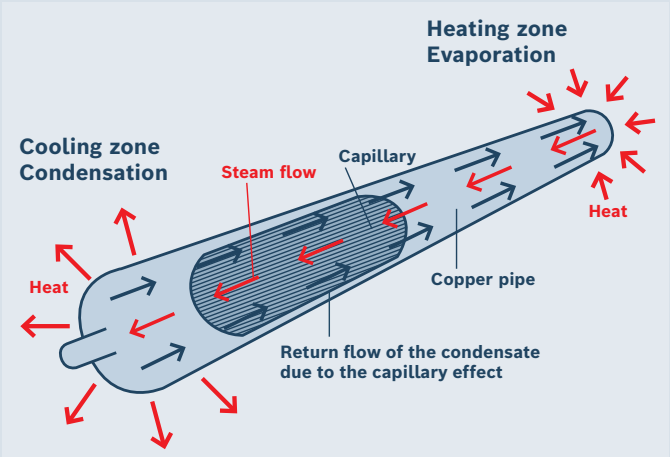
Heatpipe – Functional principle

Basically, a heatpipe consists of air-tightly sealed copper pipes with under pressure. Inside, there is a medium which transfers thermal energy. In the temperature range of hydraulic power units, the medium may be e.g. distilled water. The boiling temperature of the water is significantly reduced by the low pressure within the heatpipe, which means that a boiling or condensation process can already take place at low temperatures.

Functionality: If you dip the heatpipe for example in hot hydraulic oil, the thermal energy at the lower immersed part of the heatpipe is transferred to the water. The water exceeds the boiling point, evaporates and absorbs a large amount of thermal energy with low temperature difference (latent heat). The water steam rises to the upper part of the heat pipe which is cooled by e.g. a cooling element. Here, the water steam condensates and gives off the thermal energy to the cooling water. Thanks to the latent heat absorption and dissipation, the thermal conductivity of heatpipes can be up to 1000 times higher than the thermal conductivity of copper pipes. Due to the high elasticity of the copper pipes, the heat pipe can be easily shaped. In this way, ideal heat paths can be formed inside the hydraulic power unit and the installation space can be considerably optimized. Similar application ranges with equal optimization potential can be found in computer technology. Here, the thermal energy in laptops caused by heat sources such as the CPU are transferred to the central cooling elements using heatpipes.



▲ A heatpipe passively dissipates heat and gives off thermal energy to the cooling water supply.

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