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Maintaining die cushions regularly in the correct way: downtime costs and delivery times under control.

Deep drawing presses are an important part of tracked vehicle production. If the die cushion fails, downtime costs running into the millions could result. How can machine end-users minimize key failure risks while keeping control of maintenance costs?

Press lines play a central role in the value stream of the automotive industry. Especially the lead press is important, as the greatest forces and the longest drawing depths are occuring here.

If it fails, production can come to a standstill resulting in high costs and possibly contractual penalties. The good news: most of the risk can be eliminated with an appropriate maintenance strategy.

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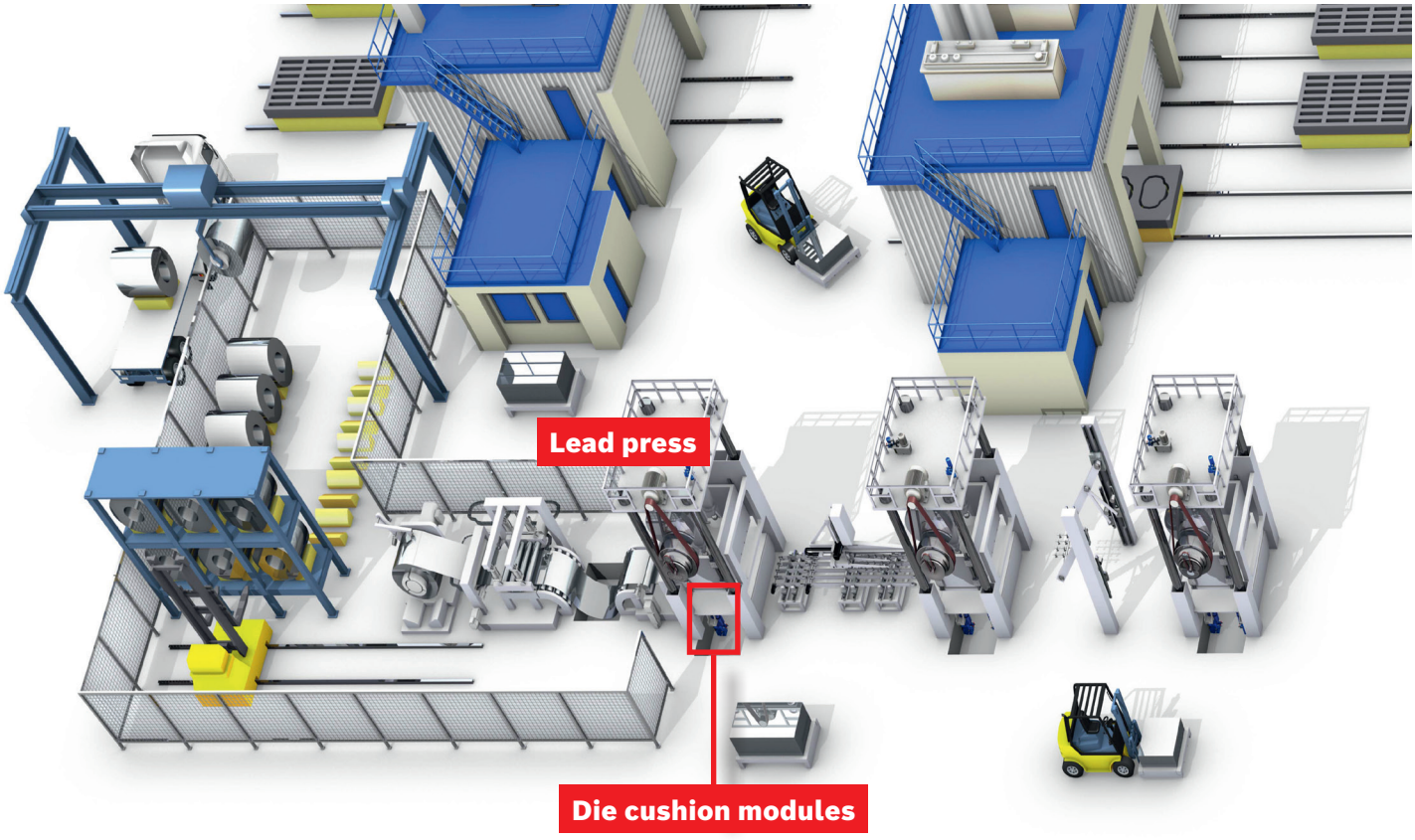
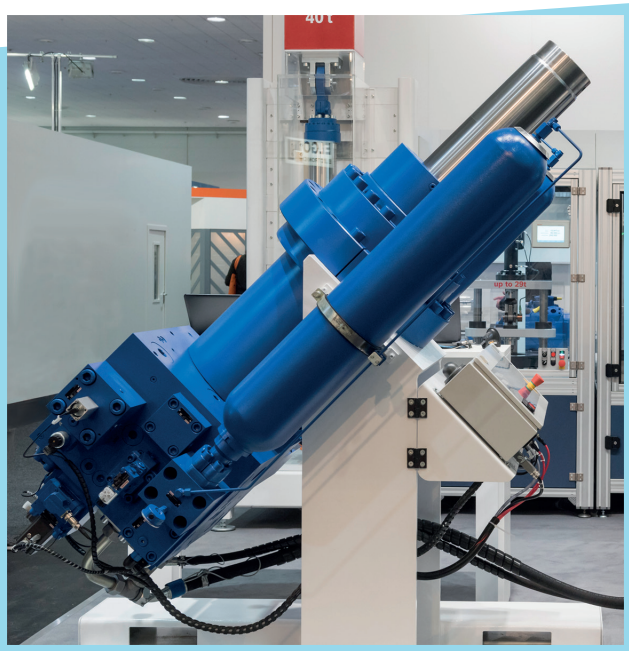


WHY ARE HYDRAULIC DIE CUSHION SYSTEMS SO IMPORTANT?

A typical automotive press line consists of four to six individual presses which use various tools to perform a wide range of tasks. The metal sheet which is to be pressed is taken to the line either straight from the roll or individually using a loading system, robot or cross-bar. It is then transported from one press to the next. The lead press does most of the forming work. It is followed by less powerful units for cutting, punching, folding and stamping.

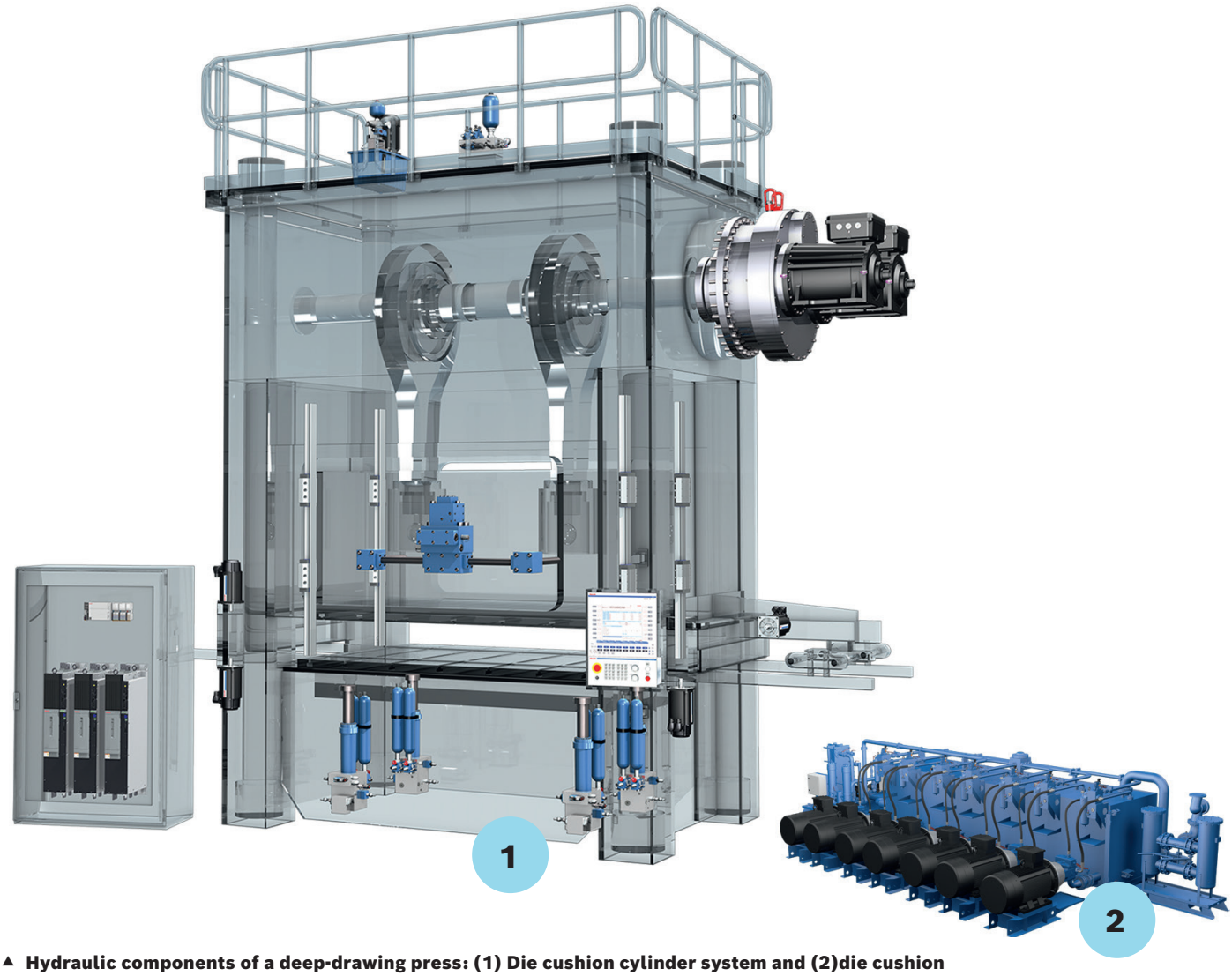
For its more complex task, the guide press is often equipped with a hydraulic drawing cushion system installed in the press basement. Using a number of die cushion cylinders, it regulates the tool clamping-force between the upper and lower tool so that the material flows optimally into the tool mold even with large forming or drawing depths. If the die cushion cylinders are intelligently pre-accelerated, the impact of the ram on the lower tool can be controlled precisely.



▲ **Die cushion module with hydraulic cylinder, control block, high-response valve, hydraulic accumulator and integrated position and pressure sensors.**

If necessary, springback or bouncing of the material can also be prevented when the ram is lifted off.

Because of its key role in process quality, the die cushion system is one of the most important systems within a press line. If problems or failures occur, the metal sheets will not be formed correctly before they are passed on to the downstream presses. All following processing steps can then no longer be carried out or will result in defective goods. In the case of time-consuming repairs, production comes to a complete standstill resulting in high downtime costs.



▲ **Hydraulic components of a deep-drawing press: (1) Die cushion cylinder system and (2)die cushion unit with cooling and filter systems and intelligent pressure-regulated pump control.**

What does a die cushion system consist of?

As elementary components of the die assembly, the drawing cushion systems provide the required drawing force. A higher-level control system controls the force, synchronism and position. Each individual die cushion module comprises a hydraulic cylinder plus a control block, a high-response valve, a hydraulic accumulator and integrated position and pressure sensors. In certain cases, the systems are connected with bridges. To ensure a highly dynamic control behavior, the hydraulic system is designed according to specific customer requirements and is optimally tuned. At Bosch Rexroth, all cylinder modules have a standardized design and are equipped with the same components, which results in cost-efficient spare parts management.

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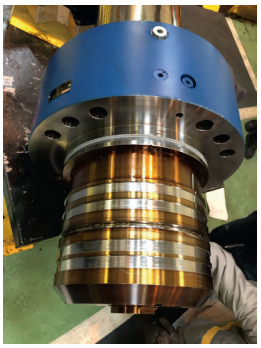
The most common wear topics

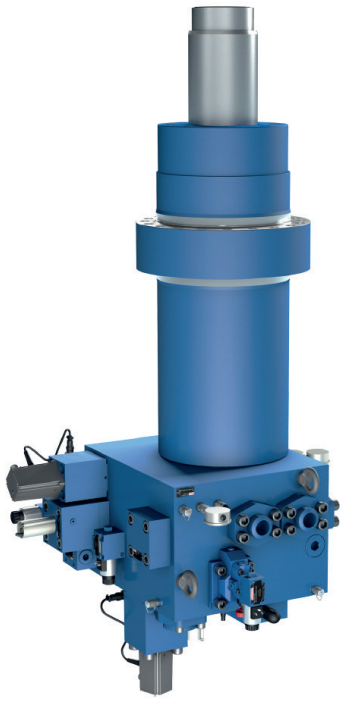
During continuous operation, die cushion modules produce large pressing forces of up to 250 metric tons. Like every other hydraulic system, they show typical signs of wear over time. Wear in seals and a range of other components is unavoidable. The question here is not when a system is worn and requires maintenance but how well the machine end-user is prepared for it. The most common causes of failures are listed here to allow appropriate maintenance planning:



1.1. Cylinder head seals and guidance systems

The extreme pressures and flow speeds in the die cushion cylinders result in high temperatures at the control edges of the servo valves. This can damage the oil because for the lubrication important additives burn. This can be seen not only as superficial discoloration of the piston. It also results in “burnt” cylinder head seals and guide tapes. Initially, the cylinder starts to leak and lose oil (outer and inner leakage). The required precision as regards synchronism and pressing force is reduced and this quickly leads to quality defects in the drawing process.

Even more significant is the mechanical damage caused by worn seals on the cylinder, piston and rod, which can lead to press failure.



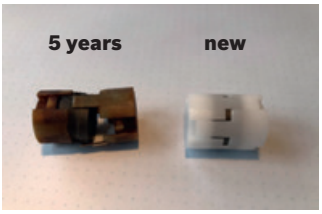
▲ **Die cushion cylinders are subject to extreme loads during 24/7 operation. Although this cannot be seen from the outside, high stroke rates and speeds, highly dynamic force/ pressure pulses and high oil temperatures lead to natural aging and wear in components.**

1.2. Contaminated servo valve filters

Particles released as a result of cavitation and the residues from burnt additives or worn seals can quickly contaminate filters. In certain cases, the contamination can reach the servo valves. These highly dynamic devices are sensitive to any form of contamination. The fact that their control quality is reduced leads to a loss of quality and then to a total failure.

1.3. Magnet of the position sensor

The magnet of the position sensor in the control block for the die cushion cylinder also plays a role in process quality. Due to high temperatures, the plastic housing can become porous over time. If the magnet becomes detached from the housing, the resulting play leads to inaccuracies in the pressure and position. Without an understanding of this effect, the resulting quality problems in the product cannot be explained and may necessitate time-consuming analytical work.



The question is not when wear becomes visible but how to be prepared for it.

2. How can downtimes be minimized effectively?

The damage processes described above occur gradually and only become apparent when quality deteriorates and faults or failures occur. In general, production will be at a standstill for several days, provided that the right spare parts or a replacement system is available. Depending on the construction of the press, the disassembly of a die cushion module can take up to two days. And if an overhaul is required, production could be at a standstill for two weeks or more. The only way to prevent this is to keep a stock of critical spare parts or a replacement system and and to practice preventive maintenance, supported by condition monitoring if necessary.

2.1. Complying with maintenance regulations

Much of the risk of a breakdown is eliminated if the machine end-user follows the general maintenance recommendations given by the manufacturer. A lot of the work can be carried out by suitably trained personnel, for example regular oil changes or the replacement of filters following visual checks. In addition to this, all the servo valves and the axial piston pump units in the power unit can be inspected on request.

2.2. Replacing seals on site

The magnet for the position transducer and the cylinder seals on the piston and piston rod should be replaced every five years. Bosch Rexroth will replace all of these as part of service. This work is carried out on the customer's site, even in the event of acute problems. The duration of work is one day per cylinder, if the operator makes it accessible in assembled condition beforehand and assigns two persons for the mechanical work. Bosch Rexroth offers a 12-month guarantee covering the supervised activities and any parts that it replaces.

2.3. Standard overhaul of the die cushion system (cylinder and manifold) at a Bosch Rexroth workshop

Bosch Rexroth can also overhaul the cylinder and the hydraulic manifold as part of a package for a fixed price. In the process, the "running surfaces" of the cylinder are cleaned and prepared, all seals are replaced and the magnetic guide for the positional transducer are renewed. The Original Rexroth Service will also overhaul the logic elements and WRCE as well as the seat valves. Filter elements and wear parts are replaced. After cleaning and installation in accordance with the Rexroth specification, the manifold and cylinder are checked to ensure they are functioning as new, painted and returned with a 12-month guarantee.

Standard overhaul vs. new product

A standard overhaul makes sense if	**Buying a replacement system** makes sense if
... **Better value for money** than a replacement ("as new" function and quality, **12-month guarantee**) ... **5 to 6 years in a 3-shift system** achieved	... **Buying new products is cheaper** (e.g. in the case of defective or irreparable main components) ... **A replacement is quicker** (e.g. if a complete unit is in stock) ... **Invest for rolling exchange** (extra unit as a reserve in the event of emergencies)

2.4. Having a replacement system ready

Because all die cushion modules in a press are identical, having a replacement die cushion module ready is another way of limiting downtimes and the resulting costs. By doing this, maintenance personnel can install the replacement system to cover the time when the machine is being overhauled or repaired and continue production with just a short delay. The overhauled unit can then be kept in stock for use as a replacement later on. The investment costs for the additional die cushion module usually pay for themselves as soon as a single downtime is avoided. This is because delivery times for a newly ordered replacement system are several weeks to months.

CONCLUSION: IT IS BETTER TO BE SAFE THAN SORRY

There is a lot at stake in the maintenance of the die cushion modules. As part of the working hydraulics system, they are particularly subject to wear which poses a threat not only to process quality but also to the downstream production chain. Anyone who would like to avoid unnecessary downtimes and the substantial resulting costs can do this with relatively little effort. The most important measures: Complying with maintenance regulations, preparing for major repairs and planning standard overhauls as part of regular maintenance. If a replacement system is available for use in an emergency, staff will be able to react flexibly and calmly when the next downtime occurs.

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