TwinCAT Hydraulic Positioning software powers production machines for innovative lightweight construction material

Seamless integration of hydraulic axes in standard control technology

The lightweight construction material Lisocore®, manufactured by Lightweight Solutions GmbH, in Bad Aibling, Germany, is used for a number of highly innovative applications where conventional wooden materials reach their limits. For example, lightweight yet strong construction materials are required for building ships or mobile homes. Beckhoff was involved right from the start in the development of the new machines required for producing the material – with PC-based control, and in particular with TwinCAT Hydraulic Positioning for seamless integration of hydraulic servo axes.

Beckhoff controller at the high-pressure press

Michael Schäpers, Managing Partner of Lightweight Solutions, inspects the core structure of the Lisocore® lightweight construction material before it enters the hydraulic press.

Lightweight Solutions was established as a startup business with a background in university research. Initially, their core process – the production of an innovative, lightweight construction material – had to be tested for readiness and implemented in series production within a short timeframe. Beckhoff was involved right from the prototype phase. The deciding factor for the selection of PC-based control technology was Lightweight Solutions' intention to start prototype production as quickly as possible, and with maximum software flexibility.

At the time, PC-based control proved to be a great advantage, as the approach enabled a direct fieldbus connection between the I/O system and valve control without any additional hardware. In addition, the synchronization control for the hydraulic drives on the twin-punch press and the control of the supply unit were easy to implement based on the TwinCAT Hydraulic Positioning library. The first three-dimensionally shaped core structures were produced with a press built entirely by Lightweight Solutions as early as 2006. The machine not only provided prototypes for testing and sampling, but produced series parts over several years.

High potential for innovation through TwinCAT 3 hydraulic positioning

Today, a spacious production hall houses four much larger successors to the first press, which are networked via EtherCAT and each controlled by a C6920 Industrial PC from Beckhoff. They form the end stations in the production lines where the core structures are assembled to create finished products. In the meantime, the TwinCAT Hydraulic Positioning library has been ported to TwinCAT 3, while retaining the tried and tested functionality.

In the new machine generation, operational reliability was further improved. In two- or four-punch presses, there is a risk of the powerful cylinder drives damaging the machine if a valve failure remains undetected or is detected too late. In order to identify developing problems at an early stage, the hydraulics library provides software functions that are used for monitoring the valve operation. The fact that not only the encoders benefit from EtherCAT interfacing, but also the valves, has proven to be advantageous. In this way, a variety of diagnostic data, including the current slider position, are available without additional effort. Comparison with a model calculated in the hydraulics library enables analysis of the valve behavior, so that warnings or alarms can be issued as appropriate. Problems can then be recognized and addressed proactively, such as malfunctions in a pilot valve supply or a main stage blockage caused by accumulated particles from the process.

Controlling complex production processes as efficiently as possible

In the highly-automated lines, cover layers are joined with the Lisocore® core structures to form sandwich elements. This process is more demanding than it may appear at first glance. A form-locking connection with a total of 15,000 mounting points is achieved in 20 seconds, which makes highly-dynamic positioning essential. Since the slabs are continuously moved forward during these operations, the milling units have to synchronize with each row based on the "flying saw" principle, perform the processing steps and return as quickly as possible so they are ready for the next row. More than 20 servo axes are installed in this part of the plant alone.

Once the protective layers and the core structure have been joined correctly, the "sandwich material", which is still quite fragile, is transferred to a hydraulically operated, scissor-type lifting table. This table transfers the incoming products to a multi-level press, where the individual elements are joined in a dimensionally accurate, permanent manner with a hardening adhesive.

An undesirable characteristic of such scissor-type lifting tables is their tendency to oscillate. This is difficult to avoid, even in the end position. This creates increased waiting time, which unnecessarily delays the forwarding of the sandwich slabs, resulting in reduced production throughput. It also has a negative impact on the dimensional accuracy, due to a possibly undefined hardening of the adhesive. As a solution to this problem, condition feedback was implemented, in which correction values derived from the chamber pressures of the hydraulic cylinder are offset with the valve control signals. The electronic attenuation generated in this way ensures fast stabilization in the target position.

A C6650 control cabinet Industrial PC with multi-core processor is used for higher-level control and monitoring of the entire Lisocore® production plant.

A multi-core Industrial PC with TwinCAT 3 controls the entire system

The transfer between the scissor-type lifting tables and the multi-level presses requires intensive communication, because there are no fixed rules to determine which of the four levels the next product is conveyed to. In addition, the position of the levels changes continuously, due to the stack-type design of the press. Here, TwinCAT 3 shows its strength in conjunction with the C6650 control cabinet Industrial PC with cutting-edge multi-core CPU (Intel® Core™ i7, 4 cores). This is also found in the numerous other synchronous transfer stations between conveyor belts and processing zones. The realization of the entire plant software on a single PC-based platform eliminates the need to exchange and transmit data and signals between different controller types.

Even the wide mix of technologies in this plant is no longer a drawback: the hydraulic axes with an adapted technology software library, complex motion control for the Servo Drives, and even the modules for waste heat recovery work seamlessly together. To this end, almost 900 EtherCAT slaves (IP 20 I/O terminals, IP 67 I/O modules and AX5000 Servo Drives with AM8000 OCT servomotors) are linked via two EtherCAT masters, according to Jens Hülsebusch, Project Manager of Systems Engineering at Beckhoff. The set values for 130 NC axes are calculated within a 2 ms task interval.

"Without TwinCAT 3 and its multi-core support, it would not have been possible to realize such a system," emphasizes Michael Schäpers, Managing Partner of Lightweight Solutions. "Four processor cores were available to execute the various tasks separately. Plus, with the integrated EtherCAT-based technology from Beckhoff, we didn't have to worry about the communication routes in the plant. What's more, the process data obtained from the machines can simply be fed back into the plant. This special feature helps us develop new processes and products more easily. It is essential that we operate the machine flexibly and access the controller data easily. Another argument in favor of the Beckhoff system is TwinCAT 3 Scope. This software oscilloscope can be used to achieve detailed analysis of the process sequence, and it is possible to retrieve all required data for a new process. All in all, this means a tremendous speed advantage in terms of product and process development."

The entire automation technology is already linked to SAP via intelligent solutions. Looking ahead, Michael Schäpers notes that "As manufacturers of special purpose machines, we will continue to collaborate with Beckhoff on projects by leveraging the concepts of Industrie 4.0."

Scissor-type lifting table in the process of removing a finished Lisocore® panel from the multi-level press.

Further information:

www.lightweight-solutions.com/lisocore

www.beckhoff.com/hydraulic