TwinCAT CNC controls laser cutting machines for high precision pipe perforation

Perforated pipes are key components in the extraction of petroleum in order to properly separate sand from pumping fluid. The shape, size and arrangement of the punch-outs in the pipe vary according to the specifications of the bore, the geological conditions and/or the consistency of the pumping fluid. The Wuhan Farley Laserlab Cutting System Engineering Company of China has developed a technique for perforating pipes by means of a laser cutting method. The CNC machine, which can be converted flexibly to the most diverse “cutting patterns,” is controlled by a PC- and EtherCAT-based automation platform from Beckhoff.

The Wuhan-based Farley Laserlab Cutting System, a subsidiary of Huagong Laser Engineering Co., Ltd., is one of the leading Chinese companies in the field of high-performance laser cutting and welding machines. “Due to the increasing use of laser cutting technology in the manufacturing of filter pipes that extract petroleum, the demand for appropriate laser cutting machines has surged tremendously,” says Wang Zheng, Deputy CEO of Farley Laserlab.

Integrated PC-based control
Farley Laserlab uses the PC-based control platform from Beckhoff in its laser cutting machines for the perforation of pipes; this consists of an Industrial PC (IPC), TwinCAT CNC automation software, distributed I/O terminals and EtherCAT as the communication system. In the drive technology area, AXS000 EtherCAT Servo Drives and the servomotors from the AM8000 series with One Cable Technology (OCT) are used. “Communication is based entirely on EtherCAT, which is characterized by high speed and reliability. The integrated bus structure of EtherCAT is clear and simple to handle at all levels,” Wang Zheng emphasizes and he adds: “Through the use of the motors with One Cable Technology we have also been able to considerably reduce cabling efforts and costs.”

TwinCAT CNC controls the cutting beam at fast speeds of up to 120 m/minute with precise positioning in the X and Y direction. It also controls the lifting and lowering of the cutting head, the rotation and positioning of the perforated pipe, the tilting of the cutting head, the feeding axis for the feeding of the pipe in the longitudinal direction as well as the axis for the synchronization of the laser beam with the electric drive.

All control requirements integrated on a single PC platform
For the control of the seven servo axes, interpolated motion control is required where the servo axes can position themselves precisely and drive to separate positions. The TwinCAT CNC software platform in use encompasses PLC, visualization, interpolating motion control and multi-axis positioning. “In the past, when Farley Laserlab used conventional CNC systems, we had three different CPUs for the PLC, motion control and HMI. In addition, the software of the individual CPUs was developed on different programming platforms, which meant that different engineers had to specialize in one and work together on the development of the overall software. With the Beckhoff control platform we have the entire machine controller with TwinCAT CNC on a single PC,” explains
Changbo Gao, deputy chief electrical engineer responsible for the software development of the laser cutting machines for pipe perforation.

**TwinCAT CNC meets complex requirements**

The process requirements for the laser cutting machines for pipe perforation are very complex. The perforation of the filter pipes varies according to the geological conditions and the raw materials to be pumped. Certain applications require vertical, spiral or offset, round, rectangular or trapezoidal cut-outs. Sometimes the perforation must be smaller inside the pipe than at its surface and must be executed at a certain angle so that the oil can pass through better, but the sand less well. When cutting trapezoidal openings, the requirements for the control of the tilt axes are particularly strict, since maximum precision is demanded depending on the wall thickness and angle of inclination. "In addition, the motion control function library in TwinCAT NC PTP offers a convenient interface for changing, for example, parameters such as the tilt angle from within the PLC flexibly and at any time," says Changbo Gao.

**Remote maintenance simplifies customer service**

Because the TwinCAT CNC platform is PC- and Windows-based, only the control PC need be connected locally to the Internet in order to implement comprehensive remote maintenance and diagnostics. This also simplifies adaptations and the downloading of programs. What's more: since the entire software is executed on a single CPU, changes to the G-code, PLC program and HMI can be made remotely via the Internet.

**Flexible parameter adaptations in software**

The prerequisite for high quality pipe perforation and efficient production is the flexible and simple adaptation of the parameters for the laser power, the precise focusing, the pulse frequency, the duty cycle, the feeding speed, the auxiliary gas pressure and the specification of the nozzle of the laser head. These factors are decisive for perforation cutting quality and the overall quality of the pipes. Different hole punching patterns can be stored, such as continuous hole punching or multi-stage hole punching. In addition, the gas pressure and the laser power must be continuously adapted via the motion control pattern of the Z-axis during the hole punching process. "This places high demands on the openness and flexibility of the control system, which TwinCAT CNC entirely fulfills," explains Changbo Gao. "With the support of Lanli Wang, the technical engineer from Beckhoff China, we have developed various hole punching patterns for diverse areas of application."

Further Information:

www.farleylaserlab.cn
www.beckhoff.cn