Automated ultrasonic welding and cutting
machine for PVC awnings

EtherCAT facilitates high-precision cutting "on the fly"

Jentschmann AG, a Swiss company with a tradition of many years as a manufacturer of industrial sewing machines, specializes in fully automated ultrasonic welding and cutting machines for awnings and other technical textiles. The utilization of ultrasonic technology is no coincidence, nor is the consistent use of emission-reducing and energy-saving technologies that reduce production costs. The machine's high productivity is ensured by PC- and EtherCAT-based control technology from Beckhoff, which integrates dynamic drive control and accurate position measuring systems.

Manual control level of the web roller carriage, with which the cloth roll is driven into the machine

Jentschmann AG, based in Hüntwangen, Switzerland, specializes in machines that manufacture awnings. Using the type 3796 combined automatic ultrasonic cutting and welding machine, awnings for motor homes and caravans are manufactured with a maximum length of 6 m (19.7-ft) and widths of between 2.5 m and 3.2 m (8.2-ft and 10.5-ft). Depending upon the necessary width, two thermoplastic-coated cloth webs and the piping seams are welded and cut precisely to size.

In order to ensure a continuous welding process, Jentschmann uses so-called "roll sonotrodes" with radial oscillation (amplitude), by means of which the PVC-based fabric is heated up and welded. The awning material runs continuously between the synchronously driven roll sonotrodes and the anvil rollers. The prerequisite for this dynamic process is the precise guidance of the fabric; the setting of the different welding parameters must be correspondingly precise and is automatically readjusted during the welding procedure.

Fully automated seaming, welding and cutting in a matter of seconds

The machine produces continuously from the roll; i.e. a roll of 180 m (590.5-ft) in length is processed in approximately 23 minutes at a speed of 8 m/min (26.2-ft/min). "The loading of the roll and the in-feeding of the cloth webs and the round piping profile, as well as the positioning of the ultrasonic welding head, take place manually," explains Pierre Bartholdi of Jentschmann AG, who is responsible for the machine concept: "The order-dependent pull-off lengths and lot sizes are loaded via the operating panel from the product database and transferred to the controller."

Upon starting the plant, the pulling carriage drives forward. "During transport both edges of the awning web are turned upwards first and then inwards by mechanical guides," says Pierre Bartholdi, describing the intake of the awning web. "The round piping profile is bound into this fold synchronously. Ultrasonic welding heads with roll sonotrodes weld the assembly seam and the piping seams."

Beckhoff Servo Drives from
the AX5000 series

The severed awning web is removed
and set down by the pulling carriage;
the awning cloth is tensioned by
the cutting gantry and transported
further.

Servomotor for the edge control with mechanical locking (front right)
and positioning of the unwinder via coupling and spindle

After reaching the specified cloth length, the cross cutting gantry, which is programmed with the TwinCAT flying saw automation software, synchronizes itself to the pull-off speed, fixes the cloth by means of pneumatically actuated holders and cuts its transversely. "The precise cloth length is an important quality criterion for our machines," explains Pierre Bartholdi. "We cut with an accuracy of ±1 to 2 mm. The intake of the cloth is regulated in width via an edge controller." After the cross cut has been made, the pulling carriage drives at high speed with the finished awning cloth to the rear and sets it down on the delivery table, while the cross cutter continues to pull the welded cloth web until the pulling carriage takes over the pulling of the cloth again after having driven back. Upon that the cross cutting unit returns to the home position and waits for the

next cross cut. The production of a finished cloth of 3.5 m (11.5-ft) in length takes approx. 26.25 seconds.

Advanced drive technology as a core feature
The production sequence runs fully automatically after the awning web is set up. Five Beckhoff EtherCAT Servo Drives from the AX5000 series plus servo motors from the AM3000 series – complete with attached two-stage planetary gear units and integrated single-turn Biss absolute encoder – drive the material web unwinder, the edge controller, the belt drive for the seam press, the cross cutting unit and the pulling carriage. The belt drive is the so-called "pilot drive," with feed rate entered as a fixed value. The speed of the material web unwinder drive is controlled in relation to the feed rate and the

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The anvil roller (above) and the roll sonotrode (below) without the awning web. The flow direction of the material is from right to left. This combination is likewise present on the right side of the web; it can be adjusted to the web width there.
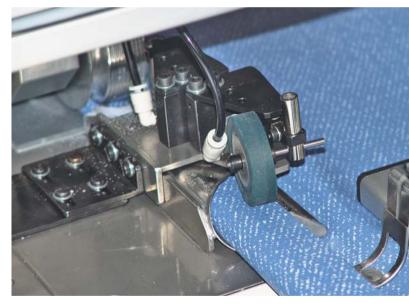
diameter of the material web roll. To this end, the diameter of the material web roll measured during setup is adopted into the control loops of the plant controller in the case of a known material thickness. Because the diameter of the cloth roll decreases as the awning web is unwound, the speed of the material web unwinder drive must be increased proportionally.

The diameter of the cloth roll is calculated precisely at the beginning via a dancer roll and incorporated in the dancer position control in order to avoid deviations. The control concept on which this is based was programmed with the TwinCAT Controller Toolbox. Pierre Bartholdi praises the clear sequence: "The dancer roll has an ultrasonic sensor with which the height is measured. The higher the roll rises, the more the unwinder drive must accelerate. This way, all parameters for control are known and, as a result, it is guaranteed that the unwinder will not oscillate during the production sequence."

The loop is closed and the piping band is pulled taut by a guide roller.

Customer-specific machine design requires open, scalable control technology

On questions of automation, Jentschmann AG consistently practices labor division in the case of complex plants: Indutron AG from Spreitenbach is brought in for the control technology and all electro-technical tasks. As a system partner, the company specializes in the process automation of machines and employs PC-based control technology from Beckhoff. As Indutron Managing Director, Harry A. Stirnemann states, the cooperation with Jentschmann AG has already proven its value in many common projects: "The automation of the Jentschmann 3796 automatic cutting and welding machine is a special project because the machine is conceptually designed so that it permits additional options." In principle, each machine is unique rather than being a series product, which makes an open, scalable control solution necessary. As a Beckhoff Solution Provider, Indutron

AG, which is responsible for the entire control technology from the project engineering to commissioning, has been familiar with the Beckhoff automation platform for years.

Project engineering and development time shortened

A CP6201 Panel PC with 12-inch touchscreen and TwinCAT software is employed as the controller for the Jentschmann 3796 automatic cutting and welding machine. TwinCAT NC PTP is used to control the drives. Furthermore, the TwinCAT Flying Saw software library is used for the cutting gantry and the TwinCAT PLC Controller Toolbox is utilized for the control of the dancer devices. "These function modules in TwinCAT software give us a big advantage," says Harry Stirnemann

Josef Müller, plant expert from Jentschmann AG, at the operating panel with buttons and indicator lamps

Harry Stirnemann, Managing Director of Indutron AG

Indutron AG

The company Indutron AG, with head office in Spreitenbach, is a Beckhoff Solution Provider in Switzerland. Indutron AG was founded by Harry Stirnemann in 1983. Indutron develops control systems for the textile and wire production/processing industries as well as for handling and assembly machines and for special purpose machines.

from Indutron: "We save a great deal of project engineering and development time because many control tasks cannot be solved with standard controllers. With the TwinCAT PLC Controller Toolbox, we were able to create the complex control of the drive coordination from basic software building blocks."

The entire machine periphery is detected using Beckhoff EtherCAT Terminals. The EK1100 EtherCAT Coupler connects the periphery to the Panel PC via the EtherCAT bus system. The servo controllers and the integrated absolute value encoders of the servo motors are likewise networked via EtherCAT.

In addition, the Panel PC has a modem, via which the service specialists from Indutron can dial-in to the machine controller in the event of a malfunction. "This releases us from the necessity to carry out service on-site at the customer's premises," explains Harry Stirnemann.

Convenient, self-explanatory operating concept

Indutron paid particular attention to the self-developed, multilingual user interface, which allows intuitive operation. The operator can call up machine functions on the one hand and integrate special job-related characteristics on the other. The user interface displays messages and informs about malfunctions, and recipes can be selected or created, e.g. process or product-related data for all awning materials to be processed. These concern the welding speed, the cloth width or the temperature. Although all technologies are already stored in the machine controller, the machine operator must also be able to enter new programs. To do this, an existing program is copied and subsequently modified, so that the new awning cloth is welded cleanly and cut precisely to size. The openness of the user interface ends where the danger of an incorrect input exists. Harry Stirnemann remarks: "The operator cannot change anything on the machine controller; access to this level is protected by a password."

Interface to the customer's IT system realized

The HMI solution is also prepared for connections to the ERP or MES level. "In this way we have implemented connections to the IT systems, for example, of customers who operate cutting machines," states Harry Stirnemann: "That is becoming increasingly important. The controller receives the cutting data from the customer's IT system via the integrated interface. The interface between our user interface and the customer's IT system is implemented via Visual Basic; communication between the TwinCAT system and the user interface takes place via TwinCAT ADS."

Potential for the future

Beckhoff's PC-based automation technology opens up further mechanical and technological possibilities for the latest generation of Jentschmann automated ultrasonic welding and cutting machines. These concern, for example, the automation of the cloth roll feed, the belt width control or the choice of an alternative joining process. With regard to machine safety, additional possibilities are also offered by Beckhoff's safety technology. However, safety-relevant technology such as "Safe Stop" is already in use in the existing axis drives.

Jentschmann AG   www.jentschmann.ch
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