Positioning of Straightening Rolls

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Straightener roll-positioning solutions adapted to the application and process simulation for calculating the necessary roll positions.

Roll-type straightening units and systems, their components and the results that can be achieved using them are increasingly moving to center stage in the production and processing of wire-shaped process materials. The roll-type straightening process is also being confronted by higher production speeds, advanced materials, quality/environmental issues and changing production processes characterized by more automation and networking.

Of the many possible ways to meet these spiraling requirements, systems for the positioning of straightening rolls and the advanced calculation of essential roll positions are key instruments.

Rail-roll adjustment and single-roll adjustments are two relevant technical variants of straightening-roll positioning systems. With rail-roll adjustment, the rolls of at least one row are fixed in line on a rail, which can be positioned by rotation and translation. The ability to rotate the rail in conjunction with the angle results in different spacings between the straightening unit's rolls. With the single-roll adjustment variant, it is possible to position individual rolls. Units with one row of fixed rolls plus a row of individually adjustable rolls are in widespread use, as are units with only individually adjustable rolls. The highest degree of freedom for making adjustments is obviously offered by a straightening unit on which all rolls can be individually adjusted.

Adjustment mechanisms transform a rotary movement into a translatory movement of the straightening rolls, or they are exclusively based on translation. A more common variant is a mechanism that uses both translation and rotation modes. Various methods are available for applying the power needed for a positioning operation. These are selected according to the physical requirements of the application. Apart from the purely conventional adjustment method using the simplest of tools, there is the semiautomatic positioning of straightening rolls, and for specific applications, fully automatic process control using modern actuator and automation technology.

Fig. 1 — Example of the semiautomatic straightening of process materials.

New Automated Straightening Technology

The advantage of automated straightening units and systems is that the straightening rolls are adjusted by defined and reproducible amounts. Furthermore, the positions of the rolls can be identified at any time. **Figure 1** is an example of a straightening machine equipped with semiautomatic straightening units. Flat wire measuring up to 4.5 mm wide (0.2") and up to 1.5 mm (0.06") thick are processed in two lines arranged one above the other. The objective is to produce straightened material with a one or two-dimensional bend. At the heart of the system is a PLC, which defines the specific straightening processes in interaction with the control terminal, implemented software and the data input by the user. The system uses and manages 500 data sets, each consisting of 40 data items, to ensure rapid setting of the machine for a variety of feed materials and finished products.

Building on its familiar semiautomatic straightening technology and the knowhow accumulated by WITELS-ALBERT in precision positioning of straightening rolls and advance calculation of roll positions, the company is introducing the second generation of semi-automated CS EASY straighteners (**Figure 2** and **Figure 3**). The new series features simple construction, low component count and a user-friendly human-machine interface.

CS EASY series devices do not need a PLC or IPC and initiators. The software has been designed to ensure that any user can generate defined settings at the press of a key. As you would expect, the user can save parameters and settings. From an engineering standpoint, the strategies used for zero-backlash positioning of the straightening rolls are the most outstanding feature of the CS EASY series of semiautomatic straightening units. And the unprecedented price/performance ratio of these semiautomatic straightening systems will be good news to business management.

Fig. 2 — Second generation of semiautomatic straighteners (CS EASY LE unit).

Fig. 3 — Second generation of semiautomatic straighteners (CS EASY IV unit).

More Efficient Roll Positioning

Instead of positioning the rolls with permanently assigned actuators, a single intelligent tool—the Computerized Tool—can be used to adjust the straightening rolls (**Figure 4**). Using only one specific tool for any number of straightening rolls reduces the components' effort to a minimum, since only one actuator and sensor are required. This is more efficient than similar semiautomatic solutions, which require multiple actuators and sensors. However, the greatest efficiency can be achieved when the Computerized Tool is used to adjust the straightening rolls of several straightening systems in different locations, e.g., on different processing machines. This new category of straightening for process materials is successfully in use on equipment like spring production and bending machines. With the right software, it is possible to save the roll positions for a specific final product or quality of wire and call them up for machine-setting purposes whenever required. This takes less time, work, process material and energy for positioning the straightening rolls.

Fig. 4 — Computerized Tool for the defined positioning of straightening rolls.

Improved Mechanical Roll Setting

Conventional straightening units and systems with a mechanical position display can help achieve reproducible roll settings, but they are not capable of saving and calling up the settings. They are dependent on setting values documented by hand and represent a very low-cost solution for achieving the desired quality of straightening.

Fig. 5 — ABR EASY straightening machine equipped with straightening units of the ER PO series with mechanical position displays.

Figure 5 (previous page) shows an ABR EASY machine equipped with ER PO series straightening units from WITELS-ALBERT. The adjustment mechanisms of the straightening rolls are equipped with position displays from which it is possible to read off the exact roll positions in relation to a reference position. Supported by the machine controller, pneumatic cylinders, a wire guide and a powerful NAD S wire feeding unit, ABR EASY machines make it very easy and cost effective to implement operations such as continuous or discontinuous material transport. If an intermittent process control is needed, ABR EASY machines can be completed to ABR EASY POS machines, which use a length measuring device and a specific user panel able to accept variable wire feed lengths. Users can link ABR EASY and ABR EASY POS series machines to upstream and downstream equipment and processes.

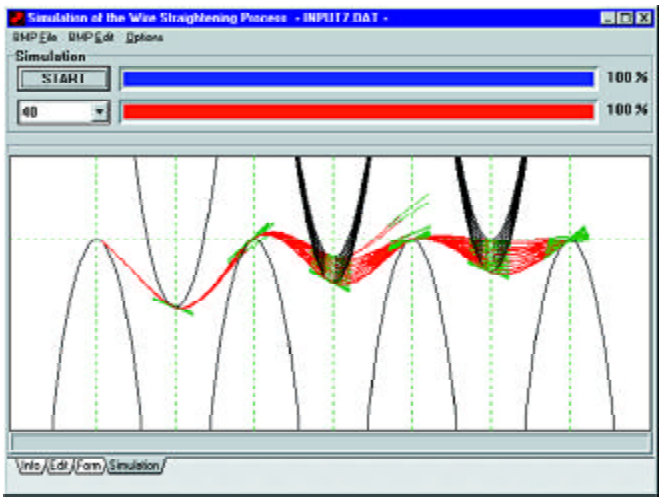

Fig. 6 — Computer simulation of the wire straightening process.

Roll-Straightening Process Simulation

In pursuing a specific level of straightening quality, it is widespread practice to change the roll positions of a straightening unit or system subjectively, by constantly watching the straightened material leaving the machine. Such trial-and-error adjustments are usually made with no knowledge of the material's parameters before and after the straightening.

WITELS-ALBERT replaces this ineffective approach with simulation of the roll-straightening process. With simulation, it is possible to calculate in advance (with due consideration of the material's characteristics and the geometric boundary conditions of the respective straightening unit) the roll positions needed to create a straight product or one with a defined bend. The process simulation is based on a model of alternating elastic-plastic deformation. It is also based on the relationship between bending moment and curvature, which can be determined for every bending operation taking place in the straightening unit. Thus, it is possible to determine the material's bending characteristic, leading to calculation of the roll positions by numeric integration of the second-order differential equation applicable for deformation by bending.

Figure 6 illustrates the simulation process.

Conclusion

WITELS-ALBERT provides extensive support in designing technical straightener roll-positioning solutions adapted to the manufacture of specific final products as well as in the use of process simulation for the advanced calculation of the necessary roll positions.

Identification of the process material, along with simultaneous specification of the purpose of the respective roll-straightening process, plays a key role in this technological support.

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Author Profile...

Marcus Paech *headed the Research and Development Division of* ***WITELS Apparate-Maschinen ALBERT GmbH*** *between 1997 and 2000. He studied at the Department of Metallurgical Engineering at Otto-von-Guericke University and was an Assistant Professor. At WITELS Apparate-Maschinen ALBERT, he developed an automation strategy that includes a virtual mirroring of the wire-straightening process while determining specific process-material and real-process data. He also develops technological solutions for identifying process materials and implements advanced wire-related manufacturing ideas. Since 2001, Marcus Paech has worked as the WITELS-ALBERT Technical Managing Director.*

Company Profiles...

WITELS Apparate-Maschinen ALBERT GmbH *of Germany, and its USA-based operation,* ***Witels-Albert USA, Ltd.****, provides wire straightening equipment and accessories, and ancillary processing units matched to the requirements of its customers. Products include rotary and roll-type straighteners, roller guides, high-quality rolls, WICAS® cassette straighteners, simulation programs and specialized solutions as well as preform heads, drive units and decoil straighteners.*