Characteristics of the automatic level control roller tables given-receiver mill DUO-300

Charakterystyka układu automatycznej regulacji poziomu samotoków podawczo-odbiorczych walcarki DUO-300

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The article presents a description of the automatic level control roller tables given-receiving mill DUO-300 forms part of the rolling of the Faculty of Production Engineering and Materials Technology of Czestochowa University of Technology. Control of technological line based on PLC. For communication between the individual elements used bus CANBus. Realized an automatic level control roller tables rolling laboratory DUO-300, despite the relative simplicity associated with the lack of proportional valves and the resulting inability of proportional control, allows you to achieve satisfactory accuracy parameters and time settings.

KEYWORDS: roller tables mill DUO-300, controller PLC, data bus CANBus

One of the important aspects of conducting research and development in the field of plastic processing, concerning rolling processes, is the problems connected with the effect of the angle of a band application to the cage on its geometry and the possibility of preventing its bending by introducing asymmetric rolling [1]. In order to enable this type of research, the design and commissioning of the D300 laboratory rolling mill was not only designed to independently control the speed of the upper and lower rolls, but also to provide mechanized given-receiver mills ensuring their precise height and inclination angle, at the Faculty of Production Engineering and Materials Technology of the Czestochowa University of Technology [2]. This functionality also allows for symmetric feeding of the band to the rolling boiler at varying heights in subsequent culverts [3, 4].

Made in the mechanical part by an outside company, the given-receiver control roller tables were automated by the staff of the Department of Production Engineering and Material Technology of PCz. The view of the reversible DUO-300 roll cage, which is the central element of the entire rolling mill, including the roller tables, is shown in fig. 1.

Fig. 1. View of a rolling mill cage with feeder-receiver roller tables

Construction of roller tables

The structural drawing in the single-picture projection is shown in fig. 2.

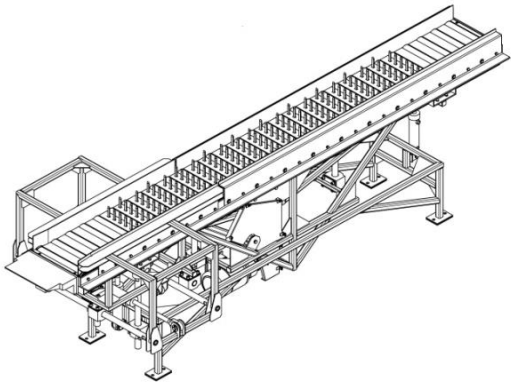

Fig. 2. Structural view of the roller tables

The roller table consists of a base and a 3 m long table with driven roller conveyors. The rollers have a diameter of 60 mm and a length of 300 mm, and the spacing between them is 100 mm. The surface between the rollers is covered and shields the drive system and hydraulics against scale and direct thermal interference.

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The drive is a three-phase asynchronous motor, integrated into the reducer and powered by a frequency inverter. The power from the motor to the rollers is transferred by means of a chain.

The bench is mounted on two hydraulic cylinders and is stabilized with four linear guides. This enables - at two points of support 2 m away - to change its position within ± 50 mm from the top reference level of +835 mm forming the lower cylinder. By varying the position of the support points, one can also adjust the angle of inclination of the table. This makes it possible to accurately record the rolling conditions associated with the feed rates in the actual rolling mills.

In the front of the roller table, a manipulator is installed, which, before entering the cage, allows the centering or positioning of the band with the ruler in the range of ±125 mm with respect to its longitudinal axis. In addition, the roller tables are equipped with a conveyor belt over the conveyor rollers by pulling the pins between the rollers. When reversed, reversing and changing the setting of a rolling slot, raising the belt prevents the cooling of its lower part by heat exchange with the roller table. Spot elevation also ensures more uniform, inter-operational cooling, if required by rolling technology. These systems (as well as the system of raising / lowering tables) are fully mechanized and driven with the aid of hydraulic cylinders.

Each functional roller table is an autonomous, isolated device controlled by a PLC with the ability to local, manual control of its basic functions. On the other hand, the control over the work of the whole rolling mill is overridden by the control of the assembly.

Automatic level control system

The automatic setting system of the table level position consists of two identical control paths, separately for the front and rear of the roller table. As the measuring elements of the table position relative to the base, modern Temposonic EP position magnetostats from MTS with a measuring range of 100 mm and a voltage output of 0-10 V are used. They are mounted parallel to the axes of the actuators, and the movement is carried by the cable of one of the guides. Due to the absence of direct mechanical connection to the proper measuring part, these transducers are hermetic and resistant to a number of adverse factors such as shock or humidity.

The regulator functions with the VISION V280 PLC with I/O module V200E1846B, also responsible for controlling all other functions of the roller table and communicating with the operator's desk. In this controller, the two-position algorithm for positioning the front and rear of the device, in the form of a narrow hysteresis regulator, typically ±1 mm, is implemented. Hysteresis width, depending on requirements, can be changed programmatically. During rolling, the setpoint or tilt angle of the table can be manually entered via the HMI panel of the controller or automatically read from the rolling program in each pass and sent via the CANbus from the higher PLC installed on the operator panel together with the initialization signal. Once the procedure for setting the desired level of the roller table from the relay outputs of the controller is given, the control signals for the Y1 and Y2 actuators of the three-way roller table valves of type WE06, which control the flow of oil to the 100 mm CB40/22/URG hydraulic rams. These actuators are fitted with VBPDE twin check valves, locking their positions. To eliminate the interference between the hydraulic feed circuits of the front and rear actuators whose electrovalves are fed together with oil, the front and rear parts are the first set. In addition, this prevents collision of the end of the feeder table with the lower roll. Upon completion of the setting of the level of the automaton, the system sends feedback to the control system of the entire rolling mill and is ready for another operation. Basically, during reversal rolling, while receiving the band, the next setpoint of the roller table is position 0 mm, which is the maximum bottom position of the table. In this position, there is a mechanical blocking of the roller table with the rolling cage. When set in the lower position, in contrast to the set level, the back is lowered first and then the front of the roller table. The setting speed is controlled manually by means of the VRFB9003 flow control valve located in the oil supply circuit of the valve plate, on which the roller table valves are mounted. Due to the large asymmetry of the weight distribution in the structure of the roller table between its rear and the front, in which the manipulator is built, the speed settings for the front and rear differ. The accuracy of the setting is determined by the set hysteresis width of the regulator. The low setting speed at the narrow hysteresis width of the controller makes it possible to achieve high accuracy of the preset level, but this results in a longer setting time and unnecessary cooling of the band. On the other hand, too high speed causes an oscillation in the system, which makes it impossible to stabilize the position, even in extreme cases. The total setting time of the 50 mm level is approximately 5 s and the angular error of this setting for the hysteresis of the regulator ±1 mm is less than 0.1°. Setting time is used to transport the heated band from the furnace toward the cage and position it with the manipulator before feeding it to the rollers.

Conclusions

The DUO-300 automatic level control of given-receiver roller tables enables to achieve satisfactory parameters such as accuracy and set time. This makes it possible to carry out a wide range of experimental research in the field of plastic processing in rolling processes, including those related to the study of the effect of angular feed angle to the rolling boiler on the geometry of finished products.

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