AUTOMATIC CONTROL SYSTEM FOR A TUBE-ROLLING MILL

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A high degree of efficiency can be achieved in automating the various operations involved in the manufacture of rolled products by providing for integrated, interdependent monitoring and control of the entire mill line, rather than individual sections and local components.

The Nizhnedneprovskii Pipe Plant has introduced an automated system to monitor and control the equipment on the delivery side of its 140 tube-rolling unit. The system was designed and built by the Kvantor Scientific-Industrial Association together with the State Pipe Institute of Ukraine and the Nizhnedneprovskii Pipe Plant.

The equipment of the complex (a tube-reducing mill with 20 stands, in addition to mechanisms and a saw for cutting pipes up to 20 m long to measured lengths during) determines the final dimensions and commercial characteristics of the reduced pipes.

The following operations are performed on the 140 tube-rolling unit: heating of a solid circular semifinished product to 1200°C, piercing; longitudinal rolling in two successive stands to a diameter of 130–175 mm; heating of the semifinished tube and its rolling to its final dimensions in continuous multi-stand mills; reduction (to a diameter of 60.3–95 mm) and sizing (to a diameter of 89–168 mm).

The speeds of the electric drives of the stands of these mills are adjusted and maintained in a certain relation to one another during rolling. The speed ratios are set so that the linear velocity of the rolls matches the increased velocity of the tube after each stand as its diameter is decreased to the required value in the rolls. To decrease or maintain the wall thickness of the initial tube, the speeds of the rolls and the electric drives are regulated so as to apply sufficient tension to the hot tube between the stands of the mill (reduction with tension).

The flying saw on the delivery side of the tube-reducing mill cuts the tube leaving the mill to measured lengths with toothed rotary disks. The disks and the electric drive are mounted on the rotating frame of the saw table. The electric drive of the table is controlled by a program which matches the linear velocities of the saw disk and the moving tube. This prevents breakage of the disk and provides enough time to rotate the table in order to allow passage of the ends of tubes of the prescribed measured length.

The above-described operating regimes of the electric drives of the tube-reducing mill and the flying saw are realized by an automatic control system based on PTK UNIKONT software-hardware systems.

The universality and reliability of the hardware part of PTK UNIKONT systems, the fact that it is protected from the environment and is IBM-compatible, and the sophistication of the application programs make it possible to realize almost any methods and algorithms for monitoring and controlling metallurgical processes.

Regimes which entail simultaneous monitoring and control of the electric drives of the multi-stand tube-reducing mill and the flying saw have been developed and implemented on the basis of a single PTK UNIKONT system with a high-speed processor and a set of functional blocks (Fig. 1).

The system includes the following hardware and software components:

- the UNIKONT software-hardware complex, which is located in the same room as the control post of the tube-reducing mill and includes the following: a cabinet with functional modules that receive and convert input signals from tacho-generators and sensors and generate control signals; workstations; an alphanumeric keyboard; a printer;

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Fig. 1. Automated system for monitoring and controlling the equipment in the production line of a tube-rolling unit: S1, S2) photosensors on the entry side of the mill; S115, S116) photosensors in the saw zone; TOP) technologist-operator's panel; BVK) sensors that detect the position of the saw table; CP) current pickups.

- electrical control systems for the 20 electric drives of the reducing-mill stands and the electric drive that rotates the table of the flying saw;
- a block that matches the signals from the tacho-generators and the current pickups;
- a control panel and a switch to change the operating regimes of the saw;
- the technologist-operator's panel (TOP);
- photosensors S1 and S2 on the entry side of the mill and photosensors S115 and S116 near the saw;
- sensors BVK1 and BVK2, which determine the position of the saw table;
- the tacho-generators of the electric motors and the current pickups;

The PTK UNIKONT was used to develop algorithms for the functioning of the system that controls the speed regime of the electric motors of the reducing-mill rolls and the flying saw.

The functions of the system:
- display the prescribed values of the speeds of the motors on a screen;
- monitor the actual speeds of the motors and keep them at the prescribed levels;
- display the assigned and actual values of the speeds of the stand motors in the form of curves;
- monitor and correct the speed regime of the motor of the saw platform.

The system is designed so that it can keep a history of the rolling of different pipe sizes, in order to satisfy the conditions for product certification and to improve the technology.