CONTROL SYSTEM FOR A WINDING MACHINE

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The structure of a control system for a winding machine was examined. Microprocessor control of the winding process is based on the use of a system for coupled control of winding parameters.

We investigated the possibility of comprehensive automation of the thread winding process using microprocessor technology to improve the high-speed winding machine from Klin Khimvolokno Industrial Association.

A block diagram of the winding machine control system is shown in Fig. 1. Thread 1, entering winding device with feed unit 2 at rate \( v_{\text{feed}} \), passes through tensioner 3, thread break 5 tension sensor 4, and is wound on takeup bobbin 7. The bobbin is rotated by motor \( M_1 \), and the rotation rate is adjusted by the microprocessor as a function of the bobbin winding diameter \( D_b \). The thread is moved along the axis of the pack by a thread spreading mechanism (screw drum), moved by motor \( M_2 \) controlled by the microprocessor with a fixed program. Direct current drives are used. The spreading mechanism also contains friction cylinder 6, rotated by synchronous motor \( M_3 \) and controlled by a change in the frequency of the power transformer.

The thread tension is monitored by sensor 4, end breakage is monitored by sensor 5, rotation rate \( \omega_b \) and bobbin winding diameter \( D_b \) are controlled by sensors 8 and 9, respectively, while friction \( \omega_p \) and spreading \( \omega_q \) rates are monitored by sensors 10 and 11. Information on those parameters enters the microprocessor through linking and switching devices where the winding control program stores it. The winding process is optimized in the microprocessor in consideration of the operational data on the speed regimes, tension, and end breakage are optimized and control signals are elaborated to correct the drive speeds of motors \( M_1, M_2, \) and \( M_3 \), and thread holder \( M_4 \).

The winding speed is automatically maintained on principles of direct digital control on the microprocessor. According to the given program, the microprocessor calculates the current linear winding speed \( (v) \), obtains the error \( \Delta(v) \), changes the thyristor control angle as a function of the value of \( \Delta(v) \), thus acting on \( v \). The microprocessor simultaneously processes the new program value of the spreader run frequency and controls the change in the drive rotation rate of motor \( M_2 \), thus preserving the required relationship between the indicated parameters.

The microprocessor also regularly determines the cross winding parameter. If its value is a whole number, a signal is sent to adjust the rotation rate of motor \( M_3 \), so that the vertical effect in winding is eliminated.

An additional system for correcting the defined winding speed with the results of measuring the integral thread density is introduced in the winding speed regulation circuit. This system acts as follows: A signal for continuing (t) winding of the thread on the bobbin enters the microprocessor from the thread break sensor (5). When the signal to finish winding is received, the microprocessor calculates the length \( (L) \) of the thread on the bobbin by multiplying the duration of winding by the speed:

\[
L = v_{\text{t}}t. \tag{1}
\]

The bobbin is moved by a positioner in the robotization equipment to automatic scales from which a signal on the actual weight of the thread (g) is transmitted to the microprocessor and the actual value of the linear density of the thread is calculated:

\[
T_f = g / L. \tag{2}
\]

Then the actual value of \( T_f \) is compared with the assigned \( T_{\text{ass}} \) (quality control unit) and the value and sign of the error of determination of the linear density \( \Delta T \) is found. If \( T_f \) is within acceptable limits, then data on the weight of the thread produced

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Fig. 1. Block diagram of the winding machine control system: 1) thread; 2) feed unit; 3) tensioner; 4) thread tension sensor; 5) thread break sensor; 6) friction cylinder; 7) take-up bobbin; 8) rotation rate sensor; 9) bobbin winding diameter sensor; 10) friction sensor; 11) spreader sensor; M₁-M₃: motors; TD: thyristor drive; ATD: adjustable-frequency thyristor drive.

Fig. 2. Two-coordinate thread-winding control system: \( U_1, U_2 \): drive motor armature circuit voltage for bobbin holder and spreader, respectively.

at the work station monitored is stored in the memory of the microprocessor and the bobbin is processed further. In the opposite case, a signal is transmitted to the weighing station that the thread in the weighed bobbin is defective.