In the present article we give results from the development and introduction of control systems for a continuous process of preparing alkali cellulose at the Balakovski "Khimvolokno" PO.

In Fig. 1, we show the functional scheme of a control system which has been realized in a computer-controlling system (CCS), containing serially manufactured and newly developed automation elements [1]. The regulator 1, level sensor 2, and valve in the delivery line for working alkali to the mercerizer 3 form a system for regulating the level of slurry in the mercerizer.

A differential density sensor is used to measure the slurry ratio from experience in operating the Krasnoyarsk "Khimvolokno" PO; it is based on measuring the weight of a column of slurry delivered to the press using the pressure sensors 4 and 5 and the differential manometer 6. The regulator for the slurry ratio, a pneumatic pulse-duration regulator 7 is used; it is constructed on the principle of vibration linearization [2]. A high-speed electrical actuator mechanism 8 varies the delivery coefficient of the variable-speed drive for the sheet delivery. Together with the integrating actuator mechanism, the regulator forms a PI-law for regulating slurry ratio.

The speed sensor for the slurry, mass pump 9, the sensor for the number of cellulose stacks processed 10, the integrating electrical actuator mechanism 11, and the control algorithm which has been realized in the CCS form a control system with the output from mercerization. Thereupon, the CCS by the regression equation

\[ G = b_0 + b_1 n, \]  

where \( G \) is the mercerization output in tons/day; \( b \) is a coefficient vector; and \( n \) is the velocity of the slurry mass pump, in rpm, determines the current value of mercerization output. If the current value does not correspond with the assigned one, then the CCS issues an appropriate controlling action to the actuating mechanism 11.

Fig. 1. Functional scheme of control system for continuous process of preparing alkali cellulose: 1) regulator; 2) level sensor; 3) valve; 4, 5) pressure transmitters; 6) differential manometer; 7, 12) pulse duration regulators; 8, 11, 13) actuating mechanisms; 9) mass pump speed sensor; 10) sensor for number of cellulose stacks processed.

The free term in Eq. (1) is periodically corrected using

$$b_0^i = b_0^{i-1} + \gamma (G - \hat{G}).$$

where $b_0^i$ and $b_0^{i-1}$ are the values of the free term at the $i$th and $(i-1)$st steps in adaptation, $\hat{G}$ is mercerization productivity as evaluated from Eq. (1); $G_M$ is mercerization productivity as determined as a function of time and the weight and number of cellulose sheets processed; and $\gamma$ is the coefficient of the adaptation algorithm.

To control the $\alpha$-cellulose content of the alkali cellulose, a cascade regulation system is used having a channel for compensating perturbations in output. The system includes a sensor for the slurry pressure under the squeeze rolls 4, a pulse duration pneumatic regulator 12, which integrates the actuating mechanism for changing the speed of the rolls in the squeeze press 13, and a sensor for the speed of the slurry mass pump 9, and a control algorithm which is realized in the CCS.

The structural scheme of the system is shown in Fig. 2. The regulator and the object of control OC1 form an internal loop for regulating the slurry pressure under the squeeze rolls which ensures working out unmeasured perturbations (nonuniformity in the slurry with respect to ratio, etc.). The external loop contains a channel for compensating perturbations from change in the output of mercerization $W_F$ and a channel for controlling by feedback $W_F^o$.

When the speed of the slurry mass pump changes, assignment of slurry pressure to the regulator is corrected by the equation

$$\Delta P_F = k (n - n_0),$$

where $k$ is the coefficient of the correcting device; and $n$ and $n_0$ are the current and initial values of the speed of the slurry mass pump.

By feedback, the control channel corrects the assignment of slurry pressure to the regulator when there is inaccurate compensation of perturbations in output and when there is an action from unmeasured perturbations in the external loop $f_2$. A feedback algorithm and an external loop compensation channel have been realized in the CCS.

This system ensures transition to a new production rate with an accuracy of $\pm 0.5$ rpm with respect to the speed of the slurry mass pump ($\pm 0.4$ tons/day with respect to the starting cellulose). The use of a pressure drop sensor on the line for delivery of slurry to the squeeze press ensures an increase in the sensitivity of the slurry ratio measuring channel as compared with a flag indicator and the use of a high-speed electrical actuating mechanism instead of a pneumatic follower drive with a reducer has made it possible to increase the power of the controlling action and correspondingly the accuracy of regulating the slurry ratio. A pulse system of regulating the slurry pressure under the squeeze rolls ensures an accuracy in regulating pressure of $\pm 2$ kPa (0.02 kg/cm$^2$).