DETERMINATION OF THE CRITICAL TWIST
FOR POLYPROPYLENE YARN

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An equation that reflects the effect of the basic properties of the fibre and the linear density of polypropylene yarn on its twist was obtained. Determination of more accurate values of the yarn twist with this equation is due to the nonlinear character of the dependence of the twist on the properties of the fibre and the linear density of the yarn.

To determine the critical twist of polypropylene yarn, its linear density range was broken down into three groups: from 30 to 50 tex; from 60 to 100 tex; from 150 to 180 tex.

The cut length \( L \) (mm), relative breaking load of the fibre \( (P_{r} \) cN/tex), linear density of the fibre \( (T_{p} \) tex), and linear density of the yarn \( (T_{y} \) tex) were selected as factors that affect the output parameter.

Unifactorial and multifactorial correlation models were obtained as a result of processing the experimental data. Their analysis suggested that multifactor correlation models reflect the effect of the factors on the output parameter more accurately.

Moreover, different deviations of the twist in the models for a different linear density of the yarn and their difference from the deviations of the general model made it necessary to continue the experimental studies and obtain an empirical analytical equation for the yarn twist.

Based on the analysis of an important amount of industrial and laboratory data and studies conducted at Dimitrovgrad Institute of Technology, Control and Design (DITUD), an equation was obtained that sufficiently accurately reflects the effect of the most important properties of the fibre and the linear density of the yarn on its twist.

It was based on the Koritskii* equation derived for cotton yarn:

\[
\alpha_c = K(260-10\sqrt{N_f})\sqrt\frac{P_0}{l_m \sqrt{N_f}},
\]

where \( \alpha_c \) is the critical twist factor; \( N_f \) and \( N \) are the fiber and yarn count; \( P_0 \) is the breaking load of the fibre, g; \( l_m \) is the modal length of the fibre, cm; \( K \) is a constant coefficient, and \( K = 3.1 \) for comb yarn and \( K = 3.25 \) for carded yarn.

Since carding was used for production of polypropylene yarn in conditions of spinning in a semiworsted system, \( K = 3.25 \) was used. In converting the unit of measurement of the breaking load of the fibre from g to cN/tex, the factor before \( P_0 \) equal to 9.8 \( \times \) 10\(^{-5} \), was obtained. Since the unit of measurement of the length of the fibre cut is mm, a factor of 10 was set before \( l_m \). The yarn and fibre count was converted to linear density.

The necessity of obtaining an empirical analytical equation for determining the critical twist of polypropylene yarn, since unifactorial and multifactorial regression models for each linear density range group for this yarn individually and the general multifactorial model for the entire linear density range insufficiently accurately reflects the degree of the effect of the selected factors on the critical twist.

Substituting all of the indicated coefficients in the initial equation and performing the simplest mathematical transformations and analyzing the effect of the linear density of the yarn \((T_y)\) on its twist and using many industrial and experimental data, we obtained the equation

\[
K = 845 - 115 \frac{T_y}{80 + T_y} \sqrt[4]{\frac{P_r L}{T_f}}.
\]

The values of polypropylene yarn twist were then calculated with the equation and the multifactorial model. The comparative analysis of the calculated values of the yarn twist, determined with the model and with the equation, showed the following:

- in the calculation using the model, the twist values of yarn made from fibre with a linear density of 0.68 tex almost did not differ from the values of the twist of yarn made from fibre with a linear density of 0.33 tex; with an increase in the linear density, the critical twist of the yarn decreased insignificantly;
- in the calculation with the equation, there was a more important change in the values of the yarn twist as its linear density and the properties of the fibre changed.

In our opinion, this is due to the nonlinear character of the dependence of the yarn twist on the properties of the fibre and the linear density of the yarn.

More accurate twist values can probably be determined by using the equation obtained as a result of the studies.