Fibre Chemistry, Vol. 37, No. 2, 2005

FABRICATION OF COMPOSITE SEWING THREAD USING POLYESTER MICROFIBRES

N. N. Bodyalo and A. G. Kogan

UDC 677.022.6:687.03

New technology for manufacture of composite sewing thread using hollow spindles was developed. The manufacturing process for production of sewing thread of 21 tex × 2 structure was optimized, and the optimum values of the basic process parameters were found: first twist of 720-750 tw./m, second twist of 550-570 tw./m. Industrial testing of this sewing thread showed that it has good sewing properties and provides for quality joining of clothing parts.

Companies in the sewing sector have recently been provided with modern high-speed sewing equipment that required the use of thermostable sewing thread with high physicomechanical properties. Reinforced thread, representing 50% of all thread manufactured, now holds a strong position among all types of sewing thread.

Garment companies in the Republic virtually do not use domestic reinforced sewing thread since it does not ensure quality sewing of clothing, although its physicomechanical indexes are as good as those of imported thread. The production technology does not correspond to the level of the technologies of such well-known firms as Amann, Gutermann, etc. [1].

The sewing (manufacturing) properties of domestic reinforced sewing thread must be improved for it to satisfy modern requirements. Research to create new production technology for composite and reinforced polyester sewing thread with improved manufacturing properties is being conducted in the Department of Spinning of Natural and Chemical Fibres at Vitebsk State Engineering University together with Groniteks Co. in Grodno. Abbreviated technology that allows eliminating doublers and ring twisters from the classic manufacturing chain is proposed for production of composite polyester sewing thread.

Composite thread is fabricated on modernized PK-100M spinning-twisting machines. One strand of twisted fibre is the composite thread and is spun on spinning-twisting machines from a complex chemical fibre introduced under the front pair of the drawing device and the fibre bundle obtained as a result of thinning of roving in the drawing device. The second strand is composite thread made on ring spinning machines with existing technology [2] and consisting of a complex chemical fibre and the fibre bundle winding it, and the cops from it are installed on the hollow spindles of the spinning-twisting machines. The two strands are twisted on PK-100MZ machines where spinning, slubbing, and twisting processes are combined. This allows halving the required number of spindles and reducing labor costs in spinning and twisting plants.

The new manufacturing process for production of composite polyester sewing thread of 21 tex × 2 structure was optimized. High-strength, low-shrinkage complex polyester fibre with a linear density of 13.8 tex was used as the core and the braid was a bundle consisting of polyester fibres of low linear density, 0.08 tex. The use of microfibre roving for spinning the fibre braid allows increasing the tenacity and uniformity of the thread and decreasing the fluffiness by reducing the linear density and increasing the number of fibres in the cross section of the thread.

Mathematical methods of experiment design were used to optimize the most important parameters of the manufacturing process for production of composite twisted polyester fibre that ensure the best quality indexes [3]. The first twist K_1 on the spinning machine and the second twist K_2 on the spinning-twisting machine were used as the experimental factors. The optimization criteria were the basic physicomechanical indexes of the fibres: tenacity (P), relative elongation at break (ε), unevenness — coefficient of variation for tenacity (C_{vP}), nonequilibrium (N) and pileup of bound constituent (H). The factors, their values, and ranges of variation in natural and coded form are reported in Table 1.

Vitebsk State Engineering University, Belarus'. Translated from *Khimicheskie Volokna,* No. 2, pp. 62-64, March—April, 2005.

TABLE 1. Values (lower/middle/upper) and Ranges of Variation of Factors

Factor	Coded designation of factor	Value of factor		Range of variation
		in coded expression	in natural expression	
K_1, tw./m	X_1	−1/0/1	600/750/900	150
K_2, tw./m	X_2	−1/0/1	570/670/770	100

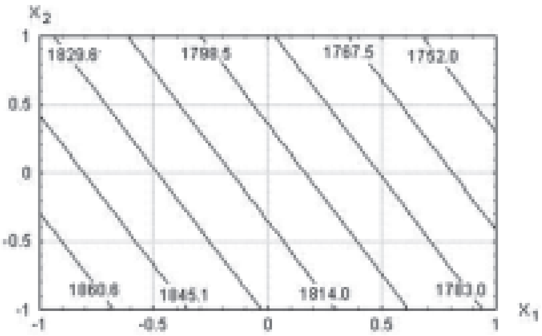

Fig.1

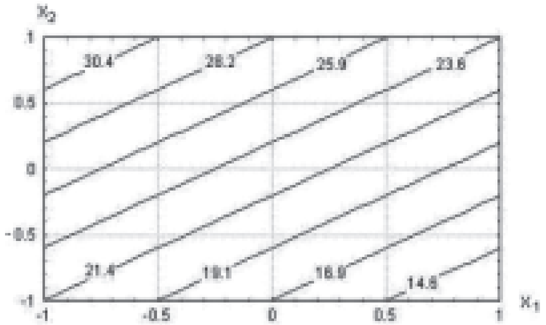

Fig.2

Fig. 1. Section of response surface characterizing the dependence of the tenacity of twisted composite fibres on first (X_1) and second (X_2) twists.

Fig. 2. Section of response surface characterizing the dependence of the nonequilibrium of twisted composite fibres on first (X_1) and second (X_2) twists.

Regression equations were obtained with the results of the experiment for calculating the parameters of composite sewing thread of 21 tex × 2 structure. The final form of the regression equations after eliminating the insignificant coefficients is:

– *tenacity*

$$P = 1806.3 - 48X_1 - 21.8X_2,$$

– *relative elongation at break*

$$\varepsilon = 13.1 - 0.2X_1 + 0.1X_2 + 0.2X_1^2 - 0.4X_2^2,$$

– *coefficient of variation for tenacity*

$$C_{\text{в}P} = 7 + 1.1X_1 - 0.6X_2,$$

– *nonequilibrium of twist*

$$N = 22.2 - 4.7X_1 + 5.3X_2,$$

– *pileup of bound constituent*

$$\text{H} = 0.6 - 0.52X_1 + 0.25X_2.$$

The response surfaces were plotted with the regression equations. The response surfaces for the tenacity, nonequilibrium of twisted composite fibres, and bound constituent pileup are shown in Figs. 1-3. In analyzing Fig. 1, note that within the limits of the investigated twist range, the tenacity of the twisted fibre decreases with an increase in the twist in spinning and twisting.

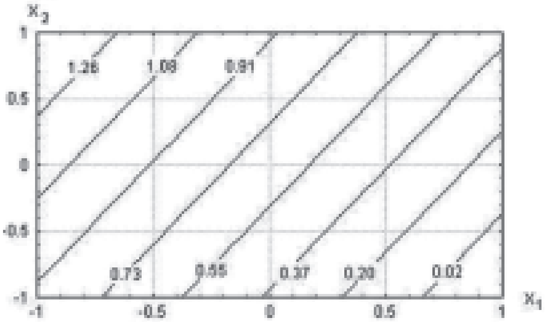

Fig. 3. Section of response surface characterizing the dependence of pileup of bound constituent on first (X_1) and second (X_2) twists.

TABLE 2. Physicomechanical Properties of Twisted Composite and Reinforced Polyester Fibres for Sewing Thread of 21 tex × 2 Structure

Indexes	Composite fibre	Reinforced fibre
Linear density, tex	43.2	43.6
Coefficient of variation for linear density, %	0.8	2.9
Breaking load, cN	1840	1850
Relative breaking load, cN/tex	42.7	42.4
Coefficient of variation for breaking load, %	5.7	3.4
Relative elongation at break, %	13.1	14.8
Nonequilibrium, loops/m	15	23

This dependence is characteristic of complex polyester fibres whose critical twist is 420-520 tw./m. The important effect of the complex fibre on the properties of the composite fibre can be explained by its high content (64%) of composite fibre in the structure. In addition, when the second twist increases, the spun strand becomes a rod due to an increase in its twist (shrinkage) and untwisting (elongation) of the strand unwound from the cop. As a result, pileup of the bound constituent increases and the strength of the twisted fibre decreases.

The analysis of Fig. 2 showed that the nonequilibrium of the composite twisted fibre decreased with an increase in the first and a decrease in the second twist. The degree of equilibrium of the thread is the basic criterion of correct selection of the twist ratio. For this reason, the experimental data were processed with the imbalance of twisted composite fibres obtained on a spinning-twisting machine, and the equation of the dependence of this index on the first and second twist coefficients was found as a result

$$N = 0.95(\alpha_1 - 0.57\alpha_0),$$

where α_0 and α_1 are the first and second twist coefficients, respectively.

The dependence of the bound constituent pileup on the twist in spinning and twisting shown in Fig. 3 totally confirms the previous conclusion: fibres with less twist in spinning and more twist in twisting have the maximum pileup due to an increase in the shrinkage of the spun strand and elongation of the strand unreeled from the cop.

The physicomechanical properties of the composite fibres together should be examined and a compromise solution with consideration of process and economic factors should be adopted for selecting the optimum combination of the twist value in spinning and twisting. As a result of multicriterial optimization, the optimum twist values were determined: 720-750 tw./m for the first twist and 550-570 tw./m for the second twist.

The comparative characterization of the physicomechanical properties of the developed composite and reinforced fibres fabricated with classic technology is given in Table 2.

Industrial testing of the sewing thread developed with the new technology showed that it has good sewing properties: low end breakage during sewing, absence of seam gaps. The seams made with this thread are sufficiently strong and have an attractive external appearance: the seam is rigorously parallel to the direction of stitching, which is due to the equilibrium structure of the sewing thread over the twist.

The reduction in process changes in production of composite sewing thread and the use of high-efficiency equipment increase labor productivity, decrease production areas and the amount of electrical power used, and increase yield of product from 1 m^2 of production area.

REFERENCES

1. A. Polushkin, *Legprombiznes — Direktor*, No. 7, 16 (2001).
2. A. G. Kogan, *Production of Composite Yarn and Thread* [in Russian], Pishch. Prom-st’, Moscow (1981).
3. A. G. Sevost’yanov, *Methods and Equipment for Investigation of Mechanical-manufacturing Processes in the Textile Industry* [in Russian], Leg. Industriya, Moscow (1980).