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AIR TEXTURING OF ARSELON THREAD

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The structure of an air-texturing unit for production of textured Arselon thread was developed. The effect of the texturing and twisting parameters on the physicomechanical properties of air-textured Arselon thread was investigated. The optimum values of the structural parameters of the aerodynamic unit are determined. The air-texturing process parameters in processing of complex Arselon fibres were optimized. A new line of air-textured Arselon fibre was developed. Recommendations were created on selection of the air-texturing method as a function of the requirements imposed on the thread.

An important trend in the development of textile production is the creation of new special-application materials and the technologies for manufacturing them. By order of the Republic of Belarus' Ministry of Civil Defense, Emergencies, and Natural Disasters, a series of studies on air texturing of Arselon complex chemical fibres used for fabrics for protective clothing for firefighting personnel was conducted in the Department of Spinning of Natural and Chemical Fibres at Vitebsk State Technological University. The main advantage of Arselon fibres and yarns manufactured by Svetlogorsk Khimvolokno Manufacturing Association is their high thermal stability, which makes it possible to make articles for use at high temperatures and in aggressive media. With respect to thermal stability, Arselon is superior to the well-known international analogs — Nomex and Kevlar. At 300°C, the foreign fibres lose 50% strength. Arselon fibre only loses 20% of its strength at 350°C. Articles made of Arselon can be used as long as desired at 200-300°C and briefly at 400°C, which is acceptable for fabrics for clothing for fire fighters.

The fibre does not melt, has high tenacity and low shrinkage, is resistant to flexing and abrasion, dyes well in bulk, and has high hygroscopicity (12% equilibrium moisture content). The ergonomic properties are close to those of cotton fibre. The high elongation of fabrics made from the fibre are determined by the high elongation of the fibre, which in the final analysis increases the lifetime of clothing, especially in extreme conditions of use.

A number of the drawbacks of Arselon complex fibres can be eliminated by air texturing. After texturing, the fibres become yarn-like, and their bulk and hygroscopicity increase, which significantly improves the consumer properties of fabrics and knits made from them.

Air-texturing units (ATU) of different designs were developed in the Department laboratory for air texturing of complex Arselon fibres with 25 tex linear density. The experimental studies allowed selecting a rational design of the unit and determining its optimum parameters. The studies showed that air-textured Arselon thread (ATT) manufactured with the ATU had higher physicomechanical properties than yarns made of Arselon fibre (Table 1).

The twist of complex thread significantly affects air texturing of filaments (Fil). The twisted thread in a free state in the ATU attempts to untwist, which causes formation of its loop structure. Twisting of previously textured thread also significantly affects its properties. In twisting, the thread is stretched, and the Fil, which assumes a helical shape, is also subject to tension. For this reason, the Fil forming the loops in the air-textured thread attempts to be positioned along helices of smaller diameter

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TABLE 1. Physicomechanical Properties of Yarn and Air-Textured Thread Made from Arselon Fibre

Indexes	Yarn	ATT
Linear density, tex	29.1	25
Coefficient of variation in linear density, %	1.8	1.3
Relative tenacity, cN/tex	17.9	22
Coefficient of variation in relative tenacity, %	9.6	9.3
Relative elongation at break, %	9.1	6.7
Coefficient of variation in relatively elongation at break, %	9.4	15.8
Twist, tw./m	585	–
Loop structure instability, %	–	2.1

TABLE 2. Physicomechanical Properties of Air-Textured Arselon Thread

Version	Tenacity, cN	Coefficient of variation in tenacity, %	Relative elongation at break, %	Coefficient of variation in relative elongation at break, %
1	550.0	9.32	6.72	15.85
2	1499.0	3.75	10.38	18.00
3	1457.0	8.30	11.64	13.23
4	751.8	2.40	7.80	8.80
5	1536.5	0.80	9.12	9.17
6	1007.0	5.20	5.09	10.20

and for this reason apply pressure on the inner layers of the thread. The thread density in the cross section is equalized, interloop voids disappear, and frictional forces increase, preventing the thread from breaking in stretching. Some protruding double loops on the surface of the threads are straightened and also participate in the breaking process. Unstraightened loops intensify the friction between the twisted strands. The loop structure of ATT is not perturbed during processing as warp on looms.

We investigated the joint effect of texturing and twisting on the properties of Arselon thread. The effect of preliminary twisting of complex thread on air texturing was determined. The twist of the initial thread and compressed air pressure in the ATU were used as the experimental input parameters. ATT was twisted on a TKD-400-Sh machine. In light twisting of a single textured thread, the tenacity increased from 550 to 752 cN, the relative elongation at break increased from 6.7 to 78%, and the irregularity of the properties decreased significantly. Comparative diagrams of the properties of twisted ATT and the initial thread with twist of 125 tw./m are shown in Figs. 1 and 2.

The air-texturing technology can be used to manufacture a relatively wide assortment of thread of different composition, structure, and linear density. ATT can be manufactured from several complex fibres by the parallel or piled method. Selection of the method of spinning ATT is determined by the requirements imposed on it.

In production of thread in two strands, combined texturing of thread previously twisted with twist of 100 tw./m is best. The tenacity of the textured thread is 1536 cN, the relative elongation at break is 9.12%, the irregularity in tenacity is 0.8%, and the irregularity in elongation at break is 9.1%.

A new assortment of air-textured Arselon thread was developed as a result of the studies. The following experimental samples of thread were made:

1) air-textured single thread with 25 tex linear density;
2) air-textured thread with 51 tex linear density from parallel texturing method;
3) air-textured thread with 53-tex linear density with piled texturing method;
4) air-textured single thread with 26.5 tex linear density with preliminary light twisting of 50 tw./m;
5) air-textured thread with 55.5 tex linear density with parallel texturing method and preliminary light twisting of 100 tw./m;
6) air-textured thread with later twisting (100 tw./m, 25 tex × 2 structure).

The physicomechanical properties of the samples of ATT obtained are reported in Table 2.

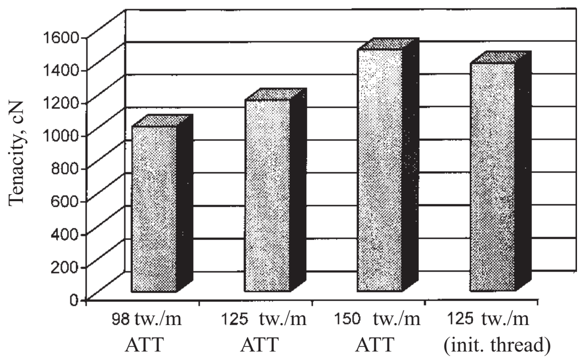

Fig.1

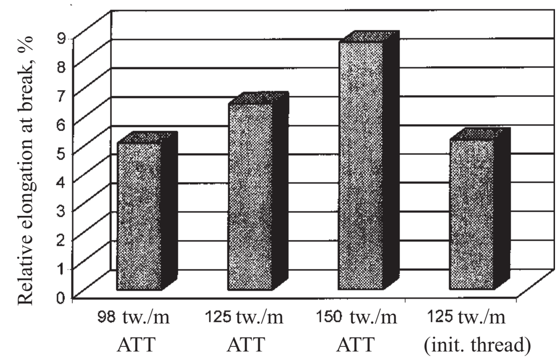

Fig.2

Fig. 1. Tenacity of twisted ATT.

Fig. 2. Relative elongation at break of twisted ATT.

It is recommended that the method of manufacturing ATT be selected as follows:

– if ATT with a linear density of under 30 tex and minimum elongation at break is required, select version 1;

– if ATT with a linear density of under 30 tex and maximum tenacity are required, select version 4;

– if ATT with a linear density of 50-60 tex are required, select version 5.

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