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STRUCTURE AND PROPERTIES OF YARN FABRICATED BY HYDRODYNAMIC SPINNING

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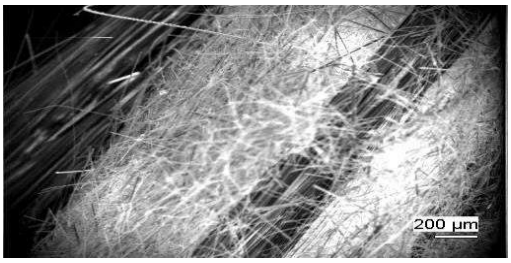
The data on physical and mechanical properties and fiber orientation in the yarn fabricated by hydrodynamic method have been summarized.

The data on physical-mechanical properties and orientations of fibers in the yarn obtained by hydrodynamical methods are given.

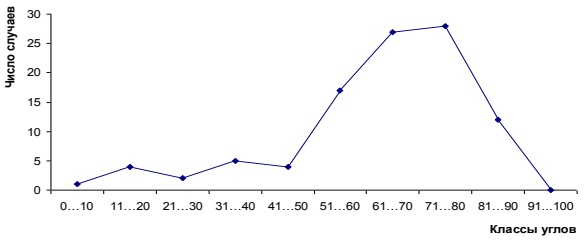
Keywords: yarn of hydrodynamic spinning, structure, properties.

The yarn fabricated by hydrodynamic spinning, which is used as a filler of the heat-insulating cord with operating temperature of 1600^0 C, is a core yarn; in this case, the fibers of aluminum oxide [1] form a peripheral layer (Picture 1).



Picture 1. Longitudinal view of the yarn T = 300 tex of hydrodynamic spinning (core PAN - threads 15 tex×2, linear density of the boundary layer - 270 tex)

As the characteristic of the yarn structure, angles of orientation of the fibers of aluminum oxide in relation to the longitudinal axis of the yarn have been used. In order to determine these angles, Webers G50s technology was used that enables to record and preserve the image of the yarn and its constituent fibers with a magnification 500^X. Angle of orientation for the clearly visible fibers of aluminum oxide, which came into focus of optical system of microscope, was measured from the photographs between the line connecting the ends of the fiber and the longitudinal axis of the yarn. In Picture 2 distribution of orientation angles of fibers in the yarn is illustrated, and in the Table. 1 – statistical characteristics of the orientation angles of fibers of yarn and flock after sampling [1], the latter are given for comparison. Measurements were made without compression of yarn and flock.



Picture 2. Distribution of orientation angles of fibers in the yarn

These data indicate that the mean and modal values of the angles of orientation in the yarn are substantially higher in the yarn than in the flock; this can be attributed to the conditions of the formation of the initial fiber by sol-gel method [2] aimed at removing the fibers flocks from their mass during the sampling and to the conditions of formation of yarn in thread suspension (flow in suspension).

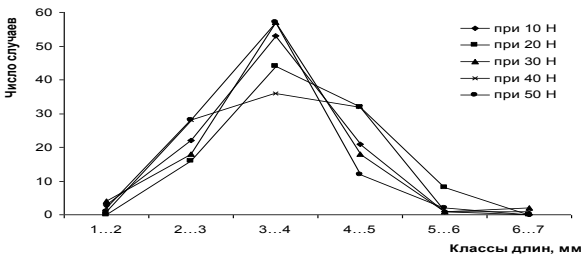
Table 1

Statistical characteristics of distributions of orientation angles of aluminum oxide fibers in the yarn and flock

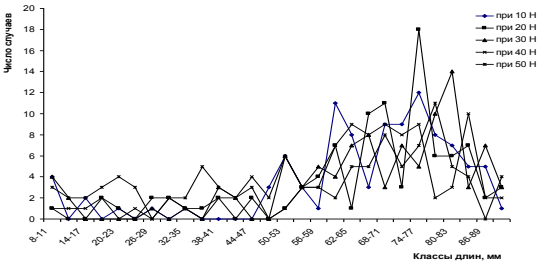
Statistical characteristics	Yarn	Flocks
Average value, degrees	63,6	46,1
Modal value, degrees	70,0	45,0
Mean square deviation, degrees	17,9	18,9
Coefficient of variation,%	28,1	41,0
Scope of variation, degrees	85,0	70,7

These data indicate that the orientation angles of fibers in the yarn in ralation to its axis are substantially larger than in flock; this points to the greater randomness in the arrangement of fibers; taking into account the purpose of yarn, more anisotropic structure of the yarn is a positive factor.

The orientation of fibers in the yarn has also been studied for its lateral compression, simulating the compression of yarn in the cord in which it is used as a filler. Section of yarn was subjected to compression with flat surface with the load 10 ... .40 H in the apparatus described in [3], in this case contacts of fibers in the layer of enamel, previously deposited on a glass slide were fixed; prints of contacts were increased by 40 times, and fixed on the screen. Length of the contact prints and orientation angle of the contact prints in relation to the longitudinal axis of the yarn have been used. Contact length was measured using curvimeter, the orientation angles - with a protractor. Statistical distribution of the lengths of prints and contact angles and of orientation angles are shown in Picture 3 and 4.



Picture 3. Distribution of length of contact fibers's prints under transverse compression of the yarn



Picture 4. Distribution of orientation angles of prints under transverse compression of yarn

These data indicate the following:

– at high compressive loads, a more flat distribution of the lengths of contact prints are observed, which is explained by the increase in the lengths of fibers sections having contact with a flat surface, with a mean and modal values of lengths of prints being close;

– in the studied range of variation of the compressive load the latter has an insignificant effect on the length and angles of fiber orientation;

– independence of the studied characteristics from the compression degree indicates the stability of the structure (in the investigated range of compressive load).

In Table 2 the results of evaluation of the statistical characteristics of length L (mm) of prints and contact angles of orientation are presented (degree), in Table 3 - the results of evaluation of the physical and mechanical properties of yarn.

Table 2

Statistical characteristics of orientation indices

m_{mean}, σ, C	Breaking load, H									
	10		20		30		40		50	
	L	α	L	α	L	α	L	α	L	α
m_{mean}	3,05	65,00	3,5	63,44	3,15	63,00	3,15	63,00	3,02	55,49
σ	0,75	18,75	0,82	17,74	0,80	19,79	0,90	18,36	0,67	23,47
C	24,59	28,85	23,43	27,96	25,40	31,41	28,57	29,14	22,18	42,29

*) Legend: m_{cp} – mean, σ - mean square deviation, C – Coefficient of variation

Table 3

Physical and mechanical properties of the yarn fabricated by hydrodynamic spinning

Characteristic	Value
The content of components	Fibers of aluminum oxide -87.0%, cotton yarn 10.0 tex×4 - 13.0%
Linear density, tex	300
Twist, tw/m	250
Coefficient of variation % of linear density on 0.05 meter length of threads	17,0
Breaking load, H	8,0
Relative elongation, %	5,0
Cover factor	0,08

CONCLUSIONS

Yarn fabricated by hydrodynamic spinning from aluminum oxide fibers and core yarns, has a complex of structural and physical-mechanical properties, indicating the possibility of using it as filler of insulation cord.

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