

УДК
677.075.54:
616.379-
008.64

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DEVELOPMENT OF FUNCTIONAL FLAME- RESISTANT KNITTED MATERIALS

Purpose. *Development of two-layer functional knitted fabrics and research of its consumer characteristics.*

Key words: *functional knit, knitting structure, flame-resistant textile material, fire-resistant yarn, flame-resistant underwear.*

Introduction. During the creation of flame-resistant knitted fabrics for the needs of the defense-industrial complex, the primary task is to ensure the necessary set of consumer characteristics, depending on the field of application and purpose of the textile material. Solving this problem largely depends on a rational combination of the properties of the selected raw material, structure parameters of the knitted material and its manufacturing technology.

Investigations of the influence of the knitting structure made from NomexDelta TA 18 tex×2 yarn in one, two, three, and four yarns on garment flammability are investigated by authors [1]. The burning time of the knit made from single yarn and folded yarns from two, three and four single yarns and a multi-layer packet from the same number of knitted fabrics made from single yarn are determined in this paper. Increasing the number of yarns simultaneously knitted into the loops allows to increase the burning time. However, such knitted material has a larger thickness and lower air permeability, which makes it impossible to use it for underwear.

The correlation between the tightness factor, the air permeability of knit made of flame-resistant yarn NomexDelta TA 18 tex×2 and the burning time are established in paper [2]. An increase in the linear density of the yarn leads to a compaction of the structure and, accordingly, to a decrease in air permeability and an increase the burning time. This allows to predict the burning time according to the porosity of the knitting structure. The influence of knitting density and yarn linear density on the air permeability of knitted material and its burning time are investigated by the study authors [3]. By changing the knitting parameters, it is possible to achieve the desired burning time. In the course of previous studies [4], double-layer knit structures were developed and their physical properties and flame resistance were

investigated. The proposed textile material is recommended for the production of heat-protective underwear. However, the question of their full compliance with the established requirements remains open.

Methodology. The work uses an experimental method of research, as well as methods of analysis and synthesis of scientific and technical information according to the research direction.

Research results. Test samples of knits were produced on a 16E gauge circular knitting machine by two-layer structure with press connection of layers by main yarns. The peculiarity of this structure consists in the formation of non-through cells in the places of formation of connecting tucks. In order to give the knitted material resistance to the action of an open source of flame, we have chosen the following raw materials: meta-aramid yarn linear density 40 tex and a mixed yarn 18,5tex×2 containing 60% meta-aramid fibers and 40% non-combustible viscose fibers.

Table 1 - Research results of the consumer characteristics of knitted fabrics

Physical and mechanical properties, unit of measure	Test result				
	sample 1	sample 2	sample 3	sample 4	sample 5
Area density, g/m ²	328,6	282,8	301,1	295,4	344,2
Thickness, mm	1,20	1,15	1,47	1,17	1,49
Air permeability at pressure 50 Pa (5 mm water level), dm ³ /m ² ·s	1044	1195	1390	1270	1385
Vapor permeability, mg/cm ² per hour	13,9	14,8	12,7	12,6	12,3
Moisture absorption, %	0,2	0,6	0,2	0,2	0,3
Hygroscopicity, %	6,8	8,4	9,0	10,2	7,4
Breaking force, N:					
length-wise	625	461	575	531	920
width-wise	441	332	431	383	621
Elongation at break, %:					
length-wise	82	82	94	74	96
width-wise	147	156	125	134	141
Extensibility under a load 6N, %:					
length-wise	17	24	27	15	17
width-wise	48	66	38	43	37

The layer of knitwear, which in underwear will come into contact with the human body, in samples 1 and 2, is made of yarn containing polyester fibers under the trade name Deo 18,5tex×2 with antibacterial action and deodorizing effect, and the outer surface of the knit, to ensure resistance to flame, is made from yarn based on meta-aramid fibers and meta-aramid

combined with non-combustible viscose, respectively. Layers of samples 3 and 4 are made of meta-aramid fiber yarn and mixed meta-aramid and non-flammable viscose yarn. The difference lies in the raw material composition of the layer, which has a cell-shaped structure. Sample 5 is completely made from meta-aramid yarn.

Table 1 shows the research results of consumer characteristics of the developed knitted fabrics. In the course of research, it has been established the influence of the cell-shaped structure of the face knit layer on the of flame penetration type to the inner layer. In addition, it was found that the burning process in the case of the location of the burner and the sample vertically in the courses direction is radically different from the case of the location of the sample in the wales direction. The level of air permeability, hygroscopicity and tearing characteristics of knits is influenced by the type of fire-resistant yarn from which the connecting tucks are formed.

Conclusion. The consumer characteristics of the developed samples of two-layer knitted fabrics with tuck connection layers by main yarns were established, namely: flame resistance, vapor permeability, air permeability, hygroscopicity, breaking load and elongation, extensibility under a load 6N, which allows assessing their compliance with the requirements to knitted materials for the flame-resistant underwear production. For their production, fire-resistant yarn of various raw materials was chosen. Forming a layer of textile material that will be in direct contact with the human body in underwear, it is suggested to use yarn containing Deo fibers with antibacterial action and deodorizing effect.

Acknowledgements. The research was carried out within the framework of the state budget theme "Development of multifunctional knitted fabrics and products for the formation of property and tactical equipment of servicemen" DB 16.04.73, state registration number: 0121U109756 (2021-2022) supported by the Ministry of Education and Science of Ukraine.

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