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RESEARCH OF KNITTED FABRIC MATERIALS ON THE RESISTANCE TO PUNCTURE AND BALL PRESSURE

Purpose. *To investigate the resistance to puncture by a rod and pressing by a ball of developed samples of knitted materials and their packages of yarn from meta-aramid fibers, para-aramid and polyethylene threads, intended for the production of protective gloves.*

Keywords: *meta-aramid yarn, polyethylene threads, para-aramid threads, super-strong knit, personal protective equipment, protective gloves.*

Introduction. One of the important elements of occupational health and safety in various industries and labor professions is the protection of hands from mechanical damage (puncture, cut, tearing, etc.). No less important at present is the issue of protecting hands from mechanical damage and the action of open flames of military personnel and sappers, who in their professional activities are exposed to risks that can potentially cause serious negative consequences. The risks of injury of hands due to the action of sharp and cutting objects and the action of fire and high temperatures are highly probable. Often the danger of a negative injury is twofold, therefore, it is important to provide protection against each of the possible injuries. Today, on the market of Ukraine we see samples of gloves made of textile materials resistant to cuts, punctures, other mechanical damage and high temperatures [1]. But they do not provide dual protection, providing protection against only one type of hazard. It is appropriate to make such gloves from textile materials and two-layer materials that will provide protection against several types of hazards at the same time. The use of such materials involves a preliminary study of consumer characteristics in order to identify the influence of the technological knitting parameters on them.

Methodology. The methods indicated in regulatory documents [2–4] were used to study the resistance of knitted materials and their packages to puncture and ball penetration. The research was carried out in the accredited laboratory of KNUVD ADVL "Textile-TEST" using a modern Microcomputer controlled

electronic universal testing machine model WDW-5ES 0.5 class. A test ball with a diameter of 2.5 cm was used to determine the values of resistance of knitted materials and their packages to being pressed by a ball. The ball is located at an angle of 90 degrees to the surface of the material and moves down at a speed of 100 mm/min. The tested sample in the form of a circle with a diameter of 7 cm is fixed in a frame (Fig. 1). During the puncture resistance test, the upper clamp with a punch (needle in the form of a pin) is moved at a constant speed of 500 mm/min until the sample is punctured (Fig. 2).

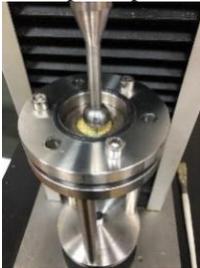


Fig. 1. Determination of the resistance to being pressed by a ball



Fig. 2. The puncture resistance test

Research results. Experimental samples of knitted materials were produced on the PA-8 flat glove knitting machine of the gauge E8 by interweaving plains from three types of functional raw materials. Characteristics of the tested knitted samples are given in Table 1.

Table 1 – Characteristics of the tested knitted samples are given

Type of raw material	Linear density	The length of the thread in the loop ℓ , mm	Thickness, mm	Surface density, g/m ²
para-aramid thread (PA)	44 Tex × 3	7,6	0,90	300,6
yarn of meta-aramid fibers (MA)	40 Tex × 3	8,2	1,27	334,0
polyethylene thread (PE)	44 Tex × 3	8,2	1,30	384,3

Four types of samples were developed and manufactured for the study of ball extrusion: single-layer samples from para-aramid and polyethylene threads and two-layer samples from a package of materials. In the two-layer samples, the para-aramid and polyethylene knitted fabrics are located in the upper layer of the samples, and the meta-aramid fabric is in the lower layer of the samples. In two-layer samples, the layers of knitwear are in contact with each other with the inside surface.

The puncture resistance of the developed samples of knitted materials and their packages was determined as follows: sample 1 (two-layer package of

materials (PA+MA) – 738 N, sample 2 (single-layer sample with PA – 627N, sample 3 (two-layer package of materials with PE+MA) – 688N, sample 4 (single-layer sample with PE) – 494N. The low level of puncture resistance of tested knitted samples made of polyethylene threads is due to the low coefficient of friction of polyethylene threads. In the loop structure of the knitted material, under the action of the pressure of the rod (punch), the thread is redistributed between adjacent loops, as a result of which a shell is formed into which the rod (punch) penetrates without destroying the sample. Threads in the structure of the knitted material do not work for destruction in a single-layer sample of polyethylene threads.

The value of resistance to ball penetration of a two-layer package of materials with PA and MA threads (sample 1) is 4538N, a single-layer sample with PA threads (sample 2) is 3369N, a two-layer package of materials with PE and MA threads (sample 3) is 5000N, a single-layer sample with PE thread (sample 4) – 5000N.

Conclusion. The results of experimental studies indicated the nature of destruction of single-layer and two-layer samples, the magnitude of the breaking load, and the change in the magnitude of the load on the sample over time until the moment of its destruction. Samples of knitted material made of PE threads demonstrate the highest breaking force in the case of ball pressing - more than 5000 N. During the study of the resistance of the knitted material to puncture among single-layer samples, the sample with RA threads demonstrated the greatest resistance to punching by a rod - 627 N.

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