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INFLUENCE OF TECHNOLOGICAL FACTORS ON THE LOOP FORMATION AND STRUCTURE PARAMETERS OF KNITWEAR MADE ON GLOVE KNITTING MACHINE

Purpose. *By implementing an active experiment and defining linear one-factor regression models, determine the influence of high-strength raw materials and knitting density on the parameters of the structure and shaping of loops of knitted material produced on a glove knitting machine.*

Keywords: *high-strength raw materials, para-aramid thread, ultra-high molecular weight polyethylene thread, durable knitted material, protective textiles.*

Objectives. When the country is in a state of full-scale war, it is a priority to provide our military with quality clothing property, and tactical equipment to preserve life. High-strength threads are used to create protective textile materials. Such high-strength textile materials are widely used in manufacturing protective equipment for military personnel, such as body armor, soft concealed body armor, panels, helmets, and shields. Most often, these are woven structures obtained using high-strength threads. However, for manufacturing small parts in military gear, which should provide additional protection from mechanical damage and simultaneously create comfortable operating conditions (take a given shape dynamically, without restricting movement), it is more appropriate to use a knitted structure. These are protective elements such as elbow and knee pads, helmet covers, and inserts to protect the face, neck, shoulders, and groin. In terms of its structure, knitted material is more amenable to reproducing the shape of an object of complex configuration due to its thread structure in the form of loops intertwined during the knitting process.

The authors of [1] proposed a method for predicting the properties of special-purpose knitted fabrics using 3D geometric models. However, it is not indicated under what specific parameters and conditions the prototypes of knitwear were developed.

In previous studies [2, 3], we found that changes in the shape of the axis line of the thread in the loop and the structure parameters are affected not only by the

type of heavy-duty threads but also by the type of knitting equipment. At the same time, in work [2], the goal was not to conduct a regression analysis to determine the dependencies that describe the influence of technological parameters on the parameters of the structure and properties of knitwear. This was precisely the direction for further research.

Methodology. The work uses the method of a linear one-factor regression mathematical model with traditional planning of an active experiment.

Research results. We have discovered that in the case of developing prototypes on flat knitting equipment of the PVRK type with a general takedown force of the fabric, which is provided by a comb with a load, under the influence of this force, even during the knitting process, a redistribution of the thread from the needle and sinker of the loops into the legs of the loop occurs (Fig.1). As a result, the thread in the loops is oriented toward the loop columns. At the same time, on a flat-knitting glove machine (PA-8-33), the takedown force of the fabric is ensured due to the presence of plates, which create a bumper plane with their chin when forming loops of a given size and keep the sinker necks of the loop arcs from lifting along with the needle during the closing operation (Fig. 2). This difference in the loop formation process operations affects both the loops' shaping and the knitted material's structural parameters.

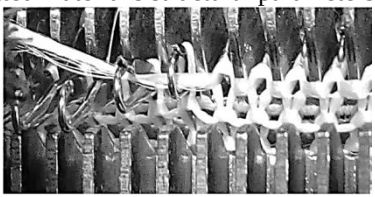

Fig. 1. **The process of forming loops on flat knitting equipment of the PVRK type**

Fig. 2. **The process of forming loops on a flat-knitting glove machine (PA-8-33)**

In the course of a preliminary experiment, the minimum and maximum levels of knockover depth were established to ensure the normal course of the looping process when processing two types of threads on a E8 PA-8-33 glove machine: para-aramid (PA) and high-molecular polyethylene (PE) linear density 44×3. To implement an active experiment [4], prototypes of a tubular knitted material with a single stockinette weaving from the specified types of threads were produced on a E8 glove machine at five levels of knockover depth of the thread in a certain range with a step of 0.1 mm, subject to constant thread tension.

In the course of the research, adequate regression mathematical dependences describing the influence of increasing knockover depth in a given range (for PE yarn h=3,55÷3,95mm; for PA yarn h=3,4÷3,8mm) on the structure parameters (thread length in the loop, knitted fabric thickness, number of wales and course in

100 mm of knitted fabric) and parameters characterizing the loop shape (loop area, angle of inclination of the tangent at the point of weave, angle of inclination of legs of loop) were obtained. It is revealed that the increase of knockover depth in the selected range leads to an increase in the length of thread in the loop of knitted material from PE yarns by - 8%, from PA by - 7.3%; knitted fabric thickness by 2.7% and 4.6%; the number of wale from PE yarns increases by - 3.5%, and from PA decreases by - 3.9%; the number, of course, decreases by 19.3% and 16.2%, respectively. At the same time, the loop shaping parameters change as follows: the loop area increases by 14% and 22.10%; the angle of inclination of the tangent at the point of weave by 4.5% and 7.6%; the angle of inclination of the legs of the loop by 6.5% and 3.7%, respectively, for knitted material made of PE and PA yarns.

Conclusion. The linear regression dependencies obtained during the implementation of the active experiment will make it possible to design high-strength knitted materials produced on flat knitting equipment with platins that provide takedown forces concentrated on the sinker of the loops, with specified structure parameters and loop formation characteristics.

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