

UDK[677.07
5:677.027.62
5.16:620.17]:
001.8

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ANALYSIS OF SCIENTIFIC STUDIES ON THE DEVELOPMENT OF KNITTED MATERIALS FOR PROTECTION AGAINST MECHANICAL IMPACTS AND FIRE EXPOSURE

Purpose. *The research is focused on exploring the potential of modern knitted materials that demonstrate high protective properties.*

Keywords: *meta-aramid yarn, polyethylene threads, para-aramid fibers, high-strength knitwear, personal protective equipment, protective gloves.*

Introduction. The issue of hand protection from mechanical injuries and fire exposure remains relevant in many sectors, including industry, medicine, rescue services, and the military. Contemporary challenges demand the creation of materials that combine resistance to cuts, punctures, and high temperatures with comfort and flexibility.

Methodology. To achieve the research objectives, an analysis of scientific studies on the development of hand protection against mechanical injuries and fire exposure was conducted. A key aspect of the study was investigating the behavior of high-strength yarn-based textile materials under mechanical stress (tearing, puncture) and thermal impacts. The review covered works that utilized advanced technologies and materials, as well as testing standards (EN 388[1] and EN 407[2]).

Research results. Modern textile materials demonstrate significant advancements in resistance to cuts and punctures, particularly due to the use of high-strength fibers and polymers with specialized coatings. Additionally, some studies focus on heat-resistant materials capable of withstanding extreme temperatures without losing their protective properties. Composite and multilayer materials have become key to providing comprehensive protection. For instance, in [3], the authors review recent developments in protective fibers and textiles for personal protective equipment (PPE). Special attention is given to high-performance polymer fibers, which exhibit excellent resistance to mechanical impacts. In particular, the study examines the application of aramids and ultra-high

molecular weight polyethylene (UHMWPE) for cut and puncture protection.

Researchers worldwide are actively investigating the properties of yarns and threads, knitting structures, and knitwear parameters that can be used in developing protective products. In their work [4], the authors review recent advancements and future prospects in the PPE field. They highlight fiber developments, including high-stretch elastic fibers based on polyester and shape-memory polyurethane and high-strength inorganic materials such as basalt fibers and carbon materials. Special textile structures that provide protection through three-dimensional fabric configurations, nanoporous materials, and changes in knit fabric structure are also described.

It has been found that the strength of knitted materials made from polyethylene and para-aramid yarns is influenced by the type of equipment and the introduction of metallic monofilament into the structure [5]. The inclusion of metallic monofilament in the knitted fabric structure leads to a reduction in the strength of polyethylene yarns.

In [6], the authors present the results of a study on the resistance to cutting of knitted fabric made from para-aramid and ultra-high molecular weight polyethylene yarns, as well as their combination in knit structures with different structural parameters. The results showed that there is an optimal knitting density at which the resistance to cutting is maximized. The highest and lowest cut resistance was observed in the directions of the loop rows and wales. Intermediate values were obtained in the diagonal direction of displacement. Hybrid samples exhibited greater tear resistance than pure samples.

The authors of another study [7] focused on the thermophysiological comfort of fighter pilot gloves. By combining materials with different properties and selecting an appropriate weaving structure, improved results in terms of breathability and moisture resistance were achieved.

In [8], the results of studies on the effect of temperature on the cut resistance of yarns based on ultra-high molecular weight polyethylene (UHMWPE) fibers when combined with stainless steel monofilament and glass fiber were presented. The findings showed an overall decrease in cutting efficiency as the temperature increased for all samples. However, knitted materials with stainless steel monofilament and UHMWPE yarn

exhibited the most significant percentage reduction compared to their counterparts with glass fibers and UHMWPE yarn.

In [9], the authors justified the use of flame-resistant yarn based on meta-aramid fibers and viscose fibers to protect military personnel from fire-related injuries.

Equally important is ensuring comfort and usability of hand protection equipment. The impact of protective gloves on hand mobility was studied by the authors in the following work. The results indicated that wearing protective gloves can restrict kinesthetic movements of the hand and forearm, potentially affecting task performance efficiency [10]. It is worth noting that gloves made from knitted material with protective properties, due to the raw fibers and the knit structure, eliminate the need for additional technological layers that add thickness.

Conclusion. The analysis of scientific studies highlights the significant potential for using advanced textile materials in the development of protective gloves capable of providing reliable hand protection against mechanical injuries and thermal exposure. The use of innovative fibers and composite structures allows for the creation of materials that meet modern safety requirements. Their application requires research into technological factors that influence the functional properties of the resulting textile materials.

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