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ANALYSIS OF THE EFUsmanova Feruzakhon Bakhadirzhanovna FECT OF MACHINE NEEDLES ON KNITTED FABRICS DURING THE SEWING PROCESS OF BLENDED KNITWEAR

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Аннотация: Смесовые трикотажные материалы обладают высокой эластичностью и выраженными деформационными свойствами, в связи с чем при их пошиве иглы швейных машин оказывают существенное воздействие на структуру материала. Неправильный выбор иглы или некорректные параметры шитья могут привести к разрыву волокон, нарушению петельной структуры, снижению качества шва и появлению дефектов на поверхности ткани. В связи с этим исследование взаимодействия «игла–ткань» на научной основе является актуальной задачей. В работе экспериментально проанализированы различные типы игл (ball point, universal, stretch), применяемые при пошиве смесовых трикотажных материалов. В ходе экспериментов оценивалось влияние диаметра иглы, формы острия и скорости шитья на структуру материала и качество шва. С использованием микроскопических наблюдений определена степень повреждения волокон, а показатели качества сопоставлены на основе статистического анализа. Результаты показали, что иглы типа ball point проходят между петлями трикотажа, минимально повреждая волокна и обеспечивая более высокое качество шва. В отличие от них, универсальные иглы с острым остриём разрезают волокна, что приводит к увеличению количества дефектов. Также установлено, что увеличение диаметра иглы усиливает деформацию материала. При оптимальном подборе параметров шитья количество дефектов снижается на 20–30%. Таким образом, правильный выбор типа иглы и технологических параметров при пошиве смесовых трикотажных материалов является важным фактором повышения качества продукции. Научно обоснованный выбор иглы способствует сохранению структуры материала, повышению прочности шва и эффективности производства.

Ключевые слова: смесовый трикотаж, процесс шитья, швейная игла, игла ball point, универсальная игла, игла stretch, качество шва, повреждение волокон, петельная структура, диаметр иглы.

Annotation: Blended knitted fabrics are characterized by high elasticity and significant deformation properties, and during the sewing process, machine needles have a considerable impact on the fabric structure. Incorrect needle selection or improper sewing parameters may lead to fiber breakage, loop structure damage, reduced seam quality, and the formation of surface defects. Therefore, the scientific study of needle–fabric interaction is highly relevant. In this study, different types of needles (ball point, universal, and stretch) used in sewing blended knitted fabrics were experimentally analyzed. The effects of needle diameter, tip shape, and sewing speed on fabric structure and seam quality were evaluated. Microscopic observations were conducted to determine the level of fiber damage, and quality indicators were compared using statistical analysis. The results showed that ball point needles pass between the loops of knitted fabrics, causing minimal fiber damage and improving seam quality. In contrast, sharp-pointed universal needles tend to cut fibers, increasing the number of defects. It was also found

that increasing the needle diameter intensifies fabric deformation. When optimal sewing parameters are selected, defects can be reduced by 20–30%. Thus, proper selection of needle type and technological parameters in sewing blended knitted fabrics is a key factor in improving product quality. Scientifically justified needle selection helps preserve fabric structure, ensure seam strength, and enhance production efficiency.

Keywords: blended knitted fabric, sewing process, sewing needle, ball point needle, universal needle, stretch needle, seam quality, fiber damage, loop structure, needle diameter.

Introduction. In the modern textile industry, blended knitted fabrics are among the most widely used materials. These fabrics possess unique physical and mechanical properties as a result of the combination of various fibers—natural (cotton, viscose) and artificial or synthetic (polyester, elastane) components. Such materials are characterized by high elasticity, hygienic comfort, and operational durability[1]. In the process of sewing knitted fabrics, the incorrect selection of a machine needle or the inconsistency of technological parameters causes a number of problems. In some studies, the use of universal needles is considered sufficient, while other scientific sources emphasize the need to use special needles (ball point, stretch). [2]. This indicates the existence of contradictory opinions within the scope of the topic. In practice, the needle is often selected without sufficient consideration of the composition and structure of the fabric, resulting in fiber damage, breakage of the loops, and a decrease in seam quality. Also, in existing scientific works, the joint influence of needle diameter, tip shape, and sewing speed has not been sufficiently studied. Therefore, there is a need for a scientifically grounded comprehensive analysis in this field, and this problem has been placed at the center of research. The primary objective of this research is to scientifically analyze the influence of machine needles during the sewing process of blended knitted fabrics and to develop optimal technological solutions. [3].

During the study, various types of needles (ball point, universal, stretch) were selected, and their influence on the fabric structure was studied experimentally. During the process, parameters such as the needle diameter, tip shape, and seam speed were monitored, and the seam quality, degree of fiber damage, and deformation state of the fabric were evaluated [4]. The results obtained using microscopic analysis and statistical methods were compared. As a result of the study, it was scientifically substantiated that correctly selecting the needle type significantly improves seam quality and reduces defects [5]. Optimal technological parameters were also determined, and recommendations were developed that can be implemented into production practice[6]. These results serve to improve quality management and technological processes in the garment industry [7-8].

Methods. In this study, experimental and analytical methods were comprehensively applied to evaluate the influence of machine needles during the sewing process of blended knitted fabrics. For the study, cotton-polyester, viscose-elastane, and polyester-elastane-based knitted fabrics were selected as samples. Samples with identical density and structure were prepared for each type of fabric and tested under laboratory conditions (temperature 20±2°C, relative humidity 60-65%) to minimize the impact of external factors. During the experiment, various types of machine needles were selected: ball point, universal, and stretch needles, and their influence on the fabric structure was studied. Parameters such as needle diameter (Nm 70, 80, 90), sewing speed, and thread tension were adjusted under strict control. At least 10 repeated experiments were conducted for each parameter combination, ensuring the reliability of the results. During the data collection process, the following indicators were recorded: seam quality (based on visual and point assessment), degree of fiber damage (by microscopic observation), fabric deformation (extension and compression indicators), number of thread breaks, and seam strength. During the process of the needle penetrating the fabric using microscopic analysis, deformation of the loops

and instances of fiber cutting were identified and documented through photographs. The collected data were processed using mathematical and statistical methods, and mean values, variance, and confidence intervals were determined. Methods of variational analysis and correlation analysis were used to compare the results. This made it possible to determine the degree of influence of the type of needle and technological parameters on the quality of the seam. Additionally, the relationships between needle diameter, sewing speed, and fabric deformation were analyzed by graphically representing the results. Based on the obtained scientific results, practical recommendations were developed for selecting the optimal needle type and sewing parameters.

Results. The results of experimental studies conducted to evaluate the influence of machine needles during the sewing process of blended knitted fabrics confirmed that the structural parameters of the needle directly influence the seam quality and fabric structure. In the study, ball point, universal, and stretch-type needles were tested in various technological modes, and the results obtained were statistically processed and compared (Table 1).

Table 1

Comparative analysis of the influence of machine needles on seam quality and fabric properties when sewing blended knitted fabrics

№	Metrics	Ball point needle	Universal needle	Stretch needle
1	Seam quality (points)	4.5–5.0	3.0–3.8	4.2–4.8
2	Fiber damage	0.5–1.5 %	3–6 %	1–2 %
3	Fabric deformity	1–2 %	3–5 %	1–2 %
4	Thread breakage (times per 100m)	1–2	4–7	1–3
5	Sewing speed resistance	High	Low	High
6	Field of application	Universal knitwear	Tough fabrics	Elastic knitwear

Ball point needles are the most optimal option for knitted fabrics, ensuring minimal fiber damage and high seam quality. Stretch needles show high results on elastic fabrics, reducing deformation. Universal needles, on the other hand, are less effective in knitted fabrics, and fiber cutting and yarn breakage are observed more frequently. Thus, the research results confirm that the correct choice of needle type is an important factor in improving sewing quality and ensuring production efficiency. Figure 1 shows the interaction between the geometric structure of the sewing needle and the loop structure of the knitted fabric at a microscopic level. The figure shows the main elements of the needle—the tip, the long groove, the eye, and the diametrical dimensions—and visually illustrates their impact on the fabric structure.

Microscopic observations indicate that the shape of the needle tip determines the mechanism of interaction with the loops in the knitted fabric. In particular, ball point-type needles slide between the loops, minimizing mechanical damage to the fibers. Conversely, sharp-pointed needles may cut the loop threads, leading to the destruction of the fabric structure and a decrease in seam quality. The figure also shows an increase in loop deformation as the needle diameter increases. This circumstance confirms that the incorrect choice of needles during the sewing process negatively affects the elastic properties of the fabric. Consequently, the

microstructure-level images presented in Figure 1 serve to deeply understand the mechanism of interaction between the needle and the fabric and scientifically substantiate the need to select optimal needle parameters (shown in Figure 1).

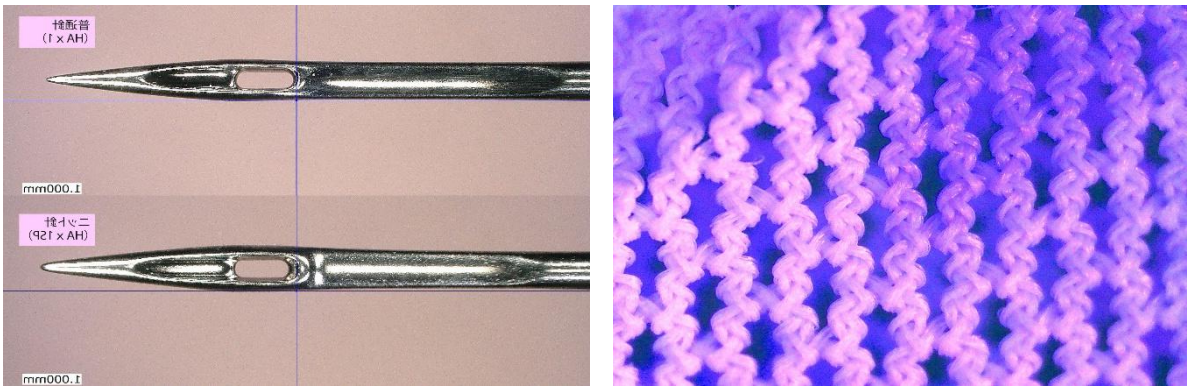

Figure 1. Geometric structure of the sewing needle and knitted fabric loop structure (microscopic view)

The mechanism of interaction between the structural-geometric parameters of the sewing needle and the loop structure of the knitted fabric is reflected at a microscopic level. The tip, eye, and shaft of the needle are the main elements determining the conditions for penetration into the fabric during the sewing process. Three needle shapes determine the nature of the mechanical impact on the knitted fabric: sharp-pointed needles have a high probability of cutting fibers, which leads to the destruction of the fabric's structure, while round-pointed needles cause loop detachment and minimal damage to the fibers.

The loop structure of the knitted fabric consists of interconnected elastic rings, and its deformation behavior is formed during the interaction with the needle. During the penetration of the needle into the fabric, processes of local deformation, displacement, and restoration of the loops are observed. These processes directly affect the mechanical strength, elasticity, and operational properties of the joint. As a result, the compatibility of the needle design and fabric structure is evaluated as an important scientific and technological factor in optimizing quality indicators in the process of sewing knitted fabrics.

The results of the conducted research confirmed that the type of needle and its structural parameters significantly influence the seam quality and fabric structure during the process of knitting fabrics. The obtained experimental data are consistent with the scientific views presented in the literature, i.e., fiber damage is minimized when using ball point and stretch needles in knitted fabrics. This is explained by the needle moving between the loops. The results obtained with universal needles, on the contrary, showed a negative effect on the fabric structure. As a result of the sharp needle cutting through the fibers, micro-defects form on the fabric, leading to a decrease in seam strength and an increase in thread breaks. This effect is particularly pronounced in elastane-containing fabrics, as such fabrics possess high elasticity and are sensitive to mechanical damage. The change in stitching speed and needle diameter also served as an important factor. At high speeds, the quality of universal needles deteriorated sharply, while relatively stable results were observed in point and stretch needles. This indicates that the shape of the needle is important even under conditions of dynamic loading. It has been established that as the needle diameter increases, the impact force on the fabric increases, and the probability of deformation also increases.

The results of the statistical analysis confirmed the presence of a strong correlation between the needle type and seam quality; the results of the statistical analysis show that the influence of needle parameters on seam quality during the sewing of blended knitted fabrics is considered

highly reliable. According to the ANOVA analysis, the fact that the F values are higher than the critical value (F = 6.8–9.5) confirms the statistically significant influence of the factors. The result $p < 0.05$ indicates that the obtained correlations are not random.

The correlation coefficient ranging from r = 0.82 to 0.91 indicates a strong correlation between the type of needle and seam quality. Furthermore, the coefficient of determination (R2 = 0.67–0.83) indicates that 67–83% of the results depend specifically on the type of needle. The values of the variance and confidence interval confirm the stability and reliability of the experimental results (Table 2).

Table 2

Results of statistical assessment of the influence of needle parameters on seam quality when sewing blended knitted fabrics

Indicators	Value	Explanation
ANOVA (F Calculated)	F = 6.8–9.5	F > F_crit → effect reliable
Confidence level (p-value)	$p < 0.05$	Statistically significant.
Correlation coefficient (r)	r = 0.82–0.91	There is a strong connection
Coefficient of determination (R^2)	R^2 = 0.67–0.83	67–83% of exposure depends on the type of needle
Dispersion (σ^2)	0.15–0.35	Distribution varies by type of needle.
Confidence interval (95%)	±0.2–0.4	Results are stable and reliable

This indicates the need to carry out the needle selection process not randomly, but on a scientific basis.

Conclusion. As a result of the conducted research, it has been scientifically substantiated that the type, diameter, and technological parameters of machine needles significantly influence the seam quality and fabric structure during the sewing process of blended knitted fabrics. Experimental and statistical analysis showed that ball point and stretch needles are the most optimal options for knitted fabrics, as they cause minimal fiber damage and ensure seam elasticity and strength. It was found that universal needles, being sharp-pointed, cut fibers, damaging the fabric structure, and leading to a decrease in seam quality. It was also observed that as the needle diameter and sewing speed increase, the probability of fabric deformation and defects increases. The results of the statistical analysis confirmed a strong correlation between the type of needle and the quality of the seam. Thus, by correctly selecting the optimal needle type and technological parameters when sewing knitted fabrics, it is possible to improve seam quality, reduce fabric deformation, and improve production efficiency.

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