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TECHNOLOGY OF GIVING SOFTNESS TO KNITTED FABRICS

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Abstract
Perforation of the fabric during the sewing of ready-made garments from knitted fabrics is one of the problematic defects. This defect occurs when the threads on the knitted fabric break. In textile materials, thread breakage is characterized by complete or partial breakage of individual threads in the fabric during sewing. The porosity of the fabric can be divided into visible and invisible types, which can be eliminated by processing different compositions. This paper explores the application of soft cationic surfactants, amino modified silicone oil - 350, amino modified silicone oil - 200, DMC amino modified silicone oil - 350 and silicone-based softeners to knitted fabrics. Based on the results of experiments on the effect of variable process factors on the perforation of knitted fabrics in the sewing process, it is recommended to use imported silicone-based softener and local amino-modified silicone oil-350. According to the results of the experiment, the technological procedure and composition of the final finishing process of "softening" of knitted fabrics with selected softeners were developed. it has been shown that it is expedient to heat-treat a fabric soaked in a softener solution for 5 minutes at a temperature of 1400C.

Keywords: Softening, hardness, porosity, thread breakage, finishing, heat treatment, knitting, surfactant.

Introduction

By reprocessing the cotton raw material grown in the Republic, turning it into a finished product, producing and selling its quality in accordance with international standards, it will be possible to make a great contribution to the development of the economy of our Republic. In this regard, chemical finishing of cotton fiber mats and other types of textile materials, including the formation of special finishing technologies for them, localization of used textile auxiliary substances is the main issue that needs to be solved.

In the process of sewing ready-made clothes from knitted fabrics, the perforation of the fabric is one of the problematic defects. One of the main causes of fabric porosity is its stiffness. A number of scientists [1, 2] have achieved positive results not only in the production process, but also in consumption, by giving soft properties to the fabric and increasing its softness. Due to the breaking of the fabric thread under the influence of the sewing needle, holes are formed on the surface of the canvas, which causes the fabric to open [3]. In order to reduce the perforation of the fabric and soften it, the fabric is treated with various softeners [5], and elastic threads are added to the fabric [4]. As softeners, surfactants, emulsions containing mineral oil

[6], silicon compounds [7.], and hydrotropic substances such as glycerin are used [8]. Darko and Dubravko studied the factors of the softening process of final finishing of canvas. Based on the results of their research, it was shown that the penetration force of the sewing needle into the fabric depends on the finish of the canvas, the type and amount of softener used, the size of the needle, and the number of sewn fabric layers. It was observed in studies that the impact force of the needle is the largest value when fatty acids are used, and the smallest value is when emulsions with fatty acids are used [9].

The degree of breakage of threads during sewing depends on several factors, namely, the structure, density, hardness, and type of finishing of the thread and fabric used in weaving, as well as the size of the needle used in the sewing process [10], the tension of the sewing thread and the length of the stitches also affects. Improper selection of the sewing needle, pressing of the sewing machine blade on the surface of the fabric with great pressure, impeding the needle, improper selection of the number of sewing threads, excessive number of layers of fabric to be sewn at the same time. also leads to the appearance of holes in the fabric [11].

During the processes of boiling and bleaching knitted fabrics, various fatty substances are released from the fabric structure, elasticity decreases, and the coefficient of mutual friction of threads increases. In such cases, when the sewing needle moves along the fabric, the threads are broken or broken. In order to reduce the coefficient of friction, after the process of dyeing, the knitted fabric is treated with various emulsions in the final washing solution or in drying-expanding equipment. Moisture content is determined for each fabric according to the nature of its constituent threads. When sewing clothes from knitted fabrics, it is recommended to have a moisture content of 5-10% if they are made of cotton fibers, 6-12% if they are made of viscose fibers, and 5-8% for fabrics made of acetate threads [12].

Experimental Research

Fabrics dyed with active dyes from the "Suprem" and "Futer" assortments were taken as an object in the research. In our experiments, in order to reduce their porosity by giving softness to knitted fabrics, we used softeners of 5 types, three domestic and two imported to the Republic: 1- Cationic SAM; 2- amino modified silicone oil- 350; 3- amino-modified silicone oil-200; 4- amino-modified silicone oil with DMC-350; 5- Silicone-based softener. The softness of the canvas GOST 10550-93 "Materialy tekstilnye. According to Polotna, metody opredelenia jestkosti pri izgibe" it was determined by the hardness of the fabric. Explicit and latent porosity in knitted fabrics "GOST 26006-83. Cotton and knitted fabrics. It is determined according to the method of definition of the yavnoy i skrytoy prorubki. Microscopic analysis of the samples was carried out with a "NIKON" microscope.

Analysis of Results

Canvas porosity is caused by treatment with substances that increase fiber hardness, electrification, fineness and reduce elasticity. One of the main ways to prevent the formation of pinholes is to reduce the friction between the canvas threads and the needle. Various softeners are used in textile finishing enterprises to reduce the porosity of canvas and increase

its softness. In some cases, hydrotropic substances that increase the humidity of the canvas and reduce its electrification are also used. Appret concentration is usually 0.5-2 g/l in the final steaming processes in batch equipment, and 5-10 g/l in continuous systems. It is recommended to keep the process temperature at 40-45^{0}C. Softeners form a thin protective film on the fabric surface that reduces its hardness and surface friction.

As part of this work, samples of 5x5 cm size taken for the object were soaked in the appret solution for 3 minutes. Compression rate is 100%. The sample was dried at a temperature of 90-100^{0}C for 10 minutes, thermally treated at a temperature of 150^{0}C for 2-3 minutes [13], the experimental results are listed in Table 1. The cited experimental results show that only the use of cationic SAM softener increases the hardness of the fabric.

Table 1. Dependence on the type of fabric softener

Fabric type	Untreated fabric	Softeners*				
		1	2	3	4	5
		Fabric stiffness, mkN · sm^2				
Suprem	3.79	4.06	5.66	5.06	4.19	5.66
Futer	8.56	8.24	9.66	11.55	8.50	10.08

* 1- Cationic SAM, 2- Amino-modified silicone oil-350, 3- Amino-modified silicone oil-200, 4- Amino-modified silicone oil with DMC-350, 5- Silicone-based softener

Cation active SAM is a product of "Clariant" based on fatty acid and polyethylene plasticizer (Uni soft NCS). Softener based on silicone - softener based on polysiloxane polymer of "Yeksoy" company (Knit soft wa-et). Amino modified silicone oil-200, amino modified silicone oil-350, amino modified silicone oil-350 with DMC are emollients offered by local manufacturers.

When treated with all three softeners offered by local manufacturers, as well as with silicone-based softeners imported from abroad, the fabric is hardly stiff. The reason for this is that they are processed in an alkaline environment. It is known that the elasticity of cotton fibers increases in a weak alkaline environment, which in turn has a positive effect on the diffusion of the components of the finishing solution into the fiber. Diffusion of softeners in large quantities into the pores and cracks of the fiber causes the appearance of additional functional groups, as a result of which the hygroscopicity of the fiber increases, increasing the moisture retention in the canvas, which in turn reduces the friction between the fabric threads and the needle. decreases - reduces the porosity of the canvas. In the process of sewing, the perforation of the fabric is determined by sewing 7 stitches every 1 cm without thread on a 150 mm long double-layer fabric [14]. Fabric porosity can be obvious and hidden (Figures 1-2) [15].

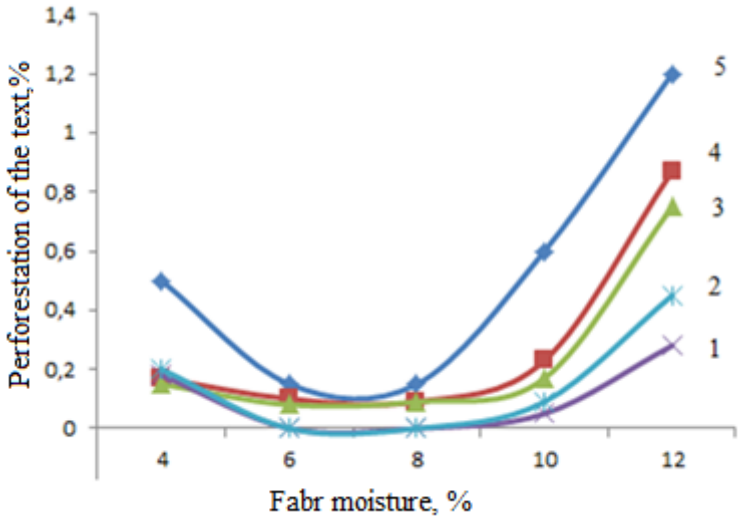


Figure 1. Effect of moisture content on latent porosity of fabric treated with different softeners. 1- amino modified silicone oil- 350; 2- Silicon-based softener; 3- amino modified silicone oil- 200; 4- amino modified silicone oil with DMC- 350; 5- Cationic SAM.

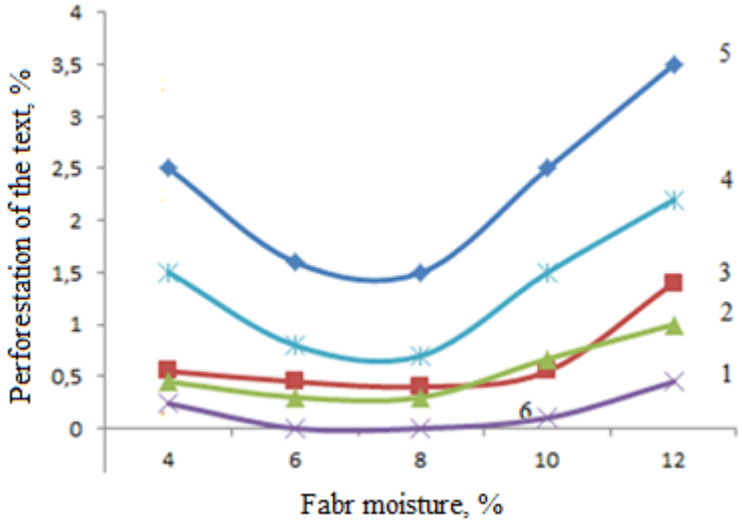
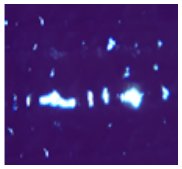
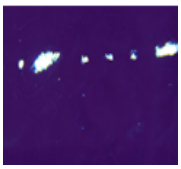
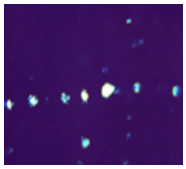
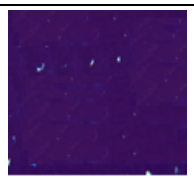
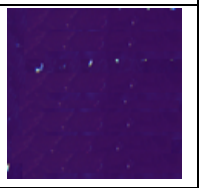


Figure 2. Effect of moisture content of fabric treated with different softeners on its apparent porosity. 1-amino modified silicone oil-350; 2-Silicone-based softener; 3-amino modified silicone oil-200; Amino-modified silicone oil with 4-DMC-350; 5- Cationic SAM.

The results of the study on fabric porosity repeat the results of the experiment on its hardness, that is, the results obtained for all silicone-based softeners have a smaller value than the porosity of the sample treated with a cationic agent. The reason for this can be explained by the fact that cationic drugs react with the hydroxyl groups of the cellulose macromolecule, forming cross-links and, as a result, reducing the character of macromolecules and increasing their viscosity. When there is obvious perforation in knitted fabrics, it is considered defective and cannot be put into production.

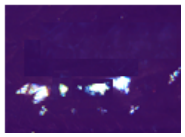
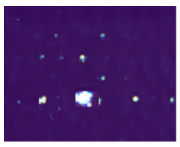
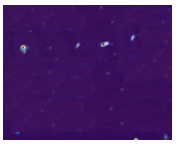
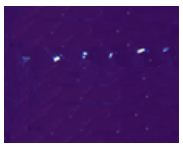
Two layers of 150 mm long knitted fabric from the Supreme assortment were sewn, without thread, 7 stitches every 1 cm. The sutures were lightly pulled on both sides, and the position of the needle was observed under a microscope. The obtained results are placed in Table 2.

Table 2. Microscopic view of needle marks on fabric

Untreated fabric	Cationic SAM	Amino-modified silicone oil with DMC-350	Amino modified silicone oil-200	Amino modified silicone oil-350	Silicone-based softener
					

The cut-off view of the samples with the "softening" finish was photographed on a Kodak camera. The softer the fabric, the less likely it is to damage the threads that make up the fabric under the influence of the sewing needle. The tensile strength of samples treated with different softeners was tested in a laboratory device. In addition to the tear resistance of the fabric, the condition of the holes in the fabric created by the needle was evaluated. The obtained results are formalized in Table 3.

Table 3. Dependence of the tensile strength of knitted fabric on the type of softener

Untreated fabric	Cationic SAM	Amino-modified silicone oil with DMC-350	Amino modified silicone oil-200	Amino modified silicone oil-350	Silicone-based softener
					
Breaking strength, N					
678.9	791.4	880.9	920.3	1070.3	1084.0

Although the needle marks were almost not detected when the knitted fabric was stitched with a sewing needle, it was shown that some stitches were broken due to the damage of the needle during the sewing process. Therefore, hidden porosity is considered a negative condition. The

results of the mentioned experiment show that the softer the fabric, the more effort is spent to break it while maintaining its deformation-elastic properties.

Therefore, softeners with the least visible and hidden porosity were selected for further research - amino-modified silicone oil-350, amino-modified silicone oil-200 and silicone-based softeners. The given results show that the porosity of the fabric is small when the moisture content of the fabric is 6-8% during the sewing process. Studies have confirmed that the porosity of the fabric is caused by improper organization of the dyeing and finishing processes, too high or insufficient humidity of the canvas.

The impact of selected softener accention, thermal processing temperature and duration is studied (Table 4, Phics 4-4) and the process of processing processing the process of knitted parks came out.

Table 4 Heat treatment temperature on fabric porosity

Softener type	Type of fabric perforation	Heat treatment temperature, ^{0}C				
		80	100	120	140	160
Silicone-based softener	hidden	1,5	0,12	0,09	0	0
	obvious	3	2	1,5	0,5	0,7
Amino modified silicone oil-200	hidden	0,9	0,25	0,17	0,2	0,23
	obvious	2,5	1	0,6	0,67	0,68
Amino modified silicone oil-350	hidden	1,4	0,17	0,05	0	0
	obvious	2	0,5	0,1	0,1	0,1

When the thermal treatment temperature was 140^{0}C for the imported silicone-based softener and domestic amino-modified silicone oil-350, and 120^{0}C for the amino-modified silicone oil-200, the porosity of the samples had small values. Because the fabric permeability was small when using amino-modified silicone oil-200, but was not 0 either implicitly or explicitly, experiments with this emollient were not conducted in further studies.

As the concentration of softener increases, the porosity of the fabric decreases, and then its increase, that is, the extreme character of the concentration of the softener on the stiffness of the fabric is reflected in the figure below. When the concentration of fabric softener exceeds 2-3 g/l, it causes breakage of fabric threads due to excessive moisture of fabric. In addition, because of the formation of an oily layer on the surface of the fabric at this concentration, the softener concentration was taken as 2-3 g/l for further research.

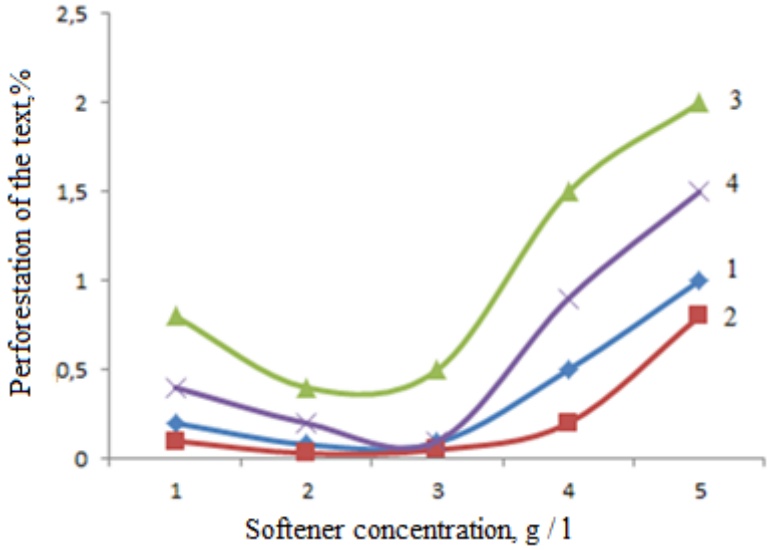


Figure 3 Dependence of fabric porosity on softener concentration. 1, 3 - amino-modified silicone oil-350, 2, 4 - silicone-based softener, 1, 2 - hidden porosity, 3, 4 - obvious porosity

The results of the study on determining the duration of the thermal treatment process when treated with both softeners under study are presented in Figure 4.

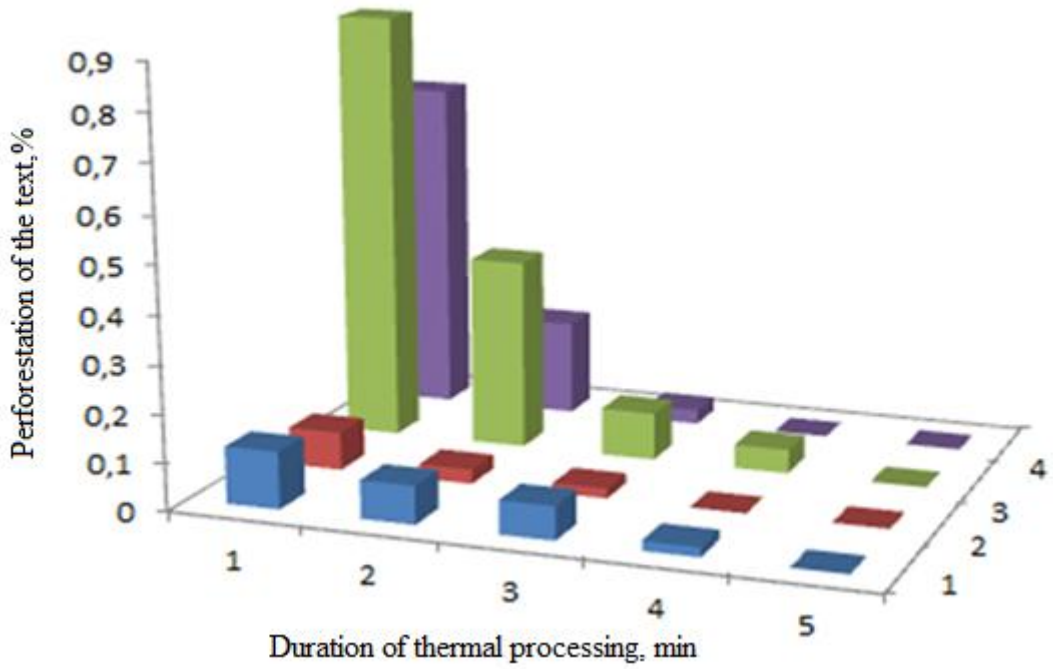


Figure 4. The effect of the length of the heat treatment process on the porosity of the fabric. 1, 3 – amino modified silicone oil- 350, 2, 4 – Softener based on silicone, 1, 2 – hidden porosity, 3, 4 – obvious porosity.

According to the results of the experiment, the technological order and composition of the final finishing process of "softening" knitted fabrics with selected softeners is presented in Table 5.

Table 5. The technological procedure and composition of finishing knitted fabrics

Technological processes	Softeners	
	Amino modified silicone oil-350	Silicone-based softener
Apprenticeship: softener concentration, g/l pH medium duration, min	 2,0 9 20	 3,0 9 20
Compression level, %	90	90
Heat treatment: temperature, ^{0}C duration, min	140 5	140 5

Conclusion

According to the results of the experiment, the technological procedure and composition of the final finishing process of "softening" knitted fabrics with selected softeners was developed. based on it, it is indicated that it is advisable to heat treat the fabric soaked in the softener solution at a temperature of 140^{0}C for 5 minutes.

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