Development of improved technology of production of sewing products using equipment for moisture-heat treatment from a composite material

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Abstract. The article covers the conditions of formation of package materials for outerwear. The developed new technology for the production of apparels using a new cushion of press equipment for moisture-heat treatment from a composite material has been described. The method of forming a package of clothes from a multilayer textile material has been substantiated. The results of the examination of the experimental wear of jackets made according to the existing and proposed technology are presented in order to conduct a comparative study of the appearance, comfort and wear resistance of products made under identical conditions. Because of theoretical and practical research, the required dimensional stability of outerwear parts has been achieved in the process of the new technology of moisture-heat treatment.

1. Introduction
The highest efficiency of using covers made of composite materials is achieved when solving the problems of reducing metal consumption, energy consumption, increasing strength characteristics, durability and reliability (specific strength), reducing the weight and cost of design, increasing technological productivity in combination with flexibility and versatility [1].

The improvement of process and equipment for the moisture-heat treatment (MHT) is the urgent direction in improving the quality of apparels. The importance of MHT is predetermined by the need to use it at various stages of the technological process of manufacturing apparels (preliminary giving some parts or sections of parts of a spatial form, interoperative MHT of parts and assemblies, end finishing, etc.), which ensures the ease of performing subsequent operations and, in general, affects on the quality of apparels. The possibility of using MHT for the manufacture of garments by the molding method [2-4], which excludes multi-stage transitions and the associated costs of various resources, imposes a number of important requirements on the design of the main working bodies – cushions made on press equipment. First, this is because that all expenses for the design, manufacture and operation of cusions are directly reflected in the cost of products, which should also be competitive in terms of quality indicators and cost [5].

In order to confirm that a new composite material was obtained based on proposed components used in the manufacture of the covers of equipment for MHT, the IR spectroscopic research was carried out in IR spectrophotometer “Nicolet iS50 FTIR AdvancedKBrspectrometer + Nicolet Continuum” and multifunctional X-ray phase diffractometer using standard methods under the
conditions of Center of advanced technologies under the Ministry of innovative development of the Republic of Uzbekistan.

2. Materials and methods
In the production of competitive apparels, it is recommended to use various types of modern textile materials for the upper and adhesive pads. For jackets designed in winter, woolen upper fabrics were chosen, for seasonal and summer jackets – fabrics made of polyester and viscose [5]. In industrial enterprises of the Republic, in the manufacture of men's jackets, in particular, to give shape stability to clothing parts (for example, lapel sections), adhesive materials on a textile basis from various companies, such as HYMO (Japan), Kufner (Germany), Iskoj (Russia, Neftekamsk), DANELLI (China), Camela (Poland) have been used. In the course of the dissertation research, several types of upper textile materials and adhesive cushioning materials were selected, and packages were formed for the manufacture of clothing parts (figure 1) [6].

\[\text{Figure 1.} \text{ Samples of jacket lapel packages: } a \text{ – package made of adhesive materials; } b \text{ – diagram of the assembly of adhesive and intermediate materials in the lapel area; } c \text{ - scheme for hand sewing on the hand seam.}\]

Improvement of the technological scheme has been made based on the study of molding mechanism on the surface of flat and volumetric sections of the lapel and their fixation (figure 2).

The characteristic of the properties of the developed method is as follows: during wet-heat treatment on the proposed cushion of the equipment, apparel 3 is placed on the lower cushion 1 with the help of vacuum drawing and the upper cushion 3 is released onto the lower cushion, then the forming part of the part is pressed by the working bodies 1 and 2 using pressure pair 4-5 sec. at a temperature of 120°C, forms a shape and through the bottom cusion 1 in the 2 sec. moves with the help of a condensate vacuum suction, and here the form is stored. The upper cushion 2 rises and part 2 is dried using a vacuum suction on the lower cushion 1 for 2 seconds, then apparel 3 is removed from the working body 1 of the equipment [7].

\[\text{Figure 2.} \text{ New technology of forming the shape and their fixation during moisture-heat treatment of parts of men's jackets (fragment): } a \text{ - general view of the press; } b \text{ - top view of the distribution of the lower forming body of the lapel of the jacket; } c \text{ - side view of the lower forming body of the lapel of the jacket. } 1 \text{ - bottom cusion, } 2 \text{- top cusion; } 3 \text{ - pack of clothes.}\]
3. Results and discussion

Research was carried out in ironing press of MHT which is used to shape the lapels of men's jackets to determine the effect of MHT parameters on the pressure applied to apparel package when forming apparels and to develop a rational MHT mode. For this, a full-factor research was carried out, and only the coefficients with the value were included in the mathematical model of the process [8].

Using multifactorial studies, the effect of drying time, evaporation temperature of apparels parts on mechanical pressure during the moisture-heat treatment was has been carried out. The regression equation obtained for the pressure on a package of clothing parts is:

\[ y = 5.5975 + 0.0525 x_1 + 0.1075 x_2 + 0.1725 x_3 - 0.0725 x_1 x_3 - 0.09125 x_2 x_3 \]

where X1 is evaporation time, sec.; X2 is drying time, sec., X3 is evaporation temperature, °C. The applied pressure is taken as the output parameter of the apparel part forming press. Based on the numerical analysis of the regression equation, graphical dependencies are built, and the recommended parameters are determined.

Based on multivariate tests, regressive equations were obtained with the following parameters ensuring the dimensional stability of clothing parts: evaporation time is 6.34 sec., drying time is 7 sec., evaporation temperature is 126.6 °C. In this case, the pressure force increases to 5.75 Pa. Increase in the force of pressure on the details of clothing to 5.85 Pa is observed if the evaporation time is 5 seconds, the drying time is 6 seconds, and the evaporation temperature is 100 °C.

The results of research to determine the modes of moisture-heat treatment for suit fabrics of various fibrous composition is shown in table 1.

| Package of materials | Pressure, Pa | Evaporation time, sec | Evaporation temperature, °C | Drying time, sec |
|----------------------|-------------|-----------------------|-----------------------------|------------------|
| AG-2788 + tanned 86040 | 5.75-5.85 | 5-7 | 160-180 | 6-8 |
| AG-2788 + tanned linen | 5.75-5.85 | 5-7 | 160-180 | 6-8 |
| E 128244 + tanned linen | 5.00-3.8 | 6-8 | 140-150 | 7-8 |
| E 128244 + tanned stockinet | 5.00-3.8 | 6-8 | 140-150 | 7-8 |
| 06650-10 + tanned linen | 5.75-2.85 | 5-7 | 120-140 | 6-8 |
| 06650-10 + tanned linen | 5.75-2.85 | 5-7 | 120-140 | 6-8 |
| BL 182273 + tanned linen | 5.75-2.85 | 5-8 | 120-140 | 6-8 |
| BL 182273 + tanned stockinet | 5.75-3.2 | 5-8 | 120-150 | 6-8 |
| SRK 180801 + tanned linen | 5.75-3.2 | 6-8 | 120-150 | 6-8 |
| SRK 180801 + tanned linen | 5.75-3.2 | 6-8 | 120-150 | 6-8 |
| SRS 180888 + tanned linen | 5.75-3.5 | 5-7 | 130-150 | 5-7 |
| SRS 180888 + tanned stockinet | 5.75-3.5 | 5-7 | 130-150 | 5-7 |

When conducting research to ensure the dimensional stability of clothing parts, various cushioning materials were used, which are currently used at the enterprises of the apparel industry, and the most rational option for the formation of a package of clothing was chosen.

Determination of physical and mechanical properties of packages made by the existing and new technological method of moisture-heat treatment was carried out in the certification laboratory “CentexUZ” at the Tashkent Institute of Textile and Light Industry. The results of the experiments are shown in figure 3.
Figure 3. The study of the physical and mechanical properties of garments based on the latest and new technology of wet-heat treatment to give the details of the shape stability of garments made of wool and viscose threads of the upper fabric, as well as from various adhesive materials.

here: 1- E 128244+ tanned linen; 2- E 128244+ tanned stockinet; 3- E 128244+ CPC; 4- BL 182273+ tanned linen; 5- BL 182273+ tanned stockinet; 6- BL 182273+ CPC; 7- SRK 180801+ tanned linen; 8- SRK 180801+ tanned stockinet; 9- SRK 180801+ CPC
The analysis of the most important indicators in the course of experimental studies based on the latest and new technology of wet-heat treatment to give the details of the shape stability of garments made of wool and viscose threads of the upper fabric, as well as from various adhesive materials. At the same time, the thickness of the package of materials increased from 3.7 to 10.15% (figure 3, a); stiffness increased from 4.11 to 4.8% (figure 3, b); breaking load in the direction of the warp thread increased from 9.73 to 17.5% (figure 3, c); breaking elongation in the direction of the warp thread increased from 4.5 to 4.9% (figure 3, d); creasability decreased from 3.05 to 1.8% (figure 3, e).

Assessment of quality (dimensional stability) of manufacture of products according to the developed technology was carried out by organizing an experimental wear. For experimental wear, 80 items were issued, manufactured in production conditions of LLC “OFS”, “Burda lyuks tekstil” and “Nilufar-95”. The quality control of the products of the pilot batch was carried out through periodic observations by specialists and carriers. The controlled parameters on the surface of the product samples and the results of the experimental wear are presented, respectively, in figure 4 and table 2 [9].

![Figure 4](image)

**Figure 4.** Scheme for measuring the parameters on surface of product samples during test wear: a—method for measuring the linear dimensions of the collar and lapel; b—method for determining the lapel bend angle on the lapel bend line

**Table 2.** Experimental data on average parameters of dimensional stability after dry cleaning and experimental wearing of products (new technology)

| Measured parameters | Value, cm | Duration of experiments, days |
|---------------------|-----------|-------------------------------|
|                     |           | 30 | 60 | 90 | 120 | 150 |
| $L_1$               | 31        | 30.5 | 30.2 | 29.6 | 29.6 | 29.6 |
| $L_2$               | 3.5       | 3.45 | 3.41 | 3.3 | 3.3 | 3.3 |
| $L_3$               | 3         | 2.95 | 2.85 | 2.8 | 2.8 | 2.8 |
| $L_4$               | 50        | 49.2 | 48.8 | 47.7 | 47.7 | 47.7 |
| $L_5$               | 10        | 9.85 | 9.8 | 9.5 | 9.5 | 9.5 |
| $K_{f1}$, %         | 100%      | 98.5 | 97.6 | 95.4 | 95.4 | 95.4 |
| $\alpha$            | 105°      | 104.5° | 104.1° | 104.1° | 104.1° | 104.1° |
| $\beta$             | 100°      | 99.6° | 99.1° | 98.8° | 98.5° | 98.5° |
| $\gamma$            | 65°       | 64.7° | 64.4° | 64.2° | 64.2° | 64.2° |
| $K_{f2}$, %         | 100%      | 99.6 | 99.2 | 99.2 | 99.2 | 99.2 |
| $\mu$               | 24°       | 23.9 | 23.8° | 23.5° | 23.4° | 23.4° |
| $K_{f3}$, %         | 100%      | 99.6 | 98.5 | 97.5 | 97.5 | 97.5 |
4. Conclusions
It is preferable to choose packages that require less labor intensity in order to ensure the same stability of the parts. After several cycles of deformation loading, the coefficient $K_f$, which is the ratio of the operational size of the sample to the initial size, was chosen as a criterion for assessing the dimensional stability.

Comparative analysis of the indicators of dimensional stability of clothing parts made using the existing and proposed technology shows the advantage of the developed technology. This is confirmed by the increased dimensional stability when analyzing the results based on measurements of linear dimensions.

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