ISSN 2181-8622

Manufacturing technology problems

NAMANGAN MUXANDISLIK-TEXNOLOGIYA INSTITUTI

Scientific and Technical Journal Namangan Institute of Engineering and Technology

INDEX COPERNICUS INTERNATIONAL

Google Scholar

Crossref doi

SLIB.UZ
Scientific library of Uzbekistan

Volume 9
Issue 4
2024

DETERMINATION OF ALTERNATIVE TECHNOLOGICAL FACTORS FOR THE PRODUCTION OF FUNCTIONAL FABRIC WITH A COMPLEX STRUCTURE

KHAMRAEVA SEVARAXON

Doctoral student of Tashkent Textile and Light Industry Institute, Tashkent, Uzbekistan
Phone.: (0890) 131-9629, E-mail.: dilfuza.qodirova.63@mail.ru
Corresponding author

KADIROVA DILFUZA

Professor of Tashkent Textile and Light Industry Institute, Tashkent, Uzbekistan
Phone.: (0890) 984-2233, E-mail.: dilfuza.qodirova.63@mail.ru

DAVLATOV BEXZOD

Master student of Tashkent Textile and Light Industry Institute, Tashkent, Uzbekistan
Phone.: (0894) 171-5715, E-mail.: unknown89906102@gmail.com

Abstract: The article reflects the research results on identifying alternative technological factors for producing functional fabrics with a complex structure on modern electronic weaving looms. New fabric samples with functional variable layers were developed on the Somet Thema Super Excel-190 (Italy) loom. For weaving experimental fabric samples, 100% cotton 25x2 tex linear density yarns were used as the body, and 50% cotton + 50% modal mixed yarns were used as the warp. Alternating fabric layers have a structure of a 6:1 ratio, in fabric formation in the loom, a six-layer part is formed, and then a single-layer part of the fabric is formed. This ratio of layers creates bumps and grooves on the surface of the fabric, which allows the bed to provide air exchange and moisture transfer for the patient, dry the product, and have massage properties due to the bumps and grooves. The air permeability of the fabric was selected as the main output factor for the alternative of the weaving process of the complex structure fabric on the loom.

Keywords: Functional, layer ratio, modal yarn, mixed yarn, woven structure, complex structure, bumps, groove.

Introduction. New types of textile fabrics with special protective, healing, functional, and rehabilitation properties are being developed based on the modern achievements of science.

The need for textile products with special functions is related to changes in the environment, human activity, or physical condition. It is especially important for patients who are in a weak state. Fabrics and items used in medicine affect the quality of medical services, the psychological state, and the health of the patient. Scientific work is devoted to the development of orthopedic mattress fabrics with complex structure and functional characteristics for patients with limited mobility.

Preliminary studies of the research object of the scientific work showed that the goal of alternative weaving processes is to achieve the maximum productivity of the weaving equipment. Reducing the percentage of yarns breaking during the weaving process (at a constant rotation speed of the main shaft) helps to achieve the set goal. The performance of a loom in the production of a functional fabric with a complex structure depends on many factors. These factors include the fiber content of raw materials, fabric structure factors, weaving loom parameters, and loom adjustment parameters [1].

Analysis of the references related to the theme. Currently, there are many innovative developments in the field of medical textile materials abroad. For the creation and research of modern innovative materials with bactericidal, antimicrobial properties, various functional properties, and high hygienic and aesthetic indicators for the production of medical tissues, foreign scientists Makarova Y.A., Kudravseva T.N., Vinogradova N.A., Ishmatov A.B. Matilla H.R., and others' work is noteworthy [2-4].

Scientists of our republic K. A. Alimova, A. E. Gulomov, F.U. Nigmatova, N. R. Khankhodjayeva, and G. H. Gulyaeva are conducting several scientific studies on the production and expansion of methods of functional medical clothing, bedclothes, and materials for medical devices from various textile fibers and yarns [5-7].

Theoretical part. To evaluate the influence of the fiber composition of raw materials, variable fabric thickness, and the number of yarn twists on the air permeability of functional fabric in the production of functional fabric with a complex structure, a factorial experiment was conducted under the conditions of the equipment of the laboratory of the TITLI "Technology of textile fabrics" department.

In the process of fabric formation with a complex structure on the loom, the influence of the following factors on the structure and properties of the fabric was determined: X_1-fiber composition of warp and weft yarns, X_2-the linear density of warp and weft yarns and their ratio, X_3-weave filling in warp and weft and their ratio, X_4 - a type of interweaving of yarns in fabric, X_5 - tension of warp yarns, X_6 - tension of weft yarns, X_7 - an assortment of fabric, fabric structure factors, X_8-loom height, X_9-loom type, X_9-loom speed, X_{10}-middle position amount, X_{11}-room temperature, X_{12}-room relative humidity, X_{13}-loom winding quality, X_{14} releasing speed of weft yarn, X_{15} moisture content of warp and weft yarn, etc. During the experiment, such factors as the linear density of warp and weft yarns, the speed of the loom, the temperature of the room, the relative humidity of the room, the number of warp and weft yarns, the type of interlacement, the density of warp and weft in the fabric, and humidity were kept constant.

A full factorial experiment with N=20 experiments and the number of factors K=3 was selected to study the effect of various factors on the loom.

Methodical part. According to the analysis of a priori data and the results of preliminary experiments, the following factors that have a significant effect on the output index were determined: X_1- fiber content of raw materials, %, X_2 - variable fabric thickness, mm; X_3 - the number of yarns, TPM [8].

Based on the analysis of a priori data, the results of preliminary experiments, and the technical capabilities of the weaving loom, the values and intervals of the main factors were selected, and the levels and intervals of the factors are listed in Table 1.

Table 1. Input factor levels and intervals.

Factors name	Encoded symbol	The actual value of the factor -1,682	-1	0	+1	+1,682	Change interval
Modal fiber percentage in raw material, %	x_1	33	40	50	60	67	10
Variable fabric thickness, *mm*	x_2	0,4	1	2	3	4	1
Yarn twists number, *TPM*	x_3	616	650	700	750	784	50

Based on the results of the Rotatable central composite experiment, we use the second-order regression multi-factor mathematical model.

Significantly different values in the experiments were checked by the Smirnov-Grabs test. For this purpose, the calculated values of the Smirnov-Grabs criterion were determined according to the following formulas for the average value of the set $\overline{X}$, dispersion $S^2\{x\}$, as well as sharply different maximum - X_{max} and minimum - X_{min} values.

The table value of the Smirnov-Grabs criterion was determined and compared with the calculated values, the values found to be sharply different were excluded from the set, and the opposite values were left in further calculations.

To obtain a mathematical model of the technological process, a second-order central rotatable matrix was used for conducting experiments.

Based on the formulas in the source [8] above, we determine the alternative air permeability of the fabric according to the obtained regression equation.

$$Yr=96{,}6802 - 0{,}8784x1 - 5.2704x2 - 3.3672x3 + 8.125x12 + 0.25x13 - 23{,}4339x_1^2 - 23{,}0589\,x_2^2 - 23{,}2464x_3^2$$

Result analysis. The resulting equation shows the relationship between the air permeability of the fabric, the fiber content of the raw material, the variable thickness of the fabric, and the number of yarn twists. The hypothesis about the adequacy of the obtained mathematical model was determined according to Fisher's criterion.

The graphs of the input factor values based on the obtained formula (Y_r) are presented in Figures 1-3. It can be seen from the isolines of dependence on the input parameters, the percentage of modal fiber in X_1- raw material and X_2- fabric thickness (Fig. 1), that as the percentage of Modal fiber in the raw material in the fabric increases, the air permeability property of the fabric is determined [9-11].

At values X_1=-1, -0,9..1; X_2=-1, -0,9..1; X_3=0

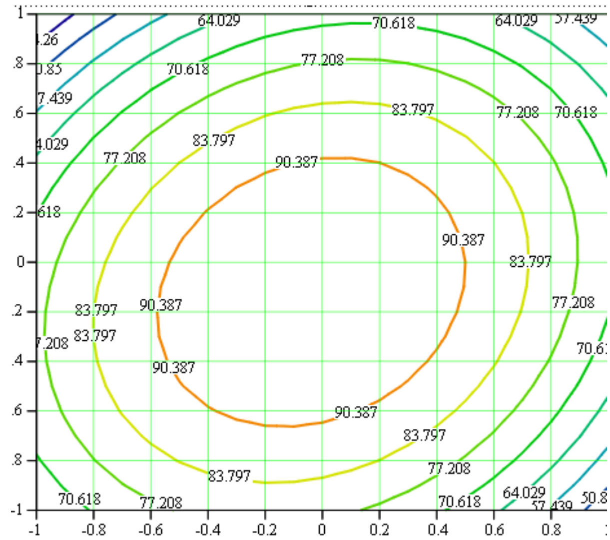

Figure 1. The isolines of dependence on the fiber content of raw materials - X_1 and variable fabric thickness - X_2 on the loom.

On the isolines of the dependence of the fabric thickness - X_2 with a complex structure on the loom on the number of twists of the yarn -X_3 (Fig. 2), it can be seen that the increase in the thickness of the fabric X_1 and X_2 values change relative to each other.

X_2=-1, -0,9..1; X_3=-1, -0,9..1; X_1=0

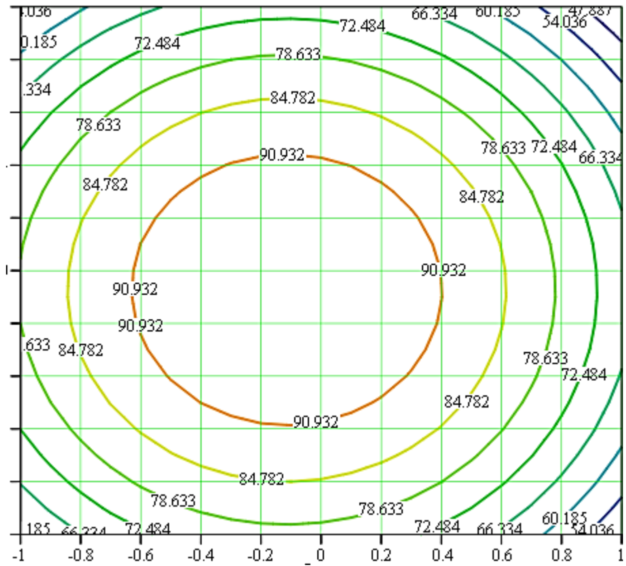

Figure 2. Isolines of dependence of X_2-variable fabric thickness on X_3-number of yarn twists

In the isolines of dependence of the proportion of modal fiber in X_1-raw material on the number of twists of X_3 yarn (Fig. 3), the air permeability of the functional fabric increases with the increase of the number of twists.

X_1= -1, -0,9..1; X_3=-1, -0,9..1; X_2=0

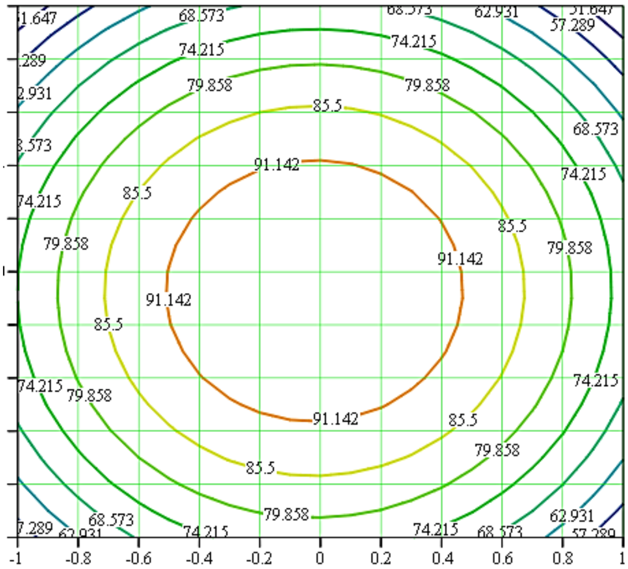

Figure 3. Isolines of the proportion of modal fiber in X_1-raw material and the number of X_3-yarn twists

The air permeability of the functional fabric with a complex structure is equal to Y_r=92m³/m²seconds when it is made with the optimal air permeability values of the fabric from the intersection of the isolines of the dependence of the modal fiber fraction on the X_1-raw material on the X_3-yarn number of twists:

1. Share of modal fiber in raw material, X_1=50 - 60%;
2. Fabric thickness, X_2=2-3 mm;
3. Number of twists, X_3=650-700 TPM.

Conclusion. On the modern Somet Thema Super Excel-190 (Italy) loom, a full factorial experiment was planned and conducted to determine the alternative technological factors for the production of functional fabric with a complex structure. The percentage of modal fiber (X_1), fabric thickness (X_2), the number of yarn turns (X_3) in the raw material of the yarn were taken as input factors, and the air permeability of the fabric (Y_1) was taken as the output criterion.

The air permeability of functional fabric with a complex structure is equal to Y_r=92m³/m²cek when the proportion of modal fiber in the fiber composition of weft yarn is -X_1=50-60%; fabric thickness - X_2=2-3 mm; the number of twists is X_3=650-700 TPM. It was determined that the air permeability of the orthopedic mattress intended for bed patients in medical facilities is 60-90 dm³/m²sec, according to the requirements set for functional fabrics with a complex structure.

References

1. Makarova, N.A. Development and study of non-woven fabrics with antimicrobial properties for medical products: dissertation for the degree of Candidate of Technical Sciences: 05.19.01. MGUTD, Moscow, 2005, 159 p.

2. Kudryavtseva, T.N., Grishchenkova, V.A., Pinchuk, Ya.S., & Goldade, V.A. "Production of innovative textile products with special properties." Workwear and PPE, no. 1(50), 2010, pp. 11-14.

3. Vinogradova, N.A. Development of methods for assessing the quality of medical tissues intended for employees of polyclinics: dissertation for the degree of Candidate of Technical Sciences: 05.19.01. MGUTD, Moscow, 2019, 230 p.

4. Mattila, H.R. Intelligent Textiles and Clothing. Woodhead Publishing Limited in association with The Textile Institute, England, 525 p.

5. Gulyaeva, G.Kh. Improving the hygienic properties of knitwear shape stability by changing the weave structure and using high-shrink lycra thread: dissertation for the degree of Candidate of Technical Sciences: 05.06.02. TTMPOS, Tashkent, 2018, 128 p.

6. Nigmatova, F.U., & Shirinova, M.Kh. "Requirements for materials of products for patients with pressure wounds." NamIET, 2nd ed., 2021, 340 p.

7. Khamrayeva, S.B., Rakhimxodjayev, S.S., & Kadirova, D.N. "Study of parameters of functional bedwetting." Results of National Scientific Research International Journal, vol. 2, no. 4, 2023, pp. SJIF-5.8, Researchbib-7.1, ISSN: 2181-3639.

8. Sevostyanov, A.G. Methods and means of studying mechanical and technological processes of the textile industry. Light Industry, Moscow, 1980, 392 p.

9. Khamraeva, S.B., Rahimkho'jaev, S.S., & Kadirova, D.N. Functional bed fabric. Patent for the invention No. IAP07369, 14 April 2023.

10. Khamraeyva, S., Kadirova, D., & Raximxodjaeyv, S. "Study of the parameters of functional bed linen." AIP Conference Proceedings, vol. 030021, March 2024.

11. Khamraeyva, S., & Kadirova, D. "Development of technology for producing functional fabric with variable structure." EPS Web of Conferences, vol. 538, 04020, 2024.

CONTENTS

PRIMARY PROCESSING OF COTTON, TEXTILE AND LIGHT INDUSTRY