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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

DEVELOPMENT OF RESOURCE-SAVING TECHNOLOGY TO IMPROVE THE QUALITY PROPERTIES OF THE SUIT PARTS

Specialty: **3326.01- Technology of materials and products of the textile and light industry**

Field of science: **Technical sciences**

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GENERAL DESCRIPTION OF THE RESEARCH

Relevance and degree of completion of the topic. The historical formation of the light industry in the Republic of Azerbaijan, im-portant factors and criteria for its development at present are consi-dered. In addition, the world's leading sewing enterprises reviewed innovations in the use of resource-saving technologies to improve the quality properties of costume parts. Currently, clothing companies around the world are doing extensive work to save energy and material resources, as well as improve the basic quality indicators of their products.

One of the issues frequently discussed in industry, science, and higher education institutions in the last decade is energy conservation. In the conducted research, the main goal of energy saving in the garment industry is to improve the economic and environmental situation, as well as increase energy efficiency. By saving energy reso-urces in industry, conditions are being created to protect the environ-ment from pollution and, most importantly, to reduce the cost of indus-trial products. This leads to satisfying the needs of consumers.

The group of energy-intensive enterprises, along with other industries, in-cludes the textile and light industries. Practical work on reducing the cost of energy and material resources in the garment industry, up-dateing outdated equipment and outdated technological processes, optimizing technological processes according to energy criteria, and improving energy supply schemes is considered. Scientific research carried out using resource-saving innovative technology was carried out in order to maintain stable consumer properties of the product or improve its quality. The main energy-consuming equipment in enter-prises producing outerwear products is humidification heating equip-ment and sewing machines.

The research examined the issues of sa-ving electricity by optimizing the operating modes of sewing machines and humidification and heating systems, thereby achieving stable product quality or improving it. A method has been developed for selecting

composites based on new criteria for glueing clothing parts with adhesive binders to order increase their rigidity and give them a certain spatial shape. The use of ultrahigh frequency current (UHF) in humidification-heating (UHF) operations was investigated, and expe-riments were conducted on a high–frequency current (HF) machine PW-1002CAS/HY.

The purpose of the study was to study the process of gluing the upper parts of clothing with adhesive pads in the field of high-frequency current. As a result of the research work, a new and complete classification of existing indicators of the quality level of in-dustrial products has been developed. A methodology has been deve-loped to improve the sequence of the expert procedure for assessing the quality of clothing. A method for controlling the cross-sections of cross-wound yarn skeins using shadow projection has been developed, and the issue of designing a comprehensive indicator of the quality of yarn appearance has been considered. O.S.Shamkhalov, N.P.Berez-nenko, S.P.Bereznenko, V.I.Kolibaba, E.O.Kutumova, E.V.Kutumo-va, A.R.Khoksolov, Kemal Khanjalich, Khalil Amin and other authors presented innovations and methods for determining and calculating the potential of energy saving and the development of energy-saving technologies in the textile and light industry.

Research on energy processes in the garment industry, optimi-zation of technological processes according to energy and quality cri-teria, research on the possibilities of humidification and heating operations in the ultrahigh-frequency field, as well as research to improve the quality of industrial products are considered relevant.

Purpose and objectives of the study. The aim of the study is to achieve flexible management of production processes by optimizing technological processes in the production of suits according to quality and energy consumption criteria. On the other hand, the innovative technology of processing clothing parts in order to save energy con-sists in exploring the possibilities of humidification and heating opera-tions in the field of ultrahigh

frequency current and analyzing existing indicators of the quality level of industrial products.

Research methods. The theoretical and methodological basis of the research is a systematic approach to studying the problem of saving energy and material resources in the garment industry. The theoretical studies used differential and integral mathematical calculations, the-oretical foundations of thermodynamics and thermophysics. Mathe-matical planning of experiments and methods of mathematical sta-tistics were used in conducting experimental studies. Microsoft Office Excel 2010 and the STATISTICA software package were used in rese-arch work when compiling reports and building graphical depen-dencies, as well as in mathematical processing of experimental results.

Main provisions to be submitted for defense.

- Study of the history and current state of the development of light industry in the Republic of Azerbaijan, identification of important factors and criteria of development in the modern era;
- Research innovations in the use of resource-saving technologies at the world's most advanced sewing enterprises to improve the quality of costume parts and conduct an experimental analysis of energy savings using modern techniques and technologies;
- Carrying out theoretical and practical analysis of energy-consu-ming processes in the manufacture of suits, conducting experi-mental studies on sewing machines in laboratory conditions and equipment performing humidification and heating operations in GILTEX LLC, based on quality and energy criteria, as well as optimizing technological processes based on quality and energy criteria;
- Conducting scientific research in the sewing workshop of GILTEX LLC and preparing proposals on the main areas of energy saving in the production of clothing;
- Development of a methodology for selecting composites based on new criteria for glueing clothing parts with adhesive

binders to increase their rigidity and give them a certain spatial shape;

- Investigation of the possibilities of innovative technology for processing clothing parts in the field of ultrahigh frequencies - humidification-heating using experimental and theoretical research;
- Expert assessment of the costume quality level and development of a new classification option, as well as analysis of quality problems and the variety of technological techniques in the garment industry;
- Researching the development of a yarn skein management methodology using expert methods for evaluating product quality with integrated indicators in quality and projection of their cross sections;
- Development of a methodology for selecting materials for light summer clothing that protects against heat;

Scientific novelty of the research. In the course of the work, the following scientific innovations were identified:

- A laboratory facility has been developed to study the energy consumption of electric motors of sewing machines. As a result of multifactorial experiments, a mathematical model of energy saving of electric motors in the sewing process was obtained.;
- Optimizations based on the results of multifactorial experiments on quality criteria and energy saving in humidification and heating processes were carried out, and recommendations were prepared for GILTEX LLC;
- For the first time, a new technique has been developed for selecting the upper fabric and adhesive binders (composites) in the details of the suit;
- Innovative processing technology in the field of ultrahigh frequency currents - theoretical and practical experiments have proved the possibility of saving energy resources during humi-dification and heating operations;
- Development of a methodology for improving the sequence of the expert procedure for assessing the quality of clothing and

determining the "threshold values of expert points on request" in the organoleptic assessment of the appearance of materials;

❖ In quality , methods have been developed for evaluating product quality based on complex indicators and managing them using the projection of cross-sections of skeins of yarn;

❖ A methodology has been developed for selecting materials for light summer clothing to protect against heat.

Theoretical and practical significance of the study. The research results presented in the dissertation make it possible to:

➢ Create a general management model based on quality and energy criteria in the management of technological processes;

➢ Save electricity in electric motors of sewing machines by eliminating machine idling and saving energy costs; The expected annual return based on the results of scientific research conducted at GILTEX LLC by optimizing the operating modes of equipment performing humidification and heating operations based on quality criteria and energy saving through practical experiments is 27,256.3 manats;

➢ Preparation of proposals for the organization, accounting and management of existing waste management at GILTEX LLC;

➢ Theoretical justification of the possibilities of energy saving during humidification and heating operations in the field of high-frequency currents due to energy savings in the process of gluing composite suit parts on a high-frequency machine PW-1002CAS/HY compared with traditional presses;

➢ Development of a new version of the classification of industrial product quality indicators;

➢ Analysis of quality problems and multivariate processing meth-ods in the manufacture of costume parts, as well as a study of the possibilities of choosing the most optimal option for proces-sing costume parts according to quality and energy consumption criteria;

➢ Development of a methodology for selecting materials for light summer clothing to protect against heat;

➢ Development of a technique for controlling cross - sections of cross - wound yarn bundles using shadow projection;

➢ When designing a comprehensive quality indicator for the ap-pearance of yarn, it is necessary to determine the purity classes of individual indicators and samples.

Approbation and application of works. The main results of the dissertation work were published in the journal Izvestia of the Ganja branch of ANAS (2018, 2019), at scientific and practical conferences and seminars of the Azerbaijan Technological University. (2014, 2016, 2019, 2022, 2023, 2024), at the International Scientific and Practical Conference "Design-innovative technologies in light indus-try" in A.N. Kosygin Russian State University in Moscow, Russian Federation (2018), on "II International Conference on Engineering Sciences" (2023). His articles have been published in the Scopus-indexed journal Technology of the Textile Industry (2023) in Moscow, Russian Federation, as well as in the journal New Science (2023) in Petrozavodsk, Russian Federation. The proposals based on the results of the dissertation work were tested at the GILTEX LLC enterprise of the Sumgait Technopark.

The name of the organization where the dissertation work is performed. The research work was carried out at the Azerbaijan Technological University (ATU) in 2014-2023. The experiments were conducted in the laboratory of the ATU, at the enterprises of Baku Se-wing House OJSC and GILTEX LLC of the Sumgait Technopark.

The total volume of the dissertation with an indication of the volume of the structural sections of the dissertation separately. The dissertation consists of an introduction, four chapters, a conclu-sion, a list of 150 sources and appendices. The book contains 28 ima-ges, 23 tables and 5 appendices. The content of the dissertation con-sists of an introduction of 7 pages and 13,734 characters, the first chap-ter of 38 pages and 70,704 characters, the second chapter of 47 pages and 76,029 characters, the third chapter of 39 pages and 72,799 charac-ters, the fourth chapter of 50 pages and 89,154 characters, the conclu-sion of 3 pages and 4,811 characters. characters, sentences of 1 page and 1,505 characters, as well as a list

of 150 references of 16 pages and 27,041 characters. The dissertation consists of 212 pages of com-puter text with a total volume of 362,962 characters (excluding the list of references and appendices - 334,412 characters).

CONTENT OF THE WORK

In the introduction, the relevance of the topic, the purpose of the research, the tasks set and the general characteristics of the dissertation are given..

First chapter. This chapter of the dissertation examines the formation and current state of light industry in the Republic of Azerbaijan on the basis of statistical and other data. The role of national leader Heydar Aliyev in the development of light industry in Azerbaijan is substantiated. It was noted that "the Azerbaijani people are a happy people because they were led by such a wise and strong politician as Heydar Aliyev." From 1970 to 1982, the average annual production growth was 7.2 percent. It should be noted that the volume of light industry products and household services increased by about 10 times in 1982 compared to 1969. In the period from 1990 to 2005, there was a very serious decline in the light industry. Thus, during the specified period, the volume of production of materials and products in light in-dustry sharply decreased, and the number of employees decreased from 97.4 thousand to 14 thousand people.

Since 2004, as a result of the implementation of the decrees of the President of the Republic of Azerbaijan "State programs for the socio-economic development of the regions of the Republic of Azerbaijan (2004-2008 and 2009-2013)", the total volume of production in the light industry in 2014 amounted to 97.5 million manats. It should be noted that the roadmap of economic development for 2013-2019 included important measures related to the development of light industry in the capital Baku and the regions. As a result of government support, new light industry enter-prises equipped with modern equipment, as well as technoparks in

Mingchevir and Sumgait, are beginning to function one after another. As a result of the study, the main criteria for the development of light industry in Azerbaijan were identified.

The innovative developments of the world's leading enterprises in the garment industry on the use of resource-saving technologies while preserving the quality properties of costume parts are analyzed. It was noted that the modern use of energy-saving technologies leads to lower production costs and creates the need for energy management in enterprises. Energy resour-ce management in light industry includes planning and operation of units related to energy production and con-sumption.

The goal is to conserve resources, avoid waste, and save money. The methodology used in the practical research we conducted at «GILTEX» LLC in-volves measuring the working time for each process using a stop-watch, and then calculating the energy consumption of each piece of equipment for each process. For this purpose, a practical experiment plan was drawn up to determine the electricity consumption in the pro-duction of 10 men's shirts produced at «GILTEX» LLC and the results were obtained: a) 5,692 kW of electricity was spent on the production of 10 men's shirts; b) 76.95% of the energy was spent on machinery and equipment, 4.24% on lighting, and 18.81% on quality and defect repair.

Second chapter. Clothing production is considered one of the most energy-intensive branches of light industry. Thus, in the garment industry, equipped with modern equipment, 65-70% of electricity and 30-35% of thermal energy are consumed in technological processes. These indicators vary depending on the equipment used at different enterprises, technological methods of product processing, and energy efficiency. As a result of theoretical and practical research, the neces-sary methods for reducing energy consumption in the manufacture of sewing products have been identified and the expediency of their use has been substantiated. The most energy-intensive equipment in the garment industry is humidification and heating equipment. At the «GILTEX» LLC enterprise of the Sumgait Technopark, the process of gluing

(duplicating) costume parts from used fabrics with adhesive binders is carried out in humidification and heating equipment. It is recommended to carefully select the processing modes and optimize the working environment of humidification and heating equipment to improve product quality and save energy resources.

Multifactorial ex-periments have been conducted to determine the technological para-meters of humidification and heating equipment. The main criteria in the experimental studies were the quality of product processing and the energy intensity of operations. It follows from experimental stu-dies that in the manufacture of clothing, the correct choice of sealing material is of great importance for adapting adhesive sealing materials to the upper fabric. Until now, the main criteria for choosing com-posite materials selection methods have been the strength of the sepa-ration of composites into layers, air and vapor permeability coeffi-cients, hardness, and other indicators.

However, there is currently no method for selecting adhesive sealants for composite materials that uses the linear shrinkage (or shrinkage coefficient) of materials as the main quality criterion. Therefore, we have developed a new method for selecting composite materials and conducted multifactorial experi-ments for this purpose. The experiments were carried out both in labo-ratory conditions and at the «GILTEX» LLC enterprise of the Sumgait Technopark using suit fabric and two types of welding materials, va-riants M and N. During the tests, the amount of moisture transferred to the sample using a humidification dosimeter was taken as an input factor, and the strength of the adhesive joint for stratification was taken as a qualitative factor.

First, the samples prepared according to variant M were heated to 440 K, and then the samples prepared according to variant N were heated to 390 K, 25% of the set weight of each sample; 50%; Experimental studies were carried out at humidity of 75% and 100%. After drying the samples in the open air and storing them under normal atmospheric conditions, the strength of the composites for stra-tification was determined using an RT-250 crushing machine.

Based on the experimental results, mathematical models of strength loss of composite compounds are calculated depending on the percentage of strength.:

Variant – N: $R_N = 0{,}94+0{,}207\ W$,

Variant – M: $R_M = 0{,}85+0{,}108\ W$.

where, W – percentage of hydration of composite samples, %.

Research has proven that when sewing clothes, its shrinkage properties should be taken into account. When performing moisture-heating operations for shaping clothing parts, it is of great importance to choose the right method of intensive cooling of fibers to fix a given shape.

For this purpose, experiments were conducted on the equipment of the «GILTEX» LLC enterprise of the Sumgait Technopark. The experi-mental results showed that the shaping of men's seasonal jackets oc-curs more intensively with vacuum suction, and the processing quality improves (fig. 1).

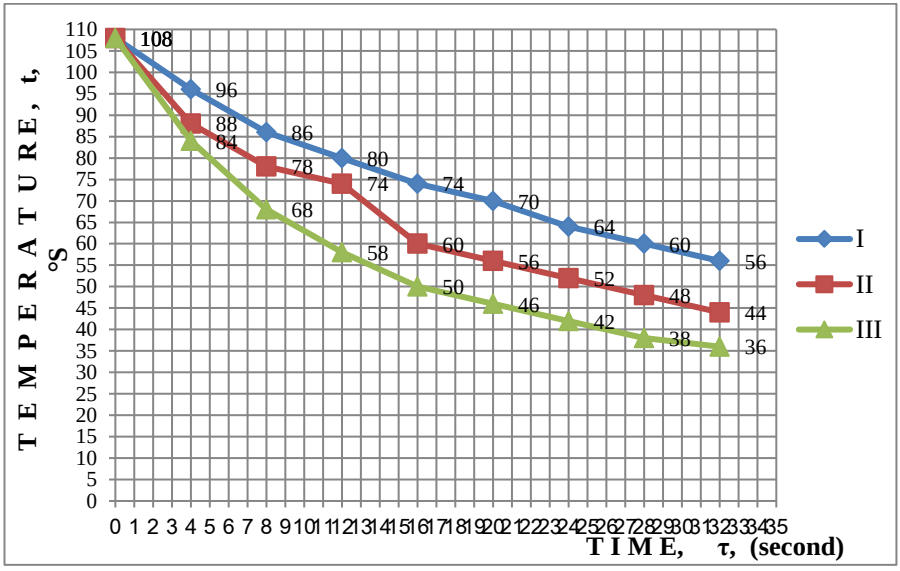

Figure 1. Fabric temperature curves depending on the cooling method.

The theoretical aspects of the energy consumption characteristics of sewing machines are investigated. A laboratory installation has been developed to study the energy consumption of electric motors used in sewing machines, without taking into account idling during sewing operations (fig. 2).

Multifactorial experiments were conducted at the laboratory stand to evaluate the energy consumption and energy saving of a two-needle industrial sewing machine «Minerva 72412-101», which performs te-chnological operations, as well as to evaluate the energy consumption and energy saving of its electric motor. During the experiments, the electric motor of the «Minerva 72412-101» sewing machine runs with-out idling, The results of measurements of the parameters of the energy spent on sewing a unit of length of selected fabric samples were obta-ined. As a result of multifactorial experiments, sewing machines. The regression dependence of the energy intensity of the engines on the technological parameters is determined. (fig.3) shows graphs of the active and reactive power of the electric motor of the «Minerva 72412-101» sewing machine at idle and operating speed, with and without idle.

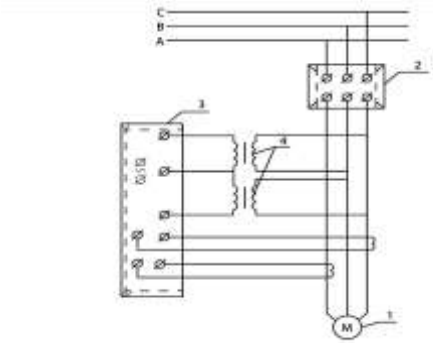

Figure 2. «Minerva 72412-101» sewing machine laboratory board layout

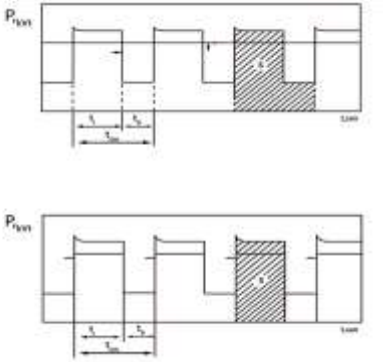

Figure 2. Sewing machine. electric transmission active and reactive costs their power: a) in an empty moving b) empty non-moving graph.

In the graphs, the area «S» characterizes the consumption of electricity and is calculated from the formula:

$$E = K_1 \cdot K_2 \cdot S, \qquad [kVt \cdot sec. = kC] \qquad (1)$$

where,

$K_1 = 1/\upsilon$ -it is the coefficient that characterizes the scale of time, sec./mm; $K_2=P/A$ -is the coefficient that indicates the magnitude of the power, kVt/mm; υ -is the tensile rate of wattmeter tape, mm/sec; A-is the length of the ordinate axis cross section corresponding to the maximum power, mm.

Third chapter. The rational use of energy resources is a very im-portant issue in the garment industry. This allows us to reduce costs and negative impact on the environment, as well as increase produc-tion efficiency. In this regard, as a result of the research, the main di-rections of energy saving in the garment industry have been identified and proposals have been prepared for «GILTEX» LLC to implement measures in these areas.

Energy savings in the production of clothing are possible due to the improvement of processing technologies and the intensification of technological processes. In this regard, the use of heating in the field of ultrahigh frequency currents in the technological processes of sewing production is extremely relevant and promising. Heating of processed products in the field of ultrahigh frequency currents is widespread in various fields of production, especially in the food industry and catering.

The conversion of microwave energy into heat is based on the principle that energy in the field of ultrahigh fre-quency current is effectively absorbed by the moisture of the heated product, and the moisture is converted into steam. Thus, in materials with a high moisture content in a changing electromagnetic field, as a result of the dipolarization of water molecules, a rapid rotational mo-tion of molecules in a changing electromagnetic field occurs. As a re-sult, work is performed and heating occurs due to intermolecular fric-tion. In this case, heat is released throughout the entire volume of the processed product, and the temperature at all points of the volume is

the same. At this time, the energy of the ultrahigh frequency current supplied to the working chamber is almost completely absorbed, regardless of its shape and mass.

In radio-electronic devices that per-form technological processes, for example: This is about 65-70%. Energy can be saved by using super-strong current devices. Experi-ments have been conducted to test the possibility of gluing adhesive binders, i.e. composites, to the material of the upper parts of clothing in the field of high-frequency current.

The experiments were carried out on a high-frequency current machine PW-1002CAS/HY, consis-ting of a stationary press and two movable tables. The power of the high-frequency current machine is 10 kW; the power supply is 380 V, 3 phases, 50/60 Hz; the frequency of the high-current generator is 27.12 MHz; The dimensions of the upper and lower cushions are 550-650 mm and 600-700 mm, respectively. As can be seen from the expe-rimental results, half-wool (wool/wool) costume fabrics containing synthetic fibers (art. 23390"C", 23395"C", 43255) are heated to higher temperatures in a high-frequency current field over a certain period of time than pure wool fabrics (art. 13253). This is due to the fact that synthetic fibers have a higher dielectric constant (for example, $\mathcal{E}_M = 3.0...3.5$ for polyester synthetic fibers).

Figure 4 shows the thermo-kinetics of costume fabrics in a high-frequency current field.

In the experiments, the coefficient of separation resistance to layers ($K_м$) was adopted, the main quality indicator of which characterizes the adhesion strength of composites, and was calculated from the following formula:

$$K_м=F_{373}/F_T, \quad (2)$$

where, F_{373} - is the resistance to separation into layers provided that the inter-layer temperature is 373˚K, DaH/sм; F_T - at values of inter-layer temperatures higher than 373 ˚K, it is the resistance to separation into layers, DaH/см.

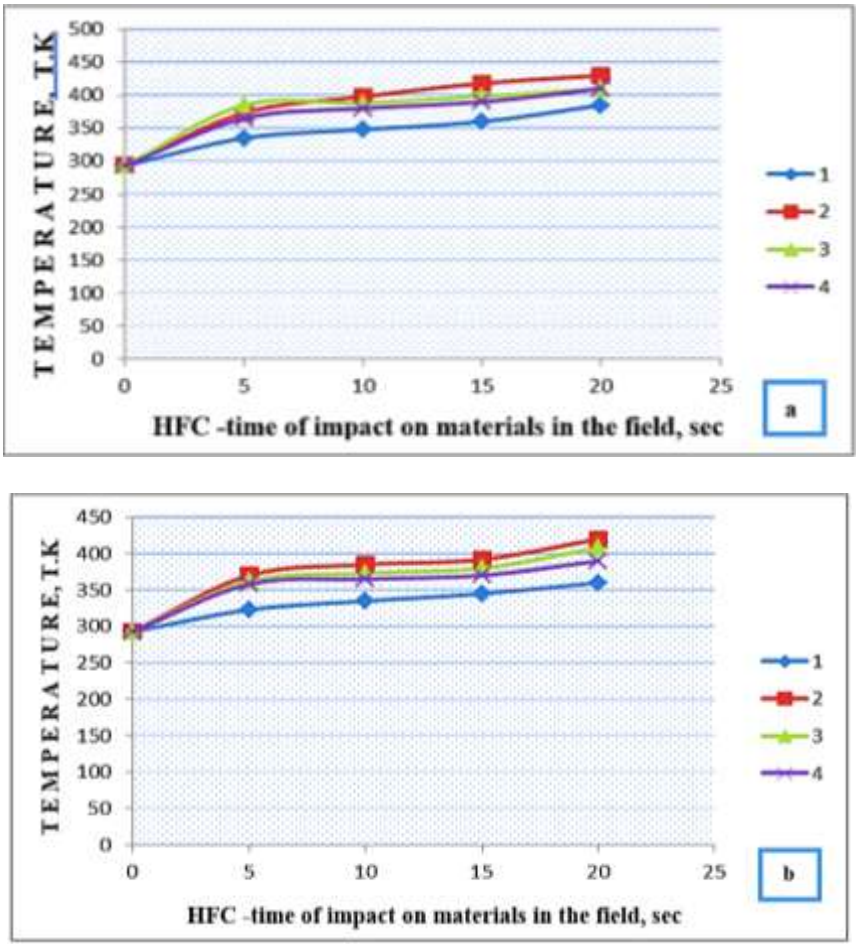

Figure 4. Thermokinetics of costume fabrics in the field of high-frequency current.

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$$F_T = F_{373}(1 + 0{,}0031\Delta T \cdot S_D) \quad (3)$$

where, ΔT - (F_T - F_{373}) is the difference of tempetatures, K; 0,0031 - is the invariant (stable) coefficient; S_D - it is the area of the supporting surface of the fabrics until processing, %. The correlation coefficient between the results of the experiment and the result of the report was more than 95 per cent.

Forth chapter. In this dissertation chapter, theoretical and experi-mental studies have been conducted to assess the quality of products and materials in quality using integrated indicators and expert me-thods. As a result of the research, a new sequence of actions is pro-posed in the practice of expert assessment of the quality level of mate-rials and products. In the process of product examination, it is advis-able to evaluate an expert survey using traditional point values (range values).

Currently, expert survey methods are characterized by a range of scores of 5 points, 7 points, 9 points and more. Based on the various types of analyses and checks of quality indicators of materials and products carried out during the examination, the threshold values of points for the purposes of expert assessment during the examination were determined. The processing of the conducted surveys showed that the application of new threshold values of estimates allowed to obtain more accurate results. It is important to note that the quality of outerwear depends on the quality of the yarn from which it is made. Therefore, studies were conducted to improve the quality of yarn pro-duced at the «GILTEX» LLC enterprise of the Sumgait Technopark. First of all, theoretical and practical studies were

planned to create a technique for controlling the cross-sections of cross-wound yarn bund-les using shadow projection. To obtain complete information about the shape of the yarn bundle, it is important to know exactly the correct location of the yarn in its cross-section.

An analysis of methods for controlling the shape of technical objects has shown that one of the promising areas is the control of cross-wound yarn skeins in spinning by shadow projection, equipped with automated image recognition tools. Then the issues of designing a comprehensive indicator of the quality of the yarn's appearance were considered. It has been estab-lished that in yarn production, improving the quality of finished pro-ducts depends on systematic and effective quality control of raw mate-rials and semi-finished products at all stages of its production.

When determining the quality of products produced in spinning, the appe-arance of the yarn is evaluated first. The consumer properties of the finished product often depend on its appearance. The purity class of the yarn is determined by its composition. Existing methods for deter-mining the purity class of yarn based on organoleptic and mechanical methods are ineffective.

Based on the expert assessment method, the linear relationship between the values of individual indicators and the expert score is functional. During the survey, the concordance coeffi-cient was 0.86. This indicates that the consensus of expert opinions is very good. The degree of agreement of individual quality indicators was used as an indicator of the average score. The values of individual individual indicators are determined.

These indicators were used in a comprehensive assessment of the external qualities of widely used cotton yarns with linear densities of 50 and 20. Practical studies have been conducted on the expert assessment of the quality level of outerwear. A new, complete classification of industrial product quality indicators has been developed (table 1).

Table 1

A new version of the classification of industrial product quality indicators

Classification sign	Industrial product requirements	Groups of quality indicators of products
1	2	3
1. According to the properties characterized	1.Hygienic requirements	Gigenic indicators, Ergonomic indicators, Safety indicators.
	2.Environmental requirements	Environmental indicators.
	3.Consumer needs	Destination indicators, Reliability indicators (refusals, eternity, reliability in repair, protection) Portability indicators Patent-legal indicators
	4.Aesthetic requirements	Aesthetic indicators Unification indicators
2.According to the way of expressing	1. Technological requirements	Technological indicators Technological-constructive indicators
	2.Measurement requirements	Indicators of expressiveness in natural units (kg, m, points, size)
3.By the number of properties that characterize	1.Value requirements	Expressiveness indicators in price units
4.According to the phased determina-tion of indicators	1.Sufficient requirements	Single indicators Complex indicators (grouped, generalized, integral).
	2.Forecast-pro-ject requirements	Predictive indicators Project indicators
5.According to the evaluation criterion	1.Absolute and re-lative requirements	Base indicators Relative index

Various samples of women's bulus-kas, men's and children's top shirts with standard device of LW-400 brand were determined and total heat resistances were calculated (tab. 2).

Table 2

Hygienic requirements for men's shirts and women's blouses

The main indicators of giginic properties	Units of measurement	Limits that can be omitted according to standards.
Thickness	mm	0,1÷0,3
Air permeability coefficient	dm^3 / (m^2 •c)	350÷700
Coefficient of moisture permeability	q / (m^2 •c)	~ 4
Hygroscopicity (at 65% relative humidity of air)	%	~ 7÷8
Total heat resistance	(m^2 ˚C) / Vt	~ 0,07÷0,08

It is known that at room temperature (t = 20˚C), the total thermal resistance is R_{total} = ~ 0.07-0.08 (m^2˚C)/W. During the research, the hy-gienic properties of women's blouses and men's shirts made of cotton (at least 30%) and mixtures of synthetic fibers, flax (at least 40%) and mixtures of synthetic fibers were determined and a production proposal was prepared.

Results

1. The historical formation and modern prospects for the development of light industry, which is part of the processing industry of the Republic of Azerbaijan, are considered. The role of national leader Heydar Aliyev in the development of light industry in Azerbaijan is substantiated. It was noted that in 1969-1982, production in all sectors of the Azerbaijani economy increased dramatically, especially the volume of goods and light industry products increased by more than 40%. Since the 1990s, Azerbaijan's light industry has been experien-cing a very serious decline: the number of manufactured materials and products has decreased 10-fold, and the number of employees has dec-reased from 97.4 thousand to 14 thousand people. Since 2006, nume-rous light industry enterprises have been operating in Azerbaijan. In 2017-2023, there was a dynamic growth in the production of the main types of light industry products in physical terms (volumes), the

number of operating enterprises and sales volumes. The important factors of the development of light industry in the republic are listed and the criteria of development are defined.

2. The innovations introduced by the world's leading sewing com-panies in the use of new materials and the use of resource-saving tech-nologies in order to improve the quality of costume parts are analyzed.

3. A practical experiment plan was drawn up to determine the electricity consumption in the production of 10 men's shirts at «GILTEX» LLC in Sumgait Technopark and the results were obtain-ned: a) 5,692 kW of electricity was spent on the production of 10 men's shirts; b) 76.95% of energy was spent on machinery and equipment, 4.24% on lighting and 18.81% on on quality and elimination of defects.

4. A theoretical and practical analysis of energy-intensive proces-ses in the garment industry is carried out. The issue of energy savings in equipment performing humidification and heating operations is analyzed. A laboratory bench has been developed to study the energy consumption of electric motors used in sewing machines, without tak-ing into account idling during sewing operations. Multifactorial expe-riments were conducted to evaluate the energy consumption and ener-gy saving of a laboratory board of a two-needle industrial sewing ma-chine "Minerva72412-101", which performs technological operations.

5. In the process of humidification and heating, when intense hygrothermal effects are exerted on materials, the mechanism of moisture and heat transfer in them is theoretically revealed. Formulas for calculating the amount of free steam or hot air in the structure of materials are given to determine energy savings in humidifying and heating equipment that transfers heat to materials by contact and convective methods.

6. New fields of application of ultrahigh-frequency current have been investigated, the nature of heating materials in the field of ultrahigh-frequency current has been studied, and the mechanism of action of an ultrahigh-frequency electromagnetic field on semi-fini-

shed products has been theoretically disclosed. Practical experiments were carried out on an operating high-frequency current machine PW–1002CAS/HY. The purpose of the study was to study the process of forming an adhesive joint in a high-frequency current field during direct bonding of clothing parts. An empirical formula is proposed for calculating the coefficient of delamination resistance (Km) as the main quality indicator in experiments. As a result of the research, a block diagram of devices providing heating of materials in the field of ultrahigh frequency current, designed for industrial applications, has been developed.

7. Research has been conducted using expert methods to assess the quality of the costume according to complex indicators. To reduce the level of error in the expert assessment, it is proposed to express the expert survey in terms of the causal value. It is proposed to carry out expert research activities on the selection of materials for clothing in a sequence determined by us. In the course of the research, "expert thresholds on request" were proposed for the organoleptic assessment of the appearance of materials used in light industry.

8. During the research work, an analysis of existing methods for assessing the quality level of industrial products (standard methods) was carried out and it was found that product requirements were not fully taken into account. A new, complete version of the classification of industrial product quality indicators has been developed. A table of the "applicability" of industrial product quality indicators has been compiled. A method has been developed for selecting "light summer materials for protection from heat" depending on the type of clothing and gender and age groups.

Recommendations for manufacturing

1. For the first time, a new technique has been developed that makes it possible to accurately determine the processing modes for the selection of composites from the materials used in the conditions of the «GILTEX» LLC enterprise of the Sumgait Technopark, and multi-factorial experiments have been conducted for this purpose.

The expected annual profit based on the results of the research work "De-velopment of a resource-saving technology for improving the quality properties of costume parts" amounted to 27,256.3 manats.

2. As a result of the research, the main directions of energy saving in the garment industry have been identified and measures in these areas have been recommended to the «GILTEX» LLC enterprise of the Sumgait Technopark.

3. The parameters of humidification and heating operations performed during the humidification and heating of ironing tables and presses have been determined and recommended for production.

4. A technique for controlling the cross-sections of cross-wound yarn bundles using shadow projection has been developed. For this purpose, the device was manufactured and tested in practice at the «GILTEX» LLC enterprise of the Sumgait Technopark.

5. An expert survey was conducted to determine the qualitative indicators of the yarn's appearance. Based on the expert evaluation method, single indicators characterizing the appearance of the yarn and the purity classes of the sample were determined. The results of the study were submitted to «GILTEX» LLC.

The main content of the dissertation is published in the following scientific papers:

1. Mirzaev R.T., O.S. Shamkhalov Methodology of applying the expert survey method in assessing the quality level of products //Proceedings of the International Scientific and Practical Conference on Sustainable Development and Technological Innovations, held at the Azerbaijan Technological University. – Ganja: -2014. Part 2. - etc. pp.310-313.
2. Mirzaev, R.T. Assessment of the technical level of industrial product quality indicators and a new classification option. / R.T. Mirzaev, O.S. Shamkhalov, T.H.Mirzoev //Azerbaijan Techno-logical University. Scientific news. Ganja: 2016. No.I (21), pp. 83-90.

3. Mirzaev, R.T. Analysis of quality indicators of industrial products //Ganja: Azerbaijan Technological University "Scientific News" -2016, №2 (22), - pp.78-83.
4. Mirzaev, R.T. Analysis of quality problems and multivariate processing methods in the garment industry. / R.T. Mirzaev, T.H. Mirzaev, S.S. Farajova, I.I. Rustamova, S.I. Muradov. // Journal "Izvestiya nauki" of the Azerbaijan Technological University. Ganja: -2018. № 02 (25), - pp. 60-66.
5. Mirzaev R.T. Determination of resistance to delamination when joining composite materials in the field of high-frequency cur-rents (HDPE). / R.T. Mirzaev, M.N. Nuriev, S.S. Faradzhova, // Information Bulletin of the Ganja branch of ANAS. - Ganja: - 2018. № 3(73) - pp. 229-234.
6. Mirzaev, R.T. Expert assessment of the quality level of outerwear / R.T. Mirzaev, M.N. Nuriev, P.F. Nasirli // "Scientific works" of ANAS, Ganja: 2018. № 01.-pp.36-39.
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8. Mirzoev R.T., Nuriev M.N. Theoretical and practical foundations of energy processes in garment production // International scientific and practical Conference "Actual problems of food and light industry" at the Azerbaijan Technological University, Ganja: -2019, pp. 111-112.
9. Mirzaev, R.T. Research of energy resources of technological equipment of the garment industry. // Materials of the scientific and practical conference "Actual problems and achievements of modern science", held at the Azerbaijan Technological University - Ganja: November 3-4, 2022. Part I, pp. 113-115.
10. Mirzaev, R.T. Analysis of energy consumption of equipment carrying out humidification and heating in the garment industry //"Technological development is the basis of economic develop-ment" Republican AMU Conference. - Ganja: -2022. pp. 84-85.

11. Mirzaev, R.T. The choice of optimal technology in the production of sewing products // Ganja: Azerbaijan Technological University, Scientific News, -2022. № 1(38), - pp.263-268.
12. Mirzayev, R.T., The Main Prerequisites For The Development Of Powerful Ultra-High-Frequency Devices Providing Centrifugal Molding of Sewing Parts//M.N. Nuriev, R.T. Mirzoev, International Scientific and Technical Conference "Design, Technologies and Innovations in textiles and light industry.- Moscow: -2018.14-November 15, pp.211-215.
13. Mirzayev, R.T., Mirzayev T.G. Development of resource-saving technology to improve the quality properties of costume parts. // V. International Scientific and Ractical Conference «Modern Science: Theoretical and Practical View» Madrid. Spain - 2023.June - 27-28.- pp. 35-40.
14. Mirzayev, T.G., Mirzoev, R.T., Improvement of wet-heat treatment (WTO) processes of sewing products and optimization of the working environment and equipment.//International Scientific and Practical Conference, (KOF-752) Petrozavodsk: - 20 - March, -2023 pp.98-104.
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17. Mirzayev, R.T. Operational safety of wet-heat treatment equipment. /II. International Conference on Engineering Sciences Ganja, Azerbaijan Technological University. September 21-22. -2023, pp. 417-422.
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20. Mirzayev, R.T. Energy-consuming processes in the garment industry // Azerbaijan Technological University. Scientific news, journal, -№ 1(46) 2024,- pp.117-121.

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