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STUDY OF THE INFLUENCE OF SOL-GEL COMPOSITIONS ON THE PHYSICO-MECHANICAL PROPERTIES OF TEXTILE MATERIALS

Abstract. In this article the possibility of combination of technology of dyeing and final finishing of cotton textile material with application method sol-gel is considered.

The new method sol - technology gel in finishing of cotton textile material is offered. The developed combined technology of dyeing and antimicrobic finishing of cotton textile material with application sol – method gel, allows to receive strong adhesive fixing of particles of the antimicrobic agent and dye on fibrous substrate.

The properties of the cellulose textile material processed by offering sol - technology gel by application of physicomechanical, physical and chemical and biological methods of a research were investigated. Processed on the offered combined technology textile material keeps operational and hygienic indicators, esthetic, resistance of coloring to friction, also improvements of functional and protective properties of textile material.

Optimum parameters are revealed, influences of temperature of processing, concentration of acetate of zinc and liquid glass are investigated. The main advantage new sol-method gel: reduction of time of processing and technological process, exception of use of expensive medicines and exception of harmful components.

Key words: sol-gel method, coloring, combined method, final finishing, antimicrobial, sodium silicate.

Introduction. Today it is paid to the technologies providing superficial modification by polymers much attention. Drawing on the surface of fabric of the polymeric medicine allowing to improve as coloristic characteristics of textile materials, and to give different types of final finishing. Receiving gel of dioxide of silicon and with inclusion in it of functional filler as which can act both dyes, and particles of oxides of metals for giving of water repellency, fire resistance, biocidal and other special properties [1].

In this regard, studying of coloristic, antimicrobic and physicomechanical properties of the fabrics modified by polymers for the purpose of development of new technologies, including, and the combined ways of a kolorirovaniye and final finishing, are a relevant task [2].

Using the appropriate synthesis conditions and careful selection of the dye and antimicrobial reagent, a large number of molecules can be incorporated inside the silicon dioxide matrix, so that the molecule particles are "protected" from exposure to oxygen and sunlight, which helps to avoid photodestruction, as well as its gradual removal from the fiber surface [3].

Modification is applied to providing a necessary complex of properties of textile materials for various products. Now there are various methods of modification of textile materials: physicomechanical, physical and chemical, chemical, biochemical. Modification of properties of materials is carried out generally at two stages: in the course of production and in the course of the subsequent finishing.

Physico-chemical modification allows you to adjust the hydrophilicity of natural materials, but the increase in strength, heat resistance, wettability reduction is always accompanied by a decrease in hydrophilicity [4]. Depending on the reagents used, abrasion resistance may be increased. Regulation of the properties of textile materials and expansion of their performance properties is possible by modifying their polymerization-capable monomers, followed by polymerization of the latter. Natural materials increases the strength, abrasion resistance, oilophobicity, resistance to washing [1].

Chemical technologies are widely used practically at all stages of production of textile materials. Polymeric compositions allow to provide or improve properties of materials in considerable limits. They are important in the course of finishing of textile materials: purifications of textile materials of pollution, kolorirovaniye and final finishing [3].

The choice of a method of modification of textile materials is influenced, mainly, by the following factors: fiber nature; physical properties of fibers, ability to bulk up, resist attrition both in damp, and in a dry state under various temperature conditions; susceptibility of fibers to chemical influences.

EXPERIMENTAL PART

Materials. As an object of a research the cotton bleached fabric of the article 1030 is chosen as 100%. For dressing of samples the following reactants were used: zinc acetate - acetic salt of zinc with a density 1.735g/cm3, sodium silicate – sodium salt of metasilicon acid, citric acid of 100% in the form of powder, direct dyes, the distilled water.

Preparation of samples. Processing of fabric took place as follows:

1. Preparation of solution of acetic zinc (5g/l) and citric acid (5g/l) in the distilled water;
2. Addition of direct dye (3g/l) in solution;
3. Addition in sodium silicate solution (liquid glass) (40, 60, 80 g/l);
4. Impregnation of fabric in solution within 1-2 minutes at the room temperature;
5. An extraction and drying of samples before full drying;
6. Heat treat mental temperature sol 100-150 °C;

Preparation time of sol of 20 minutes, temperature 40 °C.

Research methods. Assessment of the color stability of textile materials to dry and wet friction is carried out in accordance with GOST 9733.27-83 on PT - 4 devices; physical and mechanical-using AUTOGRAPH AG-I, AR-360SM ("Nisshinbo", Japan), to determine the strength characteristics and breathability of the treated cotton fabric is carried out in accordance with GOST 3813-72 “Textile Materials. Fabrics and piece products. Methods of determination of tensile properties”; GOST 12088-77 «Textile Materials and articles thereof. Method for determination of air permeability»; determination of tissue stiffness is carried out according to GOST 10550-93 "Textile Materials. Canvases. Methods of determination of stiffness in bending "on the device MT-367; Assessment of color and

coloristic indicators of images of cotton fabrics, using a spectrophotometer "Minolta", a specialized technique. The study to determine the antimicrobial activity of textile materials was conducted in accordance with the standard "methods of laboratory tests for resistance to microbiological destruction GOST 9.060–75"[1].

RESULTS AND DISCUSSION

In comparison with other methods the developed sol-gel the method possesses a number of premushchestvo and possesses the simplified technological scheme of synthesis. Indicators of stability of coloring of textile materials for dry and wet friction, to explosive loadings it is shown in table 1.

Table 1 – Indicators of stability of coloring of textile materials for dry and wet friction, to explosive loadings

№	Concentration Silicate of sodium, ml/L	Temperature of heat treatment, °C	Heat treat menttime, sec.	Stability of coloring to a frictions, (point)		Breaking load F, (N)	
				dry	wet	warp	weft
1	40	100	120	5/4/4	3/4/3	276	237
2	60	100	120	5/4/5	4/4/4	240	233
3	80	100	120	5/5/4	4/4/4	238	211
4	40	150	120	4/3/4	4/4/3	257	226
5	60	150	120	5/5/4	4/4/4	275	244
6	80	150	120	5/5/5	4/4/4	281	247
7	0*	150	120	4/3/3	2/3/2	264	200
*0 – the material is dyed according to the traditional method, the breaking load of the original fabric is 264 N.							

According to the received results of resistance of coloring to friction, it is possible to draw a conclusion that application method sol-gel when coloring cotton textile materials, does not reduce resistance of coloring to friction, in comparison with a traditional way of coloring.

Follows from the analysis of the received results that processing by composite structure positively affects mechanical properties of the finished fabric, explosive loading depending on the applied finish coat increases up to 281 N in comparison with initial tissue 264 N.This indicates that the modification of cellulose materials using the Sol-gel method does not worsen, and in some cases improves the strength characteristics of the processed textile materials.

Table 2 – Indicators of air permeability and rigidity of textile materials

№	Concentration Silicate of sodium, ml/l	Temperature of heat treatment, °C	Heat treatment time, sec.	Air permeability, ($cm^3/cm^2 \cdot c$)	Rigidity of G, cH	Elasticity У, %
1	Rawmaterial		109		0,9	241
2	40	100	120	94	1,3	67
3	60	100	120	95	1,5	23
4	80	100	120	104	2,4	35
5	40	150	120	99	1,7	40
6	60	150	120	102	1,2	54
7	80	150	120	105	2,4	35

According to the results obtained, it is shown that the treatment of cellulose materials by the Sol–gel method developed on the basis of liquid glass does not lead to a violation of air and steam exchange, does not prevent the transport of moisture vapor from the surface of the human skin to the outer surface of the materials, which ensures the maintenance of normal functions of thermoregulation of the human body. The stiffness coefficient depending on the applied sodium silicate concentration increases in comparison with the original tissue. This is due to both the formation of the most durable and dense silica coating on the fiber.

Comparative analysis showed that depending on concentration of silicate of sodium the received color slightly changes. At identical concentration of dye in solution, the general color distinction decreases. Variation of concentration of silicate of sodium of 40-80 g/l, leads to reduction of lightness of the painted samples. The coefficient of resistance to microbiological destruction at the processed textile materials in all cases made higher than 80%.

Conclusion.

1. Researches showed on resistance of coloring to dry friction 4 points, to wet 3 points.

2. By results of researches of physicomechanical indicators it is established that sol-gel a method positively affects mechanical properties of the finished fabric, durability increases in comparison with initial fabric.

3. The rigidity coefficient depending on the applied concentration of silicate of sodium increases up to 2.4 cH in comparison with initial fabric 0.9 cH.

4. Researches showed that depending on concentration of silicate of sodium the received color slightly changes.

5. The coefficient of resistance to microbiological destruction at the processed textile materials in all cases made higher than 80%.

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Резюме

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ИССЛЕДОВАНИЕ ВЛИЯНИЯ ЗОЛЬ-ГЕЛЬ КОМПОЗИЦИИ НА ФИЗИКО-МЕХАНИЧЕСКИЕ СВОЙСТВА ТЕКСТИЛЬНЫХ МАТЕРИАЛОВ

В статье рассматривается возможность совмещения технологии крашения и заключительной отделки хлопчатобумажного текстильного материала с применением золь-гель метода.

Предложен новый метод золь-гель технологии в отделке хлопчатобумажного текстильного материала. Разработанная совмещенная технология крашения и антимикробной отделки хлопчатобумажного текстильного материала с применением золь-гель метода, позволяет получить прочное адгезионное закрепление частиц антимикробного агента и красителя на волокнистом субстрате.

В работе были исследованы свойства целлюлозного текстильного материала, обработанного по предложенной золь-гель технологии с применением физико-механических, физико-химических и биологических методов исследования. Обработанный по предложенной совмещенной технологии текстильный материал сохраняет эксплуатационно-гигиенические показатели, эстетические, устойчивость окраски к трению, также улучшения функциональных и защитных свойств текстильного материала.

Выявлены оптимальные параметры, исследованы влияния температуры обработки, концентрация ацетата цинка и жидкого стекла. Главное достоинство нового золь-гель метода: уменьшение времени обработки и технологического процесса, исключение применения дорогостоящих препаратов и исключение вредных компонентов.

Ключевые слова: золь-гель метод, колорирование, совмещенный метод, заключительная отделка, антимикробность, силикат натрия.

Резюме

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ЗОЛЬ-ГЕЛЬ КОМПОЗИЦИЯСЫНЫҢ ТОҚЫМА МАТЕРИАЛДАРЫНЫҢ ФИЗИКА-МЕХАНИКАЛЫҚ ҚАСИЕТТЕРІНЕ ӘСЕРІН ЗЕРТТЕУ

Мақалада золь-гель әдісті қолдана отырып бояу технологиясы мен мақта-мата тоқыма материалын қорытынды өңдеу мүмкіндігі қарастырылады.

Мақта - мата тоқыма материалын өңдеуде золь-гель технологиясының жаңа әдісі ұсынылды. Золь-гель әдісті қолдана отырып, мақта-мата тоқыма материалын бояудың және микробқа қарсы өңдеудің біріктірілген технологиясы антимикробты агент және бояғыш бөлшектерінің талшықты субстратта берік адгезиялық бекітілуін алуға мүмкіндік береді.

Жұмыста физико-механикалық, физика-химиялық және биологиялық зерттеу әдістерін қолдана отырып, ұсынылған золь-гель технология бойынша өңделген целлюлоза тоқыма материалының қасиеттері зерттелді. Ұсынылған біріктірілген технология бойынша өңделген тоқыма материал пайдалану-гигиеналық көрсеткіштерін, эстетикалық, бояудың үйкеліске тұрақтылығын, сондай-ақ тоқыма материалының функционалдық және қорғау қасиеттерін жақсартодир.

Оңтайлы параметрлер анықталды,өңдеу температурасының әсері, мырыш ацетаты мен сұйық шынының концентрациясы зерттелді. Жаңа золь-гель әдістің басты артықшылығы: өңдеу уақытын және технологиясын оңтайландыру қымбат дәрі-дәрмектерді қолданбау және зиянды компоненттерден арылу .

Түйінді сөздер: золь-гель әдісі, бояу, бірлескен әдіс, қорытынды өңдеу, антимикробтық, натрий силикаты.