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Intensification of the Process of Dyeing Mixed Fabrics with Cubic Dyes

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ABSTRACT: The article presents an analysis of the results of experiments on the development of technology for dyeing samples of mixed fabrics based on cotton: polyester in a ratio of 75/25, 57/43, 44/56 cubic dyes in a continuous way.

KEY WORDS*:* mixed fabric, cubic dye, color intensity, soap resistance, abrasion resistance.

I. INTRODUCTION

The technology of one-time continuous dyeing of materials with a mixture of polyester and cellulose fibers was developed by the German company Monforts. Dyeing a mixed fibrous material in one dye solution with active and dispersed dyes using the Econtrol TCA technology [1], flower printing processes [2] consist of several stages, namely thermosetting curing, washing and drying.

A mixture of polyester and cellulose fibers dyed with a polyester cationic dye was investigated to create a stable color in the fabric, stabilizing the dye composition of color dispersants [3]. A blend of polyester microfiber and elastane is widely used in sportswear. Studying the influence of various technological parameters on the quality of paint, scientists have shown the possibility of optimizing the process of painting such a mixture [4]. Research has also been carried out to make it possible to dye both fiber components with dyes belonging to the same class. Studies have shown that the use of pigments, which are not at all prone to the formation of fibrous materials, in the process of dyeing a mixed fibrous material, allows you to achieve the same color in polyester and cotton fibers[5].

One of the most important factors in dyeing polyester cellulose fabrics is the nature, properties and type of binders that ensure the binding of the dye in the dye solution to the fiber. Today, in many countries of the world, many compositions based on thermosetting acrylic resins are patented, which are used for dyeing fabrics made of mixed fibers of polyester and cellulose [6-7]. In a short time, the technology of continuous dyeing of fabrics with a large volume of cotton and polyester fibers in one color is promising from the point of view of the possibility of re-use [8].

Cubic leukocytic acid dye has a lower affinity for cellulose than its sodium leuco compound. On the other hand, the cubic dye is not prone to fiber formation. Since cubic dyes are not prone to fiber formation, they can be used to dye both natural and synthetic fibers, such as pigments [9]. Cubic dyes are dyes that are temporarily water-soluble during the dyeing step and, unlike all water-soluble dyes such as reactive dyes, produce a water-resistant and luminous color. This is due to the fact that at the end of dyeing or flower printing, a water-insoluble pigment is formed inside the pores of the fiber, and a very bright color is formed, since it does not dissolve in water processes, even if it is bound to the fiber through weak intermolecular bonds. Cubic dyes are resistant to various physical and chemical influences, give many bright colors, and therefore are widely used in the textile industry. But there are no bright red shades between the colors. These dyes are mainly used in dyeing and floral printing of cellulose fibers, printing flowers on natural silk fabrics, dyeing acetate and synthetic materials.

Cubic dyes contain at least two carbonyl groups = C = O. These groups give the dye the ability to color the fibers. In general, cubic dyes can be expressed in the case of Rb = (C = O) . Before dyeing cellulose with cubic dyes, it becomes water-soluble, and after the dyeing process is completed, it again becomes insoluble in water.

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The leuco-compound of cubic dyes is unstable, easily oxidized by atmospheric oxygen or an oxidizing agent, and returns to its previous state [10]. The resulting dibasic leuco acid is insoluble in water due to its very weak acidic properties and requires a highly alkaline medium (pH = 9-11) to dissolve it. This situation limits the use of cubic dyes for alkali resistant fibers.

II. OBJECT AND METHOD OF RESEARCH

The object of research is samples of fabrics containing cotton and polyester in various proportions, which consist of cotton (Namangan-77) and polyester (polyethylene terephthalate grains produced in South Korea, formed at the «Reprocessing Uz» Joint Venture). Textiles made from a mixture of cotton and polyester fibers are dyed with a cubic dye in a high-frequency field. Quality indicators of painted materials: color intensity, color plane [11] according to the method, color fastness to washing is determined according to GOST 9733.4-83, color fastness to abrasion is determined according to GOST 9733.27-83.

III. THE RESULTS OBTAINED AND THEIR ANALYSIS

Physicochemical properties of the fibrous base in the process of chemical finishing of textile materials. Physical and mechanical properties are important. Polyester fiber, which is part of the samples of mixed fibers used for research, is produced in the Republic and scientifically substantiated by its physical and mechanical properties, supramolecular structure and morphology, similar to lavsan fiber and significantly differs in sorption properties [12]. It is known that the process of dyeing textile materials and preparing them for decoration is carried out before applying flowers to them.

The process of preparing a fabric for decoration, which contains two different natural fibers, requires the correct selection of factors. Preparation of textile materials for dyeing and floral printing consists in cleaning them from waste, as well as in giving them a stable level of whiteness. Studies have shown that blended fiber tissue samples should be treated with intermittent [13] and efficient high frequency methods, combining boiling and bleaching [14].

In our study, the possibility of dyeing samples of fabrics containing different proportions of cotton and polyester fibers (75/25, 57/43 and 44/56) with cubic dyes was studied in various ways. First, samples of all three proportions were stained using the technology [15]. Their quality indicators are shown in Table 1.

Table 1.
Dependence of color indicators of fabric from blended fibers on the ratio of fibers

Sample ratio, cotton/PE	Color intensity, K/S	Resistance to soap, scores	Persistence dry abrasion, scores	Resistance to wet friction, scores
75/25	2,9	4,5 / 3,5 / 4	4 / 4,5	2/2
57/43	2,96	5/4/5	4,5 / 4	4,5 / 4
44/56	3,18	5/5 / 4,5	4 / 4,5	2,5 / 2

The results showed that the color intensity was higher when the cotton fiber content of the sample was low. Thus, although leukocyte cubic dyes show a tendency towards cellulose fibers, but because it does not have a tendency towards fibers in a leukocyte state, we can see that the color intensity of this mixture is high due to the encapsulation of dye molecules in the synthetic fiber - polyester fiber. The sample with the highest color intensity produced during the dyeing process with cubic dyes, i.e. cotton/PE - 57/43, was selected for further research. In subsequent works, this sample was colored by performing a heat treatment process on a high frequency irradiation device.

To speed up the process, drying and two-stage heat treatment of a sample impregnated with a cubic dye with a leuco compound are replaced by a high-frequency method. The staining processes were carried out under conditions of high-frequency radiation with intensities of 70, 350 and 500, and the influence of the electromagnetic field strength on the color intensity of the samples and their resistance to various processes was studied. The results are shown in Table 2.

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Table 2.
Influence of high-frequency radiation power on color rendering quality

High-frequency radiation power, W.	Color intensity, K / s	Resistance to soap, scores	Dry abrasion resistance, scores	Resistance to wet friction, scores
70	1,5	5/4,5/5	4,5/4	2/3,5
350	1,6	5/4,5/5	4/4	3/3
500	2,06	5/5/5	4,5/3,5	3/2,5

From the results shown in the table, the color intensity obtained during the dyeing process under the influence of high-frequency radiation with a power of 500 has a higher value than that of the rest of the samples, but the color intensities of all three samples are not at the required level. This may be due to dye sublimation, when samples soaked in the dye solution heat up quickly, the color intensity may be low or oxidation of the dye may accelerate, the dye may become pigmented and its diffusion into the fiber may stop. Taking into account the above considerations, subsequent studies showed that the samples impregnated with a dye solution were first slowly dried in the open air, and then the heat treatment process was carried out under high frequency conditions. The results of the experiments are presented in Table 3 and Picture 1.

Table 3.
Color performance of mixed fiber samples

No.	High-frequency radiation power, W.	Resistance to soap, scores	Dry abrasion resistance, scores	Wet abrasion resistance, scores
1	70	4/3,5/4	4,5/3	1,5/2
2	350	4/3,5/4	4/3	1/2,5
3	500	5/3,5/3,5	4/3,5	1,5/2,5
4	700	5/4,5/5	3,5/4,5	4/3,5

The data in the table show that the color fastness was higher when the painting process was carried out with high-frequency radiation with a power of 700 W. Than the results obtained at a power of 70, 350, 500 W.

However, when the RF power is too high, the color intensity (Pic. 1) decreases sharply, which means that the dye is absorbed on the surface of the fiber and the sample dries quickly before it can penetrate through it. Under such conditions, the color intensity of the sample had a low value, since the liquid phase was insufficient for the movement of the dye molecule.

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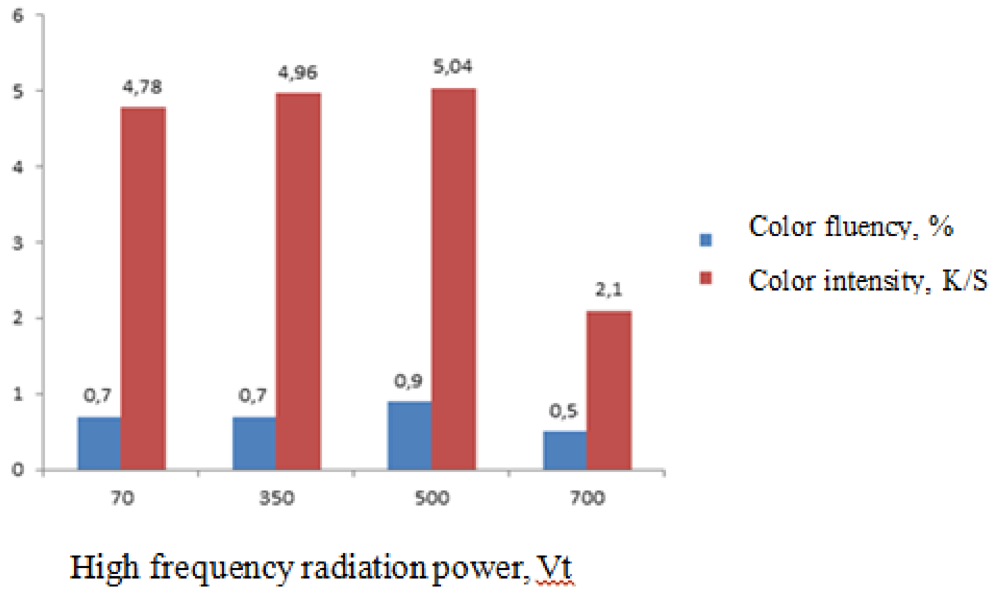


Picture 1. Influence of RF power on color smoothness and intensity.

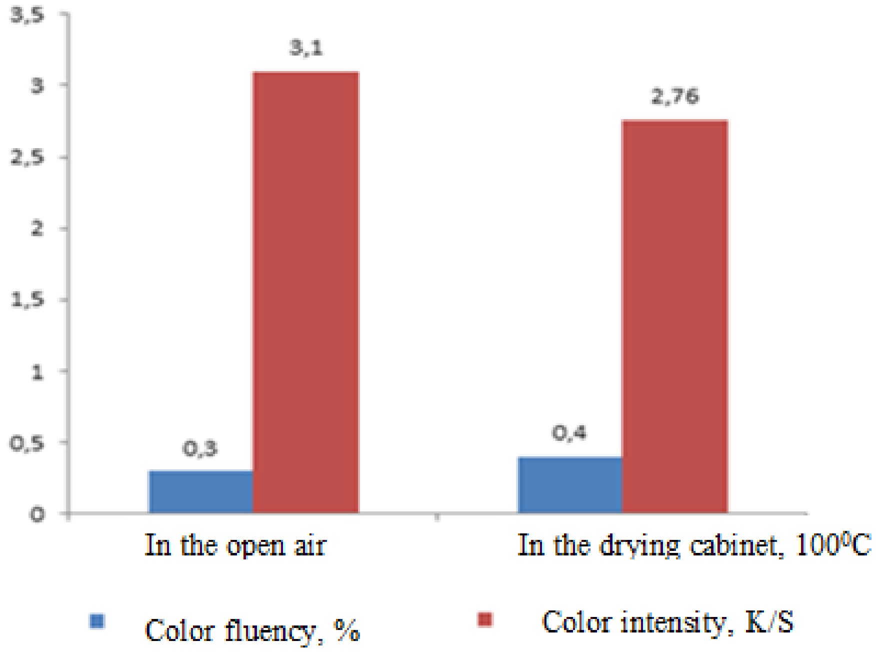
The smoothness of the color obtained as a result of the above studies, that is, the color plane, did not give a positive result due to the fact that when the dyeing process is accelerated, the dye molecule is absorbed from the solution onto the surface of the tissue, disturbing the diffusion balance in the fiber. Due to the difficulty of controlling the monomolecular, dimolecular, polymolecular balance of the dye in the dye solution during the rapid process, it was not proposed to dye samples of fabrics from mixed fibers containing cotton and polyester fibers with cubic dyes under the influence of high frequency, radiation.

In subsequent studies, in order to increase smoothness of the color, the samples were soaked in the dye solution is dried in the open air and in oven at a temperature of 100 degrees C. The stained samples Quality Indicators of this technology are given in Table 4 and Picture 2.

Table 4.
Dependence of color indicators of samples of mixed fibers on drying conditions

No.	Drying process type	Resistance to soap, scores	Dry abrasion resistance, scores	Wet abrasion resistance, points
1	On open air	5/4,5/4,5	4/4,5	4/4
2	Drying cabinet 100 deg.C	5/5/5	5/4	2/3,5

From the data in the table, it can be seen that a sample impregnated with a cubic dye can be obtained by classical processing and drying in the open air to obtain persistent colors with soap processing, the effect of dry and wet rubbing on fabrics of mixed fibers. Shows the color intensity of colored samples and their resistance to various types of processing.



Picture 2. Dependence of color rendering on drying conditions.

Smoothness of color was achieved due to the slow reaction of the dye and the fiber macromolecule at room temperature. The reason for the high color intensity can be associated with the optimal selection of conditions for the complete transfer of the dye molecule from the solution to the fiber.

Based on the research results, the following technology for dyeing cubic fiber fabrics from blended fibers containing 44% cotton and 56% polyester fiber is proposed:

1. Soaking: cubic dye - 8g/l; noionogen CAM-2 g/l; thickener- 1,5 g/l; temperature – 25 deg. C, duration - 2 minutes.
2. Compression - up to 60%.
3. Air drying.
4. Heat treatment: temperature – 140 deg. C, duration - 5 minutes.
5. Heat treatment: temperature – 210 deg. C, duration - 90 sec.
6. Absorption: return - 8 g/l; alkaline agent - 2 g/l; electrolyte - 20 g/l; temperature - 20-25 C, duration - 1 min.
7. Compression - up to 60%.
8. Evaporation: temperature – 103 deg. C, duration - 1 min.
9. Washing: temperature – 25 deg. C, duration - 1 min.
10. Washing: temperature – 60 deg. C, duration - 1 min.
11. Washing: CAM - 2 g/l; temperature – 100 deg. C, duration - 1 min.
12. Washing: temperature – 70 deg. C, duration - 1 min.
13. Washing: temperature – 25 deg. C, duration - 1 min.

IV. CONCLUSION

Deeper penetration of the dye into the inner part of the fiber ensured the resistance of the resulting dyes to abrasion. The high stability of dyes during soap procedures is due to the fact that the dye is temporarily dissolved in water. It is known from the literature that dyes made from 100% cotton fiber and formed in the process of dyeing with cubic dyes by the classical method demonstrate a high degree of resistance to soap processing.

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