THICKENING THE POLYMER COMPOSITIONS FOR FILLING COTTON FABRIC

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***Abstract:** This article discusses the development of new and improved traditional methods for obtaining thickening components for packing. It was found that the introduction of polymers such as Na – CMC and sericin into the thickener of printing inks-modified starch leads to the formation of a film with increased elasticity and fluidity. It was determined that the results obtained by the recommended composition are almost close to alginate thickeners in terms of the stability of colours to wet treatments, their intensity, strength to friction and stiffness of the printed fabric, but in almost all indicators they are superior to thickeners based on modified starch. The expediency of using printing inks based on such thickeners is due to the exclusion of interaction of chromophore anions of the dye with functional groups of polymers, the presence of an alkaline agent in the composition that serves as a thickening activator and creates a medium for the formation of a covalent bond between the dye and the fibre. It was found that printed cotton fabric with active dyes based on starch thickener does not sufficiently provide resistance to dry friction (2 points) and gives the printed fabric increased stiffness (6.7 times). To eliminate these shortcomings, in addition to modified starch and CMC, a sericin solution was introduced into the composition of the recommended printing composition, while the hardness index (2.7-6.7 times) is almost reduced to the level of the alginate thickener (1.8 times), (changes in the range of 0.2-1.1). If the quantitative ratio of the components that make up the composition is observed, the fabric stiffness is reduced, bright and durable colours are obtained, and the degree of fixation of active dyes is up to 95-96%. It was determined that the value of the amount of desorbed active dye in the process of intensive washing of printed fabric mainly depends on the number of components of Na-CMC and sericin that are part of the composition. Due to the use of the developed composition as a thickener of printing inks, it is possible to reduce the consumption and cost of chemical materials and increase environmental safety when working with textile and finishing enterprises.*

***KEYWORD:** Thickener, fixation, active dye, sericin, starch, degree of fixation, colour stability, intensity, degree of penetration.*

INTRODUCTION

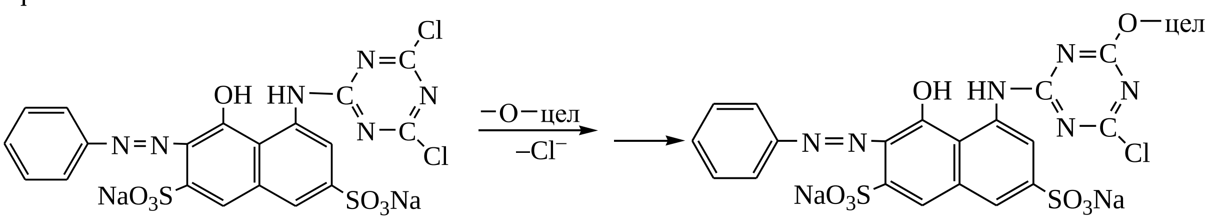
At the present stage of development of the textile industry, in the production of printed fabrics, pigments and reactive dyes are mainly used. The share of these dyes in comparison with other classes of dyes reaches up to 80%. Despite this, printing with the above dyes, having advantages and difficulties from a technological point of view, remains an urgent problem. The rationale for choosing a thickener largely depends on their rheological and print properties, as well as the colour quality of the printed fabric. It should be noted that in textile enterprises starch and its derivatives are mainly used as cheap thickeners for printing with cold dyes [1-3].

However, the use of starch as a thickener has several disadvantages, namely, it enters into chemical interaction with active dyes, and this, in turn, leads to a significant overuse of starch and dye, and is also poorly washed off from the surface of the fabric [4-6].

In this regard, the development of technology for obtaining thickening polymer compositions based on modified starch, sericin and highly swellable carboxymethyl cellulose and printing of cotton fabric with active dyes should be considered relevant and more promising. Sericin, which is one of the main components of thickening systems, by its properties meets the requirements for thickening components. This natural glue forms strong, smooth films, is highly soluble in water, non-toxic and environmentally friendly.

Due to the presence of free carboxyl and amino groups in the composition of sericin, an intermolecular interaction is possible between sericin and cellulose, which may be sufficient for binding of sericin to cellulose fibre, especially since there are fibrillar regions in the sericin macromolecule. It is known that the secondary structure of sericin has a folded β-form and, due to its chemical composition, bulky side chains [7-9].

During printing, the loose structure of the sericin film on the fibre does not hinder the diffusion and adsorption of the dye to the fibre, and the free functional groups of the side chains in the sericin can form chemical bonds with the fibre, thereby providing colour fastness. The strength and colour stability will also be influenced by the fact that due to the high polarity of the sericin molecule, the forces of intermolecular interaction between the fibre and the dye are enhanced [10-13]. The covalent bond formation that is assumed between cellulose fibre and active bright red 8X can be represented by the equation:



MATERIALS AND METHODS

Experimental part

Reagents and materials. We used modified starch, the sodium salt of carboxymethylcellulose and sericin, the physicochemical properties of which are described in [22-23].

Devices. Colour fastness was determined:

a) for washing (GOST 9733.4-83). The prepared composite samples were placed in containers, poured with washing solution heated to a temperature of 40 ± 2 ºC, and kept at this temperature for 30 minutes. The composition of the washing solution (g/l):

- soap - 5;
- sodium carbonate - 3.

At the end of washing, the samples were taken out, rinsed twice in cold distilled water, then washed with cold running water for 10 minutes. After that, they were squeezed out, embroidered, leaving a seam on one short side, and dried in the air in a suspended state at a temperature not exceeding 60 °C so that parts of the composite working sample did not touch and were protected from direct sunlight. Colour fastness was assessed by the change in the original colour and tissue staining.

b) to dry and wet friction (GOST 9733.27-83).

The test is based on painting a dry or wet cloth while rubbing against a dry test specimen on a device that moves cotton cloth over the surface of the test specimen at a distance of 100 mm with a load of 9 N and a rubbing rod diameter of 16 mm. From each test tissue, 2 samples of 140x50 mm were cut out: one in the longitudinal direction, the other in the transverse direction.

With dry friction, the sample was placed on the base of the instrument and fixed. The rubbing rod was covered with a 5x5 cm cotton cloth, making sure that the rubbing surface was smooth without folds. The rubbing rod was placed on the test cloth and the instrument was turned on for 10 strokes back and forth for 10 seconds. Evaluated the staining of cotton fabric [14-16].

Experimental conditions. The printing and technical properties of printed cotton fabrics when using the recommended polymer composition are the main ones and therefore the effectiveness of the introduction of the created technology into production depends on them.

As a result of the laboratory and pilot-industrial experiment, comparative data were obtained that characterize the print quality of cotton fabrics using the recommended and factory thickener (Table 1).

It was determined that in terms of resistance to wet treatments, their intensity, strength to friction and stiffness of the printed fabric, the results obtained with the recommended composition are practically close to alginate thickening, but in almost all parameters they are superior to thickeners based on modified starch.

Metrological processing. The calculation of the metrological characteristics of the presented methods was carried out in accordance with [24].

RESULTS AND DISCUSSION

The use of modified starch as a thickening agent for printing inks, which forms a strong film on the surface of the fabric, leads to an increase in its rigidity, which is not typical for printing with reactive dyes. In this regard, it is proposed to use a thickening polymer composition, which forms films with increased elasticity.

Table 1. Performance characteristics of fabrics printed with active dyes

Quality indicators	Thickener composition			
	Factory		Recommended composition	
	alginate-based	modified starch-based	based on modified starch and CMC	based on modified starch, CMC and sericin
Colour fastness to dry friction, score	5	2	3	4
Colour fastness to wet friction, score	4	3	4	4
Colour fastness to washing, score	5/5	4/3	5/4	5/5
Color intensity F (R)	18,6	13,8	17,4	18,5
Increase in stiffness, times	1,6	6,7	2,7	1,8

Also, analysis of the data in Table 1 shows that cotton fabric printed with reactive dyes based on starch thickening does not provide sufficient resistance to dry friction (2 points) and gives the printed fabric increased rigidity (6.7 times) [17-20]. In order to solve this problem, in addition to modified starch and CMC, a sericin solution was introduced into the composition of the recommended printed composition, while the hardness index (2.7-6.7 times) practically decreases to the level of alginate thickening (1.8 times), (changes in the interval 0.2-1.1) [21-25].

Analysis of the results obtained (Table 2) shows the importance of observing the quantitative ratio in the system of starch within 5.0-5.5%, Na-CMC - 0.2-0.3% and sericin - 0.15-0.2 %. At the same time, a decrease in the stiffness of the fabric, obtaining bright and durable colours, the absence of pronounced spreading of paint outside the contour of the pattern with a full degree of printing of the fabric is achieved. The fixation rate of reactive dyes (after washing the printed samples) is high (95-96%).

Table 2. Colouristic characteristics of cotton fabric printed with active dyes thickened with compositions

Indicators print quality	Factory-made thickener based on alginate, 4.5%	A thickener based on modified starch, Na-CMC and sericin at a concentration of 5.0; 0.3 and 0.2%, respectively
Colour fastness to dry friction, score	5	5
Colour fastness to wet friction, score	5	4
Colour fastness to washing, score	5/5	5/4
Color intensity,%	10,6	11,9
Fabric stiffness, μN cm2	1300	1430
Fixation degree, active dye,%	96,5	95,2
Multi-shade,%	–	95,2
Penetration rate,%	94,3	92,5

Analysis of samples of printed fabrics with the recommended compositions showed the presence of effects of increasing their mechanical strength (Fig. 1.).
In general, the use of the proposed polymer thickening compositions makes it possible to improve and expand the properties of the printed fabric and the consumer qualities of textiles, which is the main parameter for manufactured products.

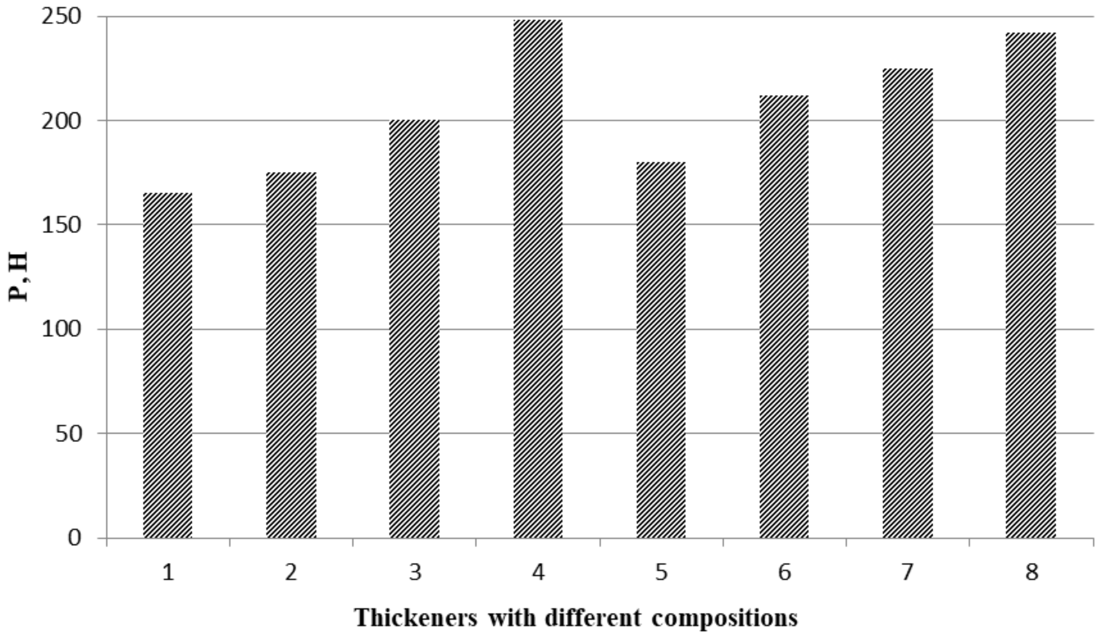


Figure 1. Mechanical strength of printed cotton fabric with different thickener compositions:

1. Unprinted cotton fabric;
2. Solvitosis - 6.0%
3. Imprint - 5.5%
4. Sodium alginate - 4.0%
5. Modified starch - 7.0%
6. Modified starch - 5.0 and sericin -0.2%
7. Modified starch - 5.0 and CMC -0.3%
8. Modified starch - 5.0; CMC -0.3 and sericin - 0.2%

CONCLUSION

As a result of the research, technologies have been developed for printing cotton textile materials with active dyes using new types of effective thickening systems based on modified starch, CMC and sericin. When printing cotton fabric, the developed thickening compositions can improve the quality of patterned colours, reduce the consumption and cost of chemical materials, and increase environmental safety during the work of finishing enterprises. The optimal composition of composite thickeners based on natural (modified starch) and synthetic (CMC and sericin) polymers for printing cotton fabrics with active dyes has been determined. The possibility of obtaining, when using them, clear contours of drawings with high indicators of intensity and strength of colours.

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