Improving the Efficiency of Acid-proof Finishing Cotton Fabrics by Using Cationic Polymers

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Abstract – The analysis of the possibility of using cationic preparation in the process of final finishing was made. Selection of technological mode of giving a cotton textile material acid-proof properties with the use of cationic polymers and potassium methylsiliconate were considered. It is shown that pre-treatment of textile material with a solution of a cationic preparation can significantly improve the durability of the protective effect for physico-chemical influence.

Key words – acid-proof finishing, organosilicon compounds, cationic polymers, acid-resistance, cellulose containing material.

I. Introduction

Prospects of development of the textile industry require innovative development, aimed at improving the competitiveness of the textile materials. They must have specific properties that are required in a particular area of human activity.

At the current level of technology development work clothes as a means of personal protection plays an important role in the complex of measures to ensure the safety of workers at work.

As is well known, fabrics for clothing must protect workers of chemical companies from exposure to various harmful substances, such as acids, alkalis and solvents, as well as from water. Fabric produced from a mixture of natural and synthetic fibers is widely used for acid-proof clothing. Sorbing onto fabrics from fibers of natural origin, spray acids react with the fiber and destroy it. This does not occur with synthetic fibers. However, the fabric of synthetic fibers easily permeable. Inasmuch as the work clothes should not only have special properties and safety, but also comfort (high absorbability, good air permeability, environmental), and despite the dynamic growth of the production of synthetic fibrous polymer, cellulose still accounts for 40-50% of the total use of textile fibers [1]. Increased interest in the cotton textile materials due to good hygienic and consumer properties of finished products based on them [2].

Cellulose has insufficient resistance to acids: usual cotton fabric loses strength after reacting for a few minutes with concentrated mineral acids. Falling on the surface of textile fibers, acid absorbed and wets material. To prevent wetting of the textile material is necessary to minimize the adsorption of aqueous solutions of aggressive reagents using hydrophobisation fiber.

An important role in this regard belongs to the organosilicon compounds, which are used widely in industry [3]. They provide the formation of a thin invisible water repellent film not violating the air permeability of textile material when applying them to the fabric. Apart from to imparting water repellency, silicone compounds significantly improve the appearance of the material, increase shine, strength and weather resistance. [4].

The main problem associated with the use of water-soluble silicone compounds for acid-proof finish, is the low stability of the protective effect to a soap-soda processing. Fastness of finishing to washing depends mainly on the fixation mechanism of preparation on the fiber and bond order of the molecules in the polymer film formed on the fiber during thermal treatment. When processing in water solution washing agent finishing fabric wetted with subsequent swelling of the fibers, resulting in fiber volume increases and silicone shell surrounding the fiber breaks, which reduces its protective action [5].

A wide range of textile-processing chemicals of different chemical nature and properties offered as an intensifying agents finishing production processes of foreign and domestic industry. Of particular interest are the cationic polymers (CP) on the basis of which are creating multifunctional fixing preparations.

The possibility of using cationic polymers has not previously been studied in technology the acid-proof finishing of cotton fabrics.

II. Experimental

The studies were conducted on cotton uniformly dyed fabrics art. 5014 (produced by "Silk Factory of Cherkassy", Ukraine) and art. 0-104, art. 0-166 (produced by "Donbas", Ukraine).

Quality acid-proof finishing was determined by means acid-resisting value (within 6 hours when exposed to 50% sulfuric acid) and its resistance to soap-soda processing and alkaline hydrolysis.

To increase the stability of the bond of the acid-proof film with textile material in the work propose using cationic polymers produced in Russia CP.1, CP.2, CP.3 and CP.4, which differ in charge density and chemical structure:

-CP.1 – quaternary polyamine – polymer based on epichlorohydrin and dimethylamine; the charge density 4,8 mg•eq/g, pH = 7;
-CP.2 – high molecular weight strongly basic cationic polymer, synthesized by radical polymerization of a monomer dimethylidiallylammonium chloride; the charge density 7,2 mg•eq/g, pH = 8;
-CP.3 – the polycondensation product of epichlorhydrin and an aliphatic diamine; the charge density 9,5 mg•eq/g, pH = 8;
-CP.4 – the composition based on polyacrylamide and polydimethylidiallylammonium chloride; the charge density 4,2 mg•eq/g, pH = 7.

III. Results and Discussion

In the work finishing was carried out on several schemes to determine the optimum conditions processing cotton fabric water-soluble cationic polymers and silicone fluid HSF-11K. In consequence of carried out researches established that the optimal technical regime of finish is:
TABLE 1

<table>
<thead>
<tr>
<th>№ CP (concentration)</th>
<th>Value</th>
<th>art. 5014</th>
<th>art. 0-104</th>
<th>art. 0-166</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (20 g/l)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of cycles soap-soda processing</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Alkaline hydrolysis, h</td>
<td>16</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>2 (7 g/l)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of cycles soap-soda processing</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Alkaline hydrolysis, h</td>
<td>10</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>3 (4 g/l)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of cycles soap-soda processing</td>
<td>5</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Alkaline hydrolysis, h</td>
<td>17</td>
<td>17</td>
<td>14</td>
</tr>
<tr>
<td>4 (20 g/l)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of cycles soap-soda processing</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Alkaline hydrolysis, h</td>
<td>10</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

According to the data presented in Table 1, pretreatment of the textile material with solutions of cationic polymer has a positive effect on the quality of the protective finishes. The most effective cationic polymers that improve the steadfastness of the acid-proof effect to soap-soda processing (2 to 5 cycles) are preparations CP.1 and CP.3 concentration of 20 and 4 g/l respectively.

In order to improve the economic efficiency of the process of giving to the textile material acid-proof properties based on the use of preparations CP.1 and CP.3 in the work investigated the possibility of reducing the concentration of potassium methylsiliconate to 50 and 75 g/l. It is established that decrease in the concentration of repellent leads to a significant reduction in steadfastness of acid-proof effect to the physical-chemical influence.

Also in the work was tested the influence of the concentration of cationic preparations on the steadfastness of the acid-proof effect to the soap-soda processing and alkaline hydrolysis. Based on the data obtained during the study, can conclude that the optimum concentration is 20 and 4 g/l for CP.1 and CP.3 respectively, and their decline affects negatively the quality of protective finish the textile material.

Thus, the use of cationic preparations in the finishing processes, particularly in giving acid-proof properties is of interest as it allows to increase the resistance of the acid-proof effect to soap-soda processing cycles 1-2 to 5 and 1-2 hours of the alkaline hydrolysis to 12-17 hours.

Conclusions

Based on the studies proved prospects use of cationic polymers to enhance the stability acid-proof effect to the soap-soda processing and alkaline hydrolysis. Decision of technological regime acid-proof finishing with using CP for cotton textile materials was implemented, the optimal concentrations of the water-soluble silicone preparation HSF-11K and cationic polymers CP.1 and CP.3 were defined. Found that the protective effect obtained by using a cationic polymer CAP.3 concentration of 4 g/l resistant to 5 cycles of soap-soda processing at t = 60 °C and 17 hours of alkaline hydrolysis (without pretreatment cationic preparation – 1 cycle soap-soda processing and 2 hours of alkali hydrolysis).

References