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DEVELOPMENT OF A TECHNOLOGY FOR OBTAINING FLAME-RETARDANT CELLULOSE-BASED FABRICS BASED ON PHYSICAL MODIFICATION WITH SILICON DIOXIDE NANOSUSPENSION

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Abstract
The article presents the results of research on the development of a technology for increasing the flame resistance of cellulose-based fabrics by treating them with modified aerosil-380 nanoparticles. Based on the results of the conducted research, a full-cycle technology was developed.

Introduction

Based on the results of the experiments conducted in the initial stages of the research [1-7], the main stages of the processes of processing (physical modification) samples of cellulose-containing fabrics were developed (Fig. 1).

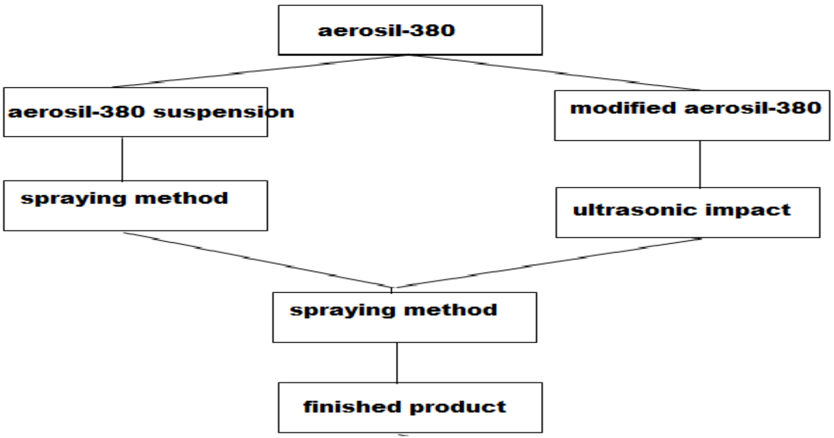

Figure 1. The main stages of the process of treating fabrics with nanosuspensions based on Aerosil-380.

As shown in the scheme, the fabrics were treated using 2 methods (spraying and ultrasonic exposure). The goal was to develop the most effective method by checking the degree of effectiveness of the fire-technical and other basic properties of the fabrics modified by each treatment method. In the next stage of research, experiments were carried out to study the basic properties of the fabrics obtained by treating them using these 2 methods.

Based on the results of theoretical and practical experimental tests carried out at this stage of the research work, technological stages for obtaining flame-retardant fabrics made of cellulose fibers were developed. This was based on the initial laboratory preparation of highly dispersed particles of silicon dioxide (Aerosil-380), studies of silicon dioxide nanoparticles (Aerosil-380), their suspensions in an aqueous solvent, and their stability and rheology. At the next stage of the research, experiments were carried out on the modification of Aerosil-380 nanoparticles with chemical reagents containing phosphorus and chalk. As a result, modified types of Aerosil-380 nanoparticles and their suspensions were obtained.

In the next stage of experiments, samples of fabrics prepared for testing with suspensions of modified Aerosil-380 nanoparticles of a new composition were treated under ultrasonic conditions.

During the experiments in laboratory conditions, fabric treatment was carried out in 2 ways (sprinkling method and ultrasonic effect), but at the final stage, the ultrasonic effect method was chosen as the main method for fabric treatment. Based on the results of these experiments, all technological stages of fabric processing were developed (Fig. 2)

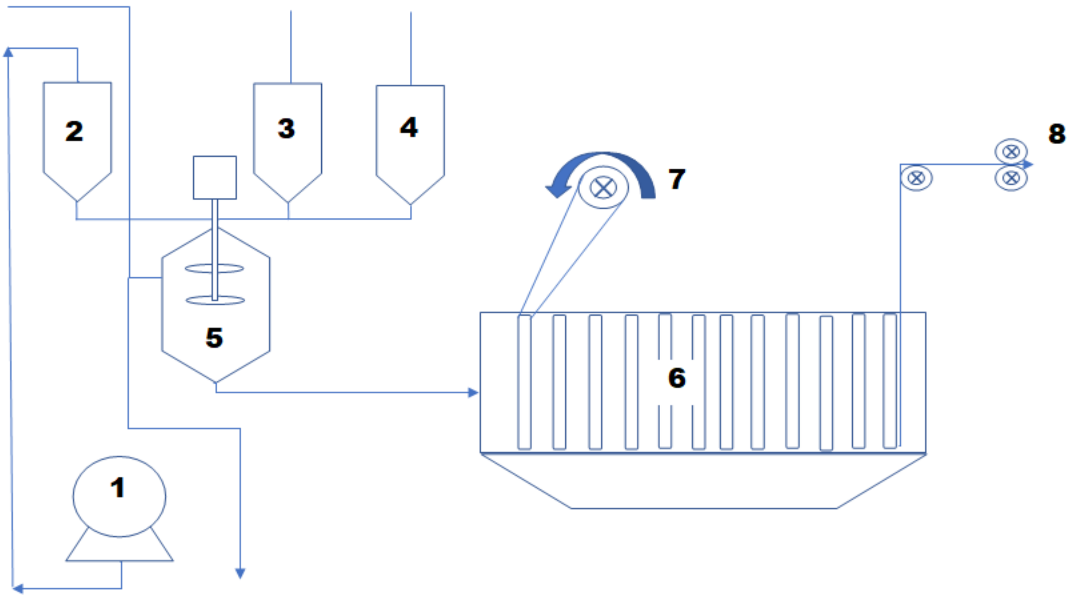

Figure 2. Technological scheme for modifying fabrics with nanoparticle suspensions

The stages of the technology for modifying fabrics with nanoparticle suspensions, shown in the technological scheme (Figure 2), are as follows. In this case, pump 1 is used to deliver the water required for preparing aqueous suspensions of nanoparticles to the top, that is, to a container with a measuring scale marked with number 2. So, in this technological scheme, number 2 is used to separate the volume of water required for preparing nanoparticle suspensions and pour

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it into the reactor (reactor 5). The volumetric container, shown in the scheme with number 3, has a measuring scale and is used to separate the required amount of Aerosil-380 nanoparticles and deliver them to the reaction medium, that is, the reactor (reactor 5). The vessel shown in the figure with the number 4 is used to deliver the required amount of chemical reagents containing phosphorus and boron to the reaction medium (reactor 5) used in the modification of Aerosil-380 nanoparticles. The heated reactor shown in the technological scheme with the number 5 is used for 2 processes. The first is used to prepare suspensions of Aerosil-380 nanoparticles and the second is used to modify Aerosil-380 nanoparticles. The device shown in the technological scheme with the number 6 is an ultrasonic bath used for fabric modification. Part of the technological scheme with the number 7 is a rotating fabric roll and a mechanism for holding it, as well as a mechanism for pulling and collecting the fabric roll processed in the ultrasonic bath (number 6) in the figure with the number 8. The function of this mechanism (figure 8) is to forcefully pull the fabric roll, which has been treated under ultrasonic conditions, through two rollers under high pressure and temperature, thereby achieving drying. As a result of the technological stages carried out in this sequence, modified flame-retardant fabrics are obtained.

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