

UDC
677.027.625

YULIYA SARIBYEKOVA, IRINA KULISH,
IHOR HOROKHOV, TATYANA ASAULYUK
Kherson National Technical University, Ukraine

INNOVATIVE METHOD FOR INCREASING FLAME RETARDANT PROPERTIES AND ANTIMICROBIAL ACTIVITY OF TEXTILE MATERIALS

The aim. Development a composition for multifunctional finishing of cotton-polyester textile materials by using a bio-based phosphorus-containing compound that can provide the flame-retardant function of the fabric through phosphorus-nitrogen synergy, while simultaneously boosting its antimicrobial properties.

Keywords: phytic acid, polyhexamethylene guanidine phosphate, fire-retardant finishing compositions, antimicrobial properties, cotton-polyester fabrics.

Problem statement. The living conditions of modern society are setting increasingly new demands for clothing. It must not only be comfortable and aesthetically pleasing, but also, in light of the current complex epidemiological situation, including the COVID-19 pandemic, offer protection against harmful viruses and microorganisms. This is especially relevant for medical textiles, but the importance of functionalizing home textiles, as well as fabrics used in transport, military applications, and other sectors, is growing. An essential challenge of our time is the search for sterilizing agents that are both effective against common pathogenic microorganisms and non-toxic, driving the development of innovative technologies to endow textile materials with antimicrobial properties. The incorporation of biomacromolecules into modern technologies as functional substances, which can serve both as fire retardants and antimicrobial agents, represents a promising, innovative, environmentally friendly, and non-toxic alternative to conventional chemical methods for creating "green" technologies.

Methods. Phytic acid (PhA) and polyhexamethylene guanidine phosphate (PHMG-p) were explored as functional substances capable of imparting both antimicrobial and flame retardant properties to fabrics through finishing processes. The finishing was applied to blended cotton-polyester fabrics (47% polyester, 53% cotton). The thermal behaviour of the treated textile was analysed using thermogravimetric and differential thermal analysis, performed on a Thermoscan-2 derivatograph. The

antimicrobial properties of textile materials were assessed by analysing the diffusion of a fabric disk.

Results. Phosphorus-containing compounds, including the PhA biomacromolecule, undergo thermal decomposition to produce $\text{PO}\cdot$ radicals, which can inhibit combustion by interrupting the flame propagation process. When the matrix burns, it generates $\text{H}\cdot$ and $\text{HO}\cdot$ radicals, which are quenched by the phosphorus species. Additionally, phosphorus-containing compounds can catalyze dehydration and carbonization reactions in materials that contain $-\text{OH}$ groups, promoting the formation of a char layer that acts as a protective barrier and further suppresses combustion.

The heat resistance results of the textile materials showed that the temperature of the end of destruction of the textile material treated with PhA $T_f = 546^\circ\text{C}$ shifts relative to the untreated sample, the end temperature of which is 507°C and moves to a higher temperature region. This confirms the improvement in the fire resistance of the fabric compared to the untreated textile. At temperatures above 500°C , the process of thermal oxidation occurs, that is the formation of a carbonized residue, the value of which on the fabric depends mainly on the organic and inorganic substances deposited on the surface. The condensed phase mechanism based on the use of PhA is further enhanced by the inclusion of PHMG-p containing nitrogen. It was found that the mass fraction of residues of the treated samples is 4.82% and 5.07% in the case of the addition of PHMG-p. The coke residue of the initial cotton-polyester fabric at a temperature of 700°C was 1.7%.

An increase in the antimicrobial activity of the fabric is confirmed by a zone of inhibition of 2 – 4 mm around the sample according to the diffusion method using gram-positive bacteria *Staphylococcus pyogenes*, and is also characterized by a pronounced retardation of the growth of microorganisms around fabric samples studied by the method of inoculation microflora from the environment.

Conclusion. The composition containing phytic acid and polyhexamethylene guanidine phosphate imparts flame retardant and antimicrobial properties to cotton-polyester textile materials due to the high content of phosphorus and nitrogen.