Abstract

The decreasing availability of water due to climate change and its deteriorating condition, caused by the intense development of industry, technology, agriculture and the continuous growth of the human population poses an increasing threat to humans as well as the fauna and flora inhabiting our planet. As a response to this, the actions undertaken in this doctoral dissertation aimed at designing a highly efficient, biodegradable or compostable for wet filtration, that reduces the presence of hazardous substances, including excessive amounts of bioavailable elements (nitrogen and phosphorus), heavy metals as well as bacteria from aquatic environments.

The goal of the conducted research was to develop two types of nonwoven fabrics. A structural nonwoven fabric (spunbond) that stabilizes filtrs and ensures the integrity of the entire system, and a filtration nonwoven fabric (needle-punched nonwoven), which was surface-modified to impart specific sorption and antibacterial properties. Both nonwoven fabrics were made from commercially available polymers, namely polylactic acid (PLA) and poly(butylene succinate) (PBS). Following this, the needle-punched nonwoven fabric was coated with solutions of adsorbents and antibacterial nanoadditives in the form of aqueous suspensions using a spray technique. These solutions were prepared by homogenizing the adsorbent or nanoadditive, acrylic acid (at a ratio of 1:1 adsorbent or nanoadditive/acrylic acid), a crosslinking agent (monomer) (at a ratio of 100:1 acrylic acid/crosslinking agent), and a polymerization photoinitiator (at a ratio of 100:1 acrylic acid/photoinitiator) in an aqueous solution. Subsequently, the system prepared and applied to the needle-punched nonwoven fabric was subjected to UV-initiated crosslinking and allowed to dry completely.

As part of the conducted research, adsorbents in the form of solid particles such as Al2O3, CaCO3, bentonite, Polonite®, activated carbon, crushed oat straw, and hemp shives were used, all of which possess sorptive properties for bioactive elements and heavy metals. Additionally, TiO2, ZnS, and nano-Ag, which have antibacterial properties, were also applied.These compounds are characterized by sorption properties for ammonium and phosphate ions, heavy metals, and antibacterial properties. The nonwoven fabrics modified during the research were placed in media containing model pollutants found in natural waters, and then, using measurement and research techniques such as SEM,

FT-IR ATR, Raman spectroscopy, ICP-OES, LCK 350 phosphate cuvette test, ASA, and microbiological testing, the effectiveness of the modifications was confirmed.

The doctoral research confirmed that the obtained composites can be used as filtration materials with potential applications in the treatment of surface waters from physical, chemical and biological contaminants.