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Research on structural and process properties of polysulfone membranes modified by CuO

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ABSTRACT

One of the problems associated with conducting a membrane filtration process is the accumulation of undesirable material on the surface of membranes. The deposited layer can significantly increase the resistance of the membrane, which leads to a reduction of the process efficacy. In many cases, the service life of the membranes is also reduced. One type of contamination that can accumulate on the surface of membranes are biological species (i.e., microorganisms). The process is called biofouling and can lead to a biofilm formation, which constitutes an integral layer resistant or completely invulnerable to many commonly used cleaning techniques. Various microorganisms, including bacteria, fungi and algae, proliferate and colonize the available surface of the membranes. Adhesion to the surface is enabled by secreted components known as extracellular polymeric substances, thanks to which a biofilm is formed on the surface. In order to reduce the intensity of biofouling, the membranes are subjected to various modification techniques. One of the modification techniques is the addition of particles with antimicrobial and anti-biofouling properties to the polymer at the stage of membrane production. In this study, copper oxide (CuO) was used as an antimicrobial material, which was added, as a nanopowder, to a polysulfone solution. From the prepared membrane-forming solution, flat ultrafiltration membranes were produced using the wet phase inversion method. The secondary solvent was the ultrapure water. The aim of the conducted research was to produce membranes with anti-biofouling properties and to characterize them in terms of structural and process characteristics. Anti-biofouling properties were determined using microbiological techniques based on standard test methods, appropriately adapted to obtain a representative result for typical realistic working conditions of separation material. Typical Gram-positive and Gram-negative bacteria found in the aquatic environment were selected for the study. Scanning electron microscopy, porosimetry and contact angle analysis were used to determine the structural properties. While characterizing the process properties, the filtration coefficient and the permeate flux change during the filtration process on an aqueous solution of bovine serum albumin were determined. Ultrafiltration membranes with pores 0.05–0.07 μm and permeability of 170 $dm^3/m^2/h \cdot bar$ have been obtained. Membranes have antibacterial properties against *Escherichia coli* and *Staphylococcus aureus*.

Keywords: Membrane filtration; Membrane modification; Anti-biofouling properties; Copper oxide

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