Title: Microfiltration membranes impregnated with silver nanoparticles via sputtering for biocidal effect

Keywords: silver nanoparticles, microfiltration, biocidal effect

Abstract:

The global market for membrane microfiltration (MF) was almost 1.9 billion of dollars in 2015, and will grow to approximately 2.6 billion of dollars by 2020 at a compound annual growth rate of 6.7% [1]. The microfiltration process is widely used for water disinfection, however, this process is limited by fouling and biofouling of the membrane, which reduces permeate flux and increases costs. To minimize these problems and promote water disinfection, the properties of the MF are associated with established advantages of nanotechnology as the largest surface area. In this context, the silver nanoparticles (AgNps) play an important role due to its bactericidal property that can reduce microorganism growth and, consequently, the membrane biofouling. Furthermore, presence of AgNps in MF membranes improves permeate disinfection, allowing the use of membranes with high porosity and permeabilities. These membranes can be used for several applications as bioreactor membranes and pre-treatment for nanofiltration and reverse osmosis. In the most accept mechanism for disinfection, silver ions interact with thiol groups in proteins, resulting in inactivation of enzymes and leading to the production of reactive oxygen species. It was also shown that AgNps prevent DNA replication and affect the structure and permeability of the cell membrane [2]. In the other hand, no evidence has been found on toxicity of AgNps for human [3]. The aim of this work was study a new technique to impregnated silver nanoparticles in polymeric membranes and investigated the biocidal effect for applications in water treatment. The MF membranes were prepared by phase inversion technique via immersion and precipitation, using polyethersulfone (PES – 15%w/w), polyvinylpirrolidone (PVP – 7,5% w/w) and dimethylacetamide (DMAc) and the AgNps were incorporated by sputtering technique with different conditions of sputter current (15, 30 and 50 mA) and sputter time (15, 30 and 120 s). The MF-AgNps membranes were characterized by Scanning Electron Microscopy with Energy Dispersive Spectroscopy (SEM-EDS) and X-Ray Diffraction (XRD); and the release of AgNps were analyzed by Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES). The antibacterial property was analyzed against *Pseudomonas aeruginosa* by the inhibition zone method after 24, 48 and 72 hours of incubation. The presence of silver in the surface was confirmed for MF-AgNps membranes and it was observed an inhibition ring only around the membranes containing AgNps, indicating the suppression of microorganism activity nearby these membranes. These results confirm the bactericide properties of the MF-AgNps membranes and the great potential to application for water treatment.

[1] BCC RESEARCH. **BCC Research**, 2016. <https://www.bccresearch.com/market-research/membrane-and-separation-technology/membrane-microfiltration-market-report-mst028f.html>.
[2] MORONES, J. R. et al. The bactericidal effect of silver nanoparticles. **Nanotechnology**, v. 16, p. 2346-2353, 2005.
[3] LI, Q. et al. Antimicrobial nanomaterials for water disinfection and microbial control: potential applications and implications. **Water Research**, v. 42, p. 4591-4602, 2008.