BIOCIDAL EFFECT OF MICROFILTRATION MEMBRANES IMPREGNATED WITH SILVER NANOPARTICLES

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Abstract: Membrane separations processes are more economical and efficient in comparison with conventional separation techniques. Furthermore, membranes showed advantages as separations without a phase change, no chemical addition required, selectivity in the separations, and facility in operation and scale-up [1,2]. The microfiltration (MF) process is widely used for water disinfection and the global market was almost 1.9 billion of dollars in 2015, and will grow to approximately 2.6 billion of dollars by 2020 [3]. However, this process is limited by fouling and biofouling of the membrane, which reduces permeate flux and increases costs. To minimize these problems, many alternatives are studied as addition of biocide agents, membrane surface modification and association with established advantages of nanotechnology as the largest surface area. The global nanotechnology market in environmental applications is expected to reach about 41.8 billion of dollars by 2020 [4]. 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. The most accepted disinfection mechanisms of AgNps are release of silver ions that interact with thiol groups in proteins, resulting in inactivation of enzymes and leading to the production of reactive oxygen species; and the penetration of AgNps in bacterial cells that prevent DNA replication and affect the structure and permeability of the cell membrane [5]. In the other hand, no evidence has been found on toxicity of AgNps for human [6]. The membranes containing AgNps can be used for several applications as bioreactor membranes and pre-treatment for nanofiltration and reverse osmosis. The aim of this work was studied a new technique to impregnated silver nanoparticles in polymeric microfiltration 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 and plate counting bioassay after 24

hours. The impregnation of AgNps on the surface by sputtering technique was confirmed and exhibited nanoparticles with average diameter between 50 and 88 nm. The silver loss was 3.16, 6.51 and 1.21% of initial silver concentration for different MF-AgNps after 1 month of immersion in water and it was observed an inhibition ring with 0.5 and 0.8 mm radius, indicating the suppression of microorganism activity nearby these membranes. Moreover, the microfiltration membranes impregnated with AgNps showed 0.7 log reduction for sessile cells and 0.6 log reduction for planktonic cells. These results confirm the bactericide properties of the MF-AgNps membranes and the great potential to application for water treatment.

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