CATECHOL-BASED COATINGS AND INCORPORATION OF AGNPS INTO NANOFIBROUS AND COMMERCIAL MEMBRANES FOR ANTIBACTERIAL PROPERTIES IN WATER FILTRATION

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Growing population, rapid development of industry and multiple drought lead to serious lack of drinkable water. It is essential to find a cheap technology which allow us fast recycle and reuse existed water. Comercial and nanofiberes membranes coated with pyrocatechol and Tris(2-aminoethyl)amine. Subsequently, AgNPs particles attached to the membrane surface in order to obtain antibacterial properties.

Keywords: antibacterial properties, catechol coatings, AgNPs, nanofibrous membrnaes, microfiltration membranes

INTRODUCTION

The growth of the human population and greater demand for drinking water not only by humans but also by industry is leading to shortages of drinkable water. Water is an indispensable element in the life of every living being. Therefore, it is important to manage the water we have well and recycle it for reuse [1]. Currently, membrane filtration seems to be considered the most efficient and inexpensive technology for water purification. It is known that water is the habitat of life for many microorganisms, including those that can be harmful to humans. The primary goal of this project was to eliminate this risk and create a membrane that would have long-lasting antibacterial properties. The second goal was to improve filtration performance and minimize the risk of scaling and biofouling during water filtration.

METHODS

Membrane preparation

Commercial membranes MV020T (PVDF) and MP005 (PES) were provided from Mann+ Hummel Water and Fluid Solutions GmbH (Germany). Nanofibrous membrane PA PVDF made by lamination and consist of PVDF nanofibers, PA adhesive web and support from PET. Nanofibrous membranes PP PE made from polyamide nanofibers and polypropylen/polyethylen support.

Coating and AgNPs attaching

Nanofibrous membranes and comercial microfiltration membranes (MV020T and MP005) immersed in 200 ml water solution of catechol and tris(2-aminoethyl)amine in a molar ratio (1:1.5) and left for 30 minutes under sterring conditions [2]. After reaction membranes washed and dipped in 3.5% $AgNO_3$ solution for 4 hours. Membranes washed again and stored in deionized water.

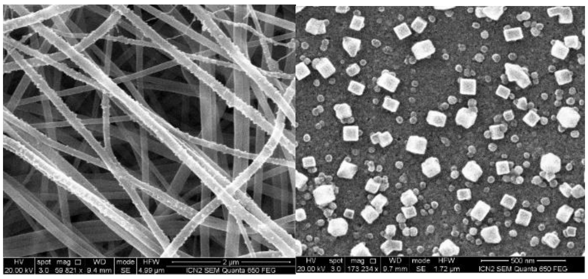
Membrane characterisation

Quanta 650 FEG scanning electron microscope was used to observe changes in surface. Antibacterial tests were conducted against *Escherichia Coli* strain according to AATCC Method 147. The water filtration paramethers measured in continuous dead end filtration with Amicon 8400 filtration cell (EMD Milipore, USA). The leaching of AgNPs checked by ICP-MS by analysis of water samples after 1,3,7,14 and 20 days of filtration.

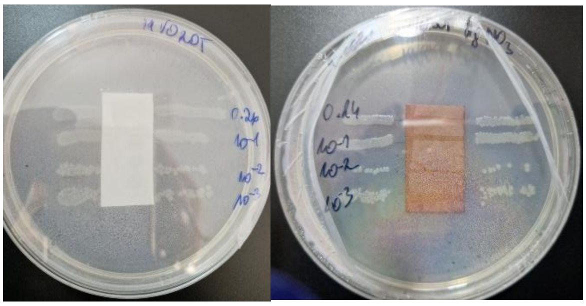
RESULTS AND DISCUSSION

The obtained size of silver nanoparticles after reaction is between 40-70 nm. According to literature silver nanoparticles have strong antibacterial activity when are smaller than 100 nm [3]. In the picture 1 it is noticed that the shape of nanoparticles is diffrent for each type of membrane. Whereas, for nanofibrous membranes obtained spherical AgNPs, the shape for flat sheet membranes was cubic.

Antibacterial tests conducted for pristine and modified membranes. The results showed antibacterial activities for modified membranes. The inhibition zones are visible in the picture 2, where bacteria *E.coli* did not grow around modified MV020T membrane. The same results obtained for PA PVDF, PP PE and MP005 membrane.

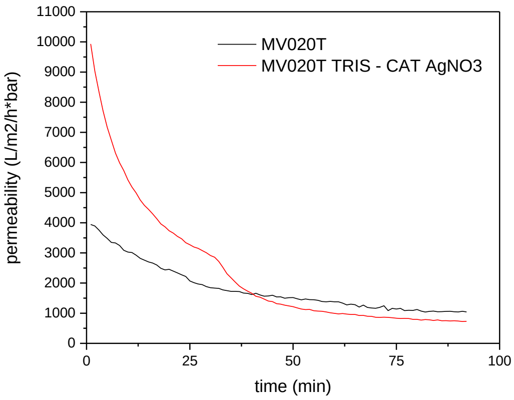


Picture 1. Imbedded AgNPs on the nanofibers PA PVDF membrane (left) and MV020T membrane (right).



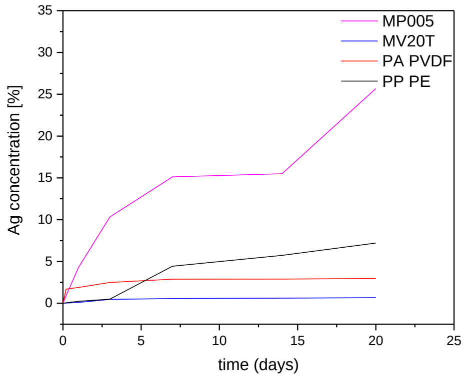
Picture 2. Antibacterial test with AATCC method 147 for pristine MV020T (left) and modified membrane (right).

The filtration tests did not showed lost in water permeability. Moreover, the coating for PA PVDF protect membrane from destructive side-effect of pressure prevents nanofibers separation. In the Picture 3 showed a water permeability for pristine and modified comercial membrane MV020T.



Picture 3. Water permeability for pristine and modified membrane MV020T.

The last test checked how many nanoparticles are released into water during filtration. The highest value reached flat sheet membrane MP005, where around 25% of silver were released to the water. However, membrane MV020T released only 0,6% AgNPs. It follows that membranes made of PVDF bind CAT-TRIS coating and embedded silver nanoparticles more strongly than the other two. The picture 4 shows a percentage of releasd silver in time for each of modified membrane.



Picture 4. The percent of released AgNPs during filtration for each modified membrane.

CONCLUSION

The obtained membranes met the initial goals and gave promising results. They showed antibacterial properties against *E. coli* and filtration parameters remained at a satisfactory level. In the case of nanofiber membranes, the coating formed also played a protective role for the nanofibers during filtration. It is essential to minimize the release of AgNPs into the water. This can be achieved by a stabilization of the nanoparticles with a suitable surfactant, such as PVP.

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