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Investigation of the treatment and antibacterial properties of pollutant-containing water using black phosphorus blended polyethersulfone membranes (BP@PES)

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ABSTRACT

The most important problem of membrane processes is clogging and therefore the reduction of their useful life. In order to eliminate such problems, the production of composite membranes is an option in membrane treatment systems. In this study, the usability of black phosphorus (BP) in membrane treatment systems, and its effect on antibacterial and treatment performance were studied. BP blended PES membranes (BP@PES) produced by loading BP into the polyethersulfone (PES) membranes were used for the treatment of bovine serum albumin (BSA) and *Escherichia coli (E. coli)*. For this purpose, BP was added at three different amounts (0.5 %, 1.0 %, and 2.0 %) into PES membranes. Membranes with different BP amounts produced were named as 0.5%BP@PES, 1.0%BP@PES, and 2.0%BP@PES. After the production of these composite membranes, they were used in the dead-end filtration system and compared with the PES membrane without BP (bare PES). The removal effectiveness of bare PES was found to be 53.40 % in the BSA rejection results, and it was discovered to be 60.90 %, 97.15 %, and 100 % for 0.5%BP@PES, 1.0%BP@PES, and 2.0%BP@PES, respectively. The antioxidant activity of BP was 70.86% at 100 mg/L. Newly prepared BP caused single-strand DNA nuclease abilities at 50, 100, and 200 mg/L. BP showed the effective antimicrobial activity. The most antimicrobial activity was determined as a minimum inhibitory concentration (MIC) value of 8 mg/L against *E. hirae* and 100 % *E. coli* viability inhibition activity was achieved at 50 and 100 mg/L after 90 min exposure. BP also inhibited the biofilm formation of *P. aeruginosa* at 87.19 % and *S. aureus* at 90.28 % at 50 mg/L. Thus, both the effect of BP on membrane performance and its antibacterial properties were investigated. Pure water fluxes, BSA and *E.coli* rejection performances, and antibacterial properties of all membranes used in the membrane filtration system were investigated in detail. It is recommended to further investigate BP-containing membranes with different production techniques.

1. Introduction

In addition to industrial and agricultural activities, the increase in the amount of water used for domestic purposes continues to increase day by day with the increasing population. Due to the impurities involved in the content of the water used, its quality either decreases or becomes unusable. Therefore, water scarcity has become a global threat due to increased consumption and contamination of available resources [1]. Existing surface and groundwater resources may be exposed to human and animal-borne pathogens (such as viruses and bacteria), industrial activities (such as heavy metals, benzene, and dyes), and agricultural pollutants (such as herbicides and pesticides) [2–4]. These kinds of pollutions need to be treated and discharged to nature in a purified form. For this purpose, many chemical, physical, and biological

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