Polytitanium chloride pre-coagulation for fouling control of ceramic membrane

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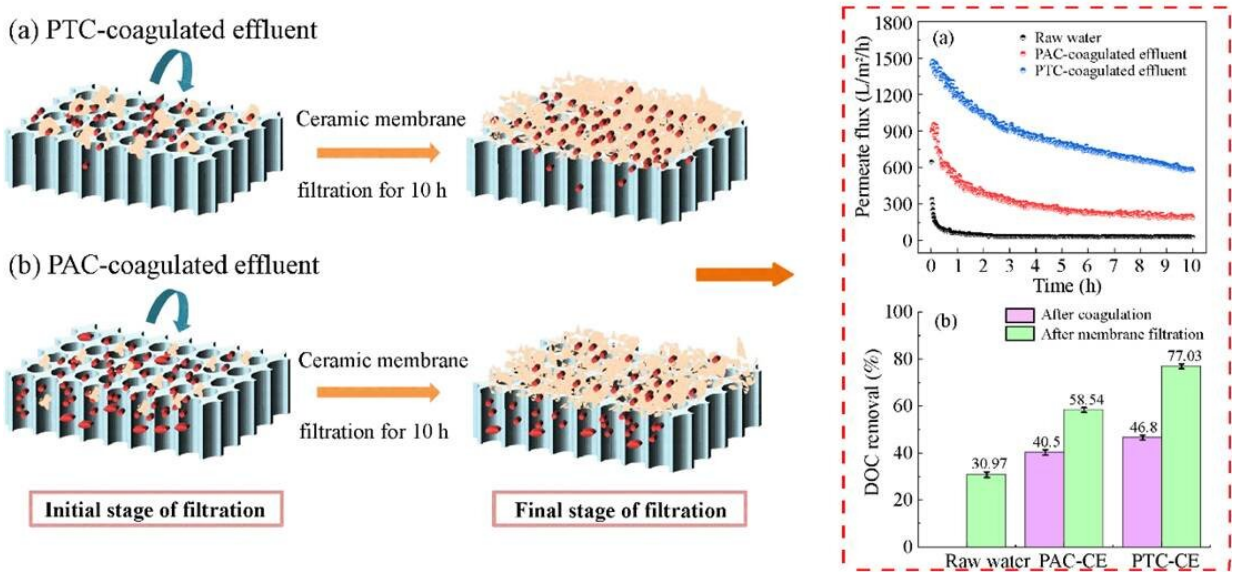

Credit: Xiaoman Liu et al

Membrane technology is widely applied in water treatment for removing suspended particles, colloids, and organic pollutants from polluted water. As a typical representative of inorganic membrane with advantages such as high flux and chemical resistance, ceramic membrane has massive potential value in the treatment of surface water, municipal wastewater, and drinking water.

However, membrane fouling is a critical issue for the development and

promotion of membrane process. This issue exists widely in various membrane processes, especially during the pressure-driven process of wastewater filtration. As a result, ceramic membrane is also inevitably restricted by membrane fouling. Therefore, an effective pretreatment technology to reduce membrane fouling is urgently needed in water treatment process.

Coagulation is regarded as one of the most successful pretreatment technologies against membrane fouling due to its low cost, high performance and the ability to remove natural organic matters (NOM). At present, Al- and Fe-based salts are the most widespread coagulants due to superior coagulation performance and cost-efficiency.

But the applications of Al- and Fe-based salts are limited by the biological toxicity and effluent coloring respectively. An advanced process, titanium-based coagulants have attracted wide attention in recent years due to innocuity, excellent performance and sludge recycling. It is expected to be used as a new generation coagulant to replace Al- and Fe-based coagulants to achieve efficient and safe water purification.

Based on the case of emerging titanium-based coagulant (polytitanium chloride, PTC), the researchers from University of Jinan, Qilu University of Technology (Shandong Academy of Sciences) and the University of Hong Kong evaluated the pre-coagulation performance of titanium-based coagulants which was compared with conventional Al-based coagulant (polyaluminum chloride, PAC), and used four varied mathematical models to synthetically investigate the fouling mechanisms of the following ceramic membrane cross-flow filtration. This study is published online in *Frontiers of Environmental Science & Engineering*.

In this study, the research team found that the filtration performance of ceramic membrane enhanced by the emerging titanium-based coagulant.

The PTC showed a significant advantage over PAC, resulting in about 20% higher organic matter removal. The follow-on filtration of the PTC-coagulated effluent with ceramic membrane produced a filtrate with improved quality (about 78.0% removal of DOC) and a high flux of around 600 L/(m^2·h).

As a reference, the PVDF membrane filtration could obtain comparable DOC removal (about 77.0%), but with a low filtration flux of ca. 60 L/(m^2·h) only. Four mathematical models were involved in simulating the fouling mechanisms of ceramic membranes. In the PTC case, the membrane fouling was slightly slower due to the main fouling mechanism of cake filtration which was indicated by the classical Hermia's model simulation, whereas for PAC, standard filtration/intermediate filtration (blocking of membrane pores) was also a key fouling mechanism.

And the standard law filtration and classical cake filtration model reported by Visvanathan and Ben aïm were not fit for fouling characterization of the ceramic membrane with no identification of R^2 values of all different cases. A segmented simulation was required to distinguish the difference of fouling mechanisms between PTC and PAC cases using a linear classical Hermia's model.

This study investigated the enhanced cross-flow performance of ceramic membrane by PTC pre-coagulation. It was found that the ceramic membrane filtration showed high performance for surface water treatment and the PTC pre-coagulation could signally enhance ceramic membrane filtration performance and effectively control ceramic membrane fouling. This work not only provides a high-effective pretreatment technology to enhance filtration performance in water treatment but also offers a way forward for the development and evaluation of the advanced pre-coagulation technologies against membrane fouling.

More information: Xiaoman Liu et al, Enhanced cross-flow filtration with flat-sheet ceramic membranes by titanium-based coagulation for membrane fouling control, *Frontiers of Environmental Science & Engineering* (2022). DOI: 10.1007/s11783-022-1531-x

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