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Advanced membrane materials based on biopolymers

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Abstract

In recent decades, interest in environmentally friendly and energy-efficient separation technologies has grown, making membrane processes a key tool for green chemistry and sustainable development. The shift from traditional methods, such as distillation and extraction, to membrane technologies is driven by their low energy consumption, minimal waste generation, compact equipment and automatization. Currently, membrane technologies (pervaporation, ultrafiltration, nanofiltration) are the most promising areas of research and have consistently demonstrated their effectiveness in separation processes, particularly wastewater treatment.

In this study, novel mixed matrix membranes (MMMs) based on biopolymers (such as sodium alginate, chitosan/chitosan succinate, etc.) were developed. These materials were selected for their renewable nature, biodegradability, high hydrophilicity, good film-forming properties, and low cost, making them an environmentally attractive alternative to synthetic polymers. To get tailored membrane transport properties, biopolymers were modified with nano- and micro- sized modifiers. The introduction of such fillers enables precise control of the membrane structure, hydrophilicity, and stability, creating next-generation functional hybrid materials. The developed membranes were characterized using various spectroscopic, microscopic methods, thermogravimetric analysis, contact angle measurements, etc. The MMMs performance was evaluated in the separation of various industrially significant mixtures. The results demonstrated that the application of modifiers for the MMMs development from biopolymers significantly change both the physicochemical and transport properties.

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