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Morphology-controlled crystallization of $Mg(OH)_2$ through ion-exchange membrane crystallization

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Brines generated during seawater desalination and other industrial processes represent a significant environmental issue due to their high concentration of dissolved salts. At the same time, these streams represent a potential source of valuable raw materials, including magnesium. Its recovery by conventional precipitation methods is often associated with co-precipitation of other substances, low product quality, and difficult separation of the resulting solid phase. A promising alternative is reactive membrane crystallization, in which the precipitating agent is separated from the brine by an ion-exchange membrane, thereby reducing the risk of product contamination while improving process control.

This work is focused on the recovery of magnesium in the form of magnesium hydroxide from model brines using hollow multi-fibre module equipped with anion-exchange hollow fibres. Sodium hydroxide, as the precipitation agent, was circulated inside the fibres, while the membrane module was immersed in a magnesium chloride solution. The transport of hydroxide ions through the membrane led to their reaction with magnesium ions and to the formation of $Mg(OH)_2$ precipitate. The study investigated the influence of operating conditions on both process performance and product morphology, with particular attention to reactant concentrations, solution volumes, volumetric flow rates, and packing density of the fibre bundle.

The morphology of the produced $Mg(OH)_2$ particles was evaluated by scanning electron microscopy, while the behaviour of the process was further interpreted using a mathematical model. The model consists of a system of ordinary differential equations solved in MATLAB describing mass-transfer and reaction phenomena in a two-compartment system separated by a single anion-exchange membrane.

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