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Antisolvent Crystallization of Sodium Chloride in Deep Microchannel Reactors

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Summary

Supersaturation strongly influences the quality the product crystals obtained from crystallization. There are several techniques to control supersaturation, and use of microchannel is one of the alternatives. It is widely accepted that the microchannels show an excellent mixing performance when the geometry and the operating conditions are optimized. Deep microchannel is a sort of microchannel which can process chemicals at a high rate. This study was conducted to examine the performance of deep microchannel as an apparatus to carry out anti-solvent crystallization.

The mixing performance of microchannels and deep microchannels was examined. The flow visualization experiment showed that the mixing quality in microchannels largely depended on the flow rate. Bends in the microchannel also enhanced mixing of fluids. The fluid flow in deep microchannels was studied by conducing computational fluid dynamics simulation. The mixing quality was evaluated by means of standard deviation of fluid composition on the outlet surface. The study showed that the mixing quality improved by increasing the flow velocity, and by forming internal structures such as expansions and cuts. This was also confirmed in an experiment to evaluate the mixing quality using Villermaux-Dushman reaction.

In an anti-solvent crystallization experiment, saturated sodium chloride solution and ethanol were mixed using flask, microchannels, and deep microchannels. When pure ethanol was used as the anti-solvent, it was not possible to conduct experiment using microchannels due to clogging. Thus, ethanol was diluted with water before the experiment. The results of the size distribution analysis proved that small and narrowly distributed particles can be obtained by employing microchannel for anti-solvent crystallization. Similar results were obtained in an experiment using deep microchannels. Deep microchannels with expanding sections were most effective in reducing both the size and coefficient of variation of the sodium chloride particles.