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Effect of Fluid Behavior in flow Crystallizers on Salt Crystallization

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Summary

Batch processes are widely used in chemical plants, but they also suffer from variation in product quality and large manpower demand. As a mean to circumvent these problems, continuous processing technology is attracting attention of many process engineers. There is an established continuous processing technology in the field of chemical engineering. However, it assumes application to large scale production processes, and thus it is not directly applicable to small scale processes in which batch processes are usually employed.

Crystallization is one of the unit operations that are deserved to be realized in a small scale continuous processes or flow processes. One of the objectives of this study is to clarify the fluid flow condition and the crystal property in flow system. Also we conducted fluid dynamics simulation to study the effect of fluid flow on the crystal growth rate.

Antisolvent crystallization of sodium chloride was conducted using a microchannel under flow condition. The size and CV of crystals obtained from the flow experiment were smaller than those obtained in an experiment using a stirred flask. To further enhance the mixing of fluids, experiment was conducted under slug flow condition. This was realized by injecting air to the mixture of ethanol and saturated sodium chloride solution. With increasing the flow rates of fluids, the mean size and CV reduced. An increase in the flow rates enhances the internal circulation of liquids in slugs, and promotes fluid mixing and subsequent nucleation rate. Thus the nucleation rate depends on the flow rates, which are primary operating parameters in slug flow conditions.

A numerical simulation of fluid flow and mass transfer around a single crystal was also carried out. The results showed existence of operating condition in which a flow apparatus shows a higher crystal growth rate than a stirred tank.