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Improvement of Suspension Density and Scale-Up of a Continuous Sodium Chloride Crystallizer

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Summary

In evaporative crystallization, ideally a high crystal growth rate, a high suspension concentration and a sharp crystal-size distribution are all required. In the present study, the influence of the seeding conditions (average diameter and mass) and heating rate on both the crystal growth rate of sodium chloride (NaCl) and the crystal-size distribution was investigated in the optimal designed draft-tube stirred vessel containing a high concentration of sodium chloride slurry up to 35 vol%.

In the case of semi-batch type operation, the crystal growth rates increase with heating rate, and decrease with seeds crystal number. On the other hand, the shape of crystal size distribution is sharper with a 200 g seeds mass than with lower seeds mass conditions. The cause of these phenomena is conjectured to be that the initial nucleation is inhibited with 200 g seeds. To determine the optimal seeding condition, we defined the optimal operation index, I_{op}, as $I_{op} = (\mathrm{d}D_{90,exp}/\mathrm{d}t)_0 \times \{(\mathrm{d}D_{90,exp}/\mathrm{d}t)_S / (\mathrm{d}D_{90,cal}/\mathrm{d}t)_S\}$. Here, $D_{90,exp}$ is the diameter of 90 % cumulative volume, and $D_{90,cal}$ is model simulation results which are calculated with an ideal assumption that the initial seeding particles will grow along the precipitation volume without any abrasions, agglomerations and nucleation. The results show that I_{op} are correlated with seed particle number, and have a maximum value. With the I_{op} correlation, the appropriate seeding conditions are determined, such as 90 g of seeds mass, 70 μm of diameter in the case of heating rate of 1,200 W.

The optimal designed draft-tube crystallizer was improved for the continuous operation, and some trial operations were performed. Furthermore, we try to operate the continuous draft-tube crystallizer stably with fine adjustments of slurry displacement on the basis of population and mass balance calculations.