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Improvement of Suspension Density in a 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 and heating rate on both the crystal growth rate of sodium chloride (NaCl) and the crystal-size distribution was investigated in a semi-batch-type, draft-tube stirred vessel containing a high concentration of sodium chloride particles.

The crystallizer was made of glass and had an inner diameter of 0.13 m and a volume of 1.73 liters. The stainless draft-tube with heating sheath coils on the outside, and a propeller-type impeller having three pitched blades were placed in the crystallizer. These dimensions were optimized to achieve a complete suspension with a low power input for a high suspension concentration of approximately 30 - 40 volume %. The heating rates used were 1,200 W, and the liquid level was kept constant by supplying a sodium chloride saturated aqueous solution; thus this system was semi-batch system. The suspension concentration in the vessel reached about 35 volume % after 3 hours at a heating rate of 1,200 W. The seeding particles were 250 - 350 μm in diameter, 0 - 200 g in mass, and they were left to stand in a saturated sodium chloride solution over night. The time evolution of the particle size distribution was measured using a suction sampling method with a high-speed video camera. The diameter of 90 % cumulative volume, $D_{90,exp}$, was calculated. To determine the optimal seeding condition, experimental data were compared with the model calculations that were calculated with an ideal assumption that the initial seeding particles will grow along the precipitation volume without any abrasions, agglomerations and nucleation.

In the case of a heating rate of 1,200 W, the time evolution of crystal size and crystal growth rate are similar to the variation in the seeding mass. On the other hand, the shape of crystal size distribution is sharper with a 200 g seeding mass than with lower mass seeding conditions. The cause of these phenomena is conjectured to be that the initial nucleation is inhibited with 200 g seeds in the particle number estimation.