Development of High Efficiency Salt Production Method in Evaporative Crystallization with Modulated Operation for Desalination Process

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Salt production has attracted attention from the viewpoint of processing byproducts in seawater desalination. Evaporative crystallization can remove the salt content, but an evaporative crystallizer must be operated at a low cost for production with high efficiency. In order to obtain salt product at high efficiency, high suspension density conditions are indispensable. However, under those conditions, the nucleation rate becomes high. Therefore, it is necessary to control the excess number of micro-crystals and size distribution. This study focused on the production rate enhancemnt by micro-crystals and modulated operation with undersaturation. In order to enhance productivity, micro-crystals may improve the growth rate, but excess micro-crystals deterriorates size distribution.

The purpose of this present study is to develop the salt production method that can promote the crystal growth rate under high suspension condition. The micro-crystals were generated by addition of anti-solvent under evaporative crystallization.

The experiments were carried out by semi-batch vacuum evaporative crystallization. While the growth rate increased temporarily by addition of anti-solvent, CV value also increased temporarily. However, CV value has improved immediately after addition of anti-solvent as an interesting phenomenon. It became clear that the operating condition which growth rate enhancement and a crystal-size distribution improvement can realize simultaneously exists. Change of solution concentration after anti-solvent addition was considered by using ternary phase diagram. When the anti-solvent evaporated, the solution became undersaturation temporarily, and the mico-crystals were dissolved.

As a result, the micro-crystals advanced production rate. On the other hand, extra micro-crystals were dissolved after evaporation of anti-solvent. This method could improve crystal-size distribution. So the modulated operation such as anti-solvent intermittent injection improves size distribution under the high suspension density conditions in evaporative crystallization.