Effect on sodium chloride crystal growth of impurities in a concentrated brine obtained from sea water

Hiroshi Ito and Masami Hasegawa

Sea Water Science Research Laboratory, The Salt Industry Center of Japan,
4-13-20 Sakawa, Odawara, Kanagawa 256-0816, Japan

The effects of three inorganic chloride salts of magnesium, calcium and potassium on the growth rate of sodium chloride seed crystals suspended in a cylindrical fluidized-type crystallizer were experimentally studied. The seed crystals having a mean size of 0.94mm were crystallized for 2 or 4 hours in a supersaturated solution containing 1 to 10wt% of each impurity. The crystal growth rate and the roughness of the grown crystal surface were determined. In each test, the size of seed crystals did not change during the initial stage of crystal growth, but subsequently increased. Therefore, the period in which the crystal did not show any growth is defined as the induction period. The induction period increased with increasing impurity content and was correlated to a power function of supersaturation. The power function of supersaturation was 1.45 in the tests using supersaturated solution containing magnesium chloride and calcium chloride, but the value decreased with increasing concentration of potassium chloride in the supersaturated solution. The crystal growth rate was observed to increase with increasing sodium chloride content in the supersaturated solution, and the surfaces of grown crystals became rough. In this paper, the crystal growth rate of sodium chloride is discussed in terms of the adherence of fine crystals, which are assumed to be suspended in a supersaturated solution, to the seed crystals.

1.Introduction

The effects of high contents of impurities of $MgCl_2$, $CaCl_2$ and KCl on NaCl crystal growth were discussed.

2.Experimental method

The saturated NaCl solution containing 1, 3 or 10wt% of $MgCl_2$, $CaCl_2$ or KCl was prepared by agitation of a slurry with NaCl crystals at 363K. The solution, supercooled through the heat exchanger, was circulated at flow rate of 5cm/s to the fluidized bed crystallizer with an inside diameter of 50mm and a height of 1000mm. The temperature of solution in the crystallizer was maintained at 362.5, 362 or 361.5K.

About 200 grams of seed crystals with a mean size of 0.94mm were added into the crystallizer and fluidized for 2 or 4 hours with

the solution flowing up from the bottom of the crystallizer. When the operation was finished, the grown crystals were removed and washed with ethanol. The crystals were then dried at 323K for 12 hours. The size distribution of the grown crystals was measured with an image analyzer and their surfaces were observed under a SEM.

3.Results and discussions

In each test, the size of sampled crystals did not change during the initial stage of crystal growth but subsequently increased. The period in which the crystal did not show any growth is defined as the period for the formation of rough crystal surfaces[1]. The induction period was increased with increasing concentration of the three inorganic salts added, and was correlated to the power function of supersaturation as a parameter of the concentration of $MgCl_2$ and $CaCl_2$. The value of the power function is 1.45. However, in the presence of KCl, the power function of supersaturation decreased with increasing of concentration of KCl in the supersaturated solution. The contamination of potassium into NaCl crystal is assumed to affect the behavior of induction period.

The observed crystal growth rate was proportional to the supersaturation, the coefficient of crystal growth rate was determined. The coefficient of crystal growth rate was found to increase rapidly with increasing NaCl content in the supersaturated solution, as shown in Figure 1; these impurities inhibited crystal growth of NaCl.

The many fine crystals were observed to adhere to the surgfaces of the grown crystals in the supersaturated NaCl solution. However, in the presence of these inpurities, the adherence of these fine crystals to the crystal surfaces was not observed.

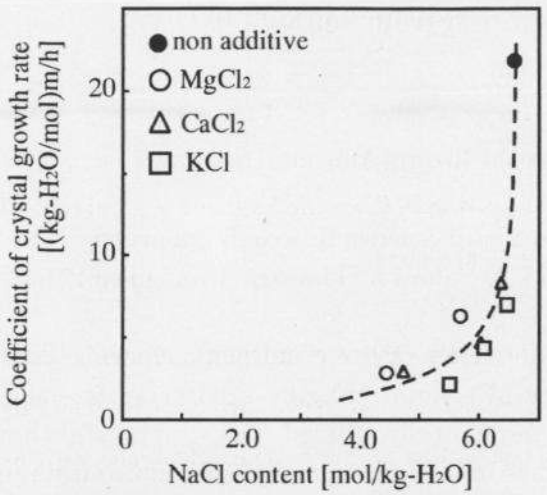

Fig.1 Relationship between NaCl content and coefficient of crystal growth rate

4.Conclusions

These results indicated that the crystal growth of NaCl was inhibited by the presence of $MgCl_2$, $CaCl_2$ and KCl. It is considered that these impurities inhibit formation of rough surfaces and adherence of fine crystals to the crystal surface.

Reference

[1] M. Hasegawa, K. Toyokura, Bulletin of the Society of Sea Water Science, 50, 131 (1996)