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Functional Mechanisms of Anti-Caking Agents for NaCl

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Summary

In order to study caking mechanisms of NaCl powder, bridge formation processes were simulated by connecting NaCl single crystal surfaces with aqueous solution of NaCl. Optical microscopic observation during drying processes revealed micro-crystal formation at the liquid surface in hyperboloid shape, and the crystal growth from the single crystal faces along the outer surface of the liquid, the latter being the main process. Typically, cylindrical bridges containing considerable amount of the solution inside were formed. The growth mechanism was explained considering super-saturation and diffusion of Na and Cl ions. At the contact of the liquid with the substrate single crystals, no super-saturation is required for the crystal growth.

In the caking of NaCl at low temperatures, formation of NaCl·2H₂O is considered to take a part. The above experiments were performed at below -10°C. Formation of the di-hydrate crystals were observed, but the growth was very slow. The growth occurs by loss of water by evaporation, not by the temperature lowering.

In order to study the function of CaCl₂, an anti-caking agent, humidity change was monitored 16.5 cm deep inside NaCl powder with and without the addition of the agent. In pure NaCl, relative humidity in the powder quickly approached the outside humidity of 70% in a few hours. With CaCl₂ added with the concentration of 1 wt%, however, the inside humidity remained intact for 150 hours, and increased gradually afterwards. CaCl₂ traps water vapor as crystal water and keeps the humidity low.

Effects of ferrocyanide was studied by observing solution growth and whisker growth of NaCl. Effects were clearly visible in both experiments at and above the concentration of 0.1 mM.