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Functional Mechanisms of Anti-Caking Agents for NaCl

H. Shindo¹, H. Mineo², A. Ohno¹, Y. Takada¹, Y. Shirota²,
H. Morooka² and K. Nakamura¹,

¹ Faculty of Science and Engineering

² Graduate School of Science and Engineering

Chuo University, Kasuga, Bunkyo-ku, Tokyo 112-8551, Japan

Summary

Functional mechanisms of various anti-caking agents for NaCl were studied by microscopic observation of bridge formation and water condensation processes between NaCl crystals at room temperature, and formation of NaCl·2H₂O at -11°C. Water vapor transport through NaCl powder layer added with various anti-caking agents was also observed.

The authors reported in their previous work with atomic force microscopy, that ferrocyanide ion stabilizes {120} facets in addition to {100} faces. By the addition of ferrocyanide to NaCl aq., tubular bridge formed between NaCl single crystal substrates contained pores in sidewalls, resulting in efflorescence growth of NaCl in later stage. The fact was explained by the change in shape of crystal growth front due to the habit modifier.

CaCl₂ having wet-keeping function caused water condensation at contact areas between NaCl crystals. Evaporation of the condensed water did not occur even under 35% relative humidity (RH). By placing fine powder of basic magnesium carbonate, which is known to have isolation effect, inhibited the water condensation between the NaCl plates added with CaCl₂.

Na₃PO₄ is known to have drying effect by taking in 12H₂O as crystal water. By adding 1 wt% of the salt in NaCl powder, inside humidity was kept below 35% for longer than 60 hours, although caking was recognized. The volume increase due to hydration probably caused reduction of free space for inward diffusion of water.

Mechanism of low temperature caking was also proposed. At temperature lower than 0.1°C, saturated NaCl aq. is in equilibrium with NaCl·2H₂O(s), not with NaCl(s). At the lower temperature, water molecules take up Na and Cl ions from NaCl to form the dihydrate. The 7.5% volume decrease accompanying the solidification may cause further packing of NaCl powder under heavy load.