Multi-effects of Temperature and Organic Acids on The Formation of Struvite Crystals and Their Physicochemical Properties

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Struvite ($MgNH_4PO_4 \cdot 6H_2O$) is an important mineral in many sciences and industries. Struvite is of great interest in medical sciences because it is often found in human urinary systems including many organics and used as (bio)cement materials. Struvite is sensitive to temperature, which may lead to significant changes in the formation of its crystal and drastic thermal decomposition. Therefore, studies for temperature-dependent properties of struvite are important to improve its applicability in various fields.

Struvite was synthesized at different synthetic ($T_{(S)}$) and drying ($T_{(D)}$) temperatures, respectively. Struvite was formed only at $T_{(S)} \leq 30$ °C without organic acids, whereas it was formed even at 37.5 ° C in the presence of organics. Crystallinity decreased with increasing $T_{(D)}$ due to the loss of water and ammonium ions in the structure, indicative of the critical thermal decomposition point, 45–60 °C. Struvite showing low crystallinity formed at high $T_{(S)}$ was easy to be an amorphous form by thermal decomposition. However, the thermal decomposition was dependent on different types of organics. The morphology of struvite crystal was also related to temperature and organic acids sensitively. Penniform crystals formed at $T_{(S)}$ 15–20 °C were more heat-resistant than those of prismatic crystals formed at $T_{(S)}$ 25–30 °C. For struvite crystals formed in the presence of organics, the size of crystals increased two to three times and their aspect ratio changed. Our results demonstrate that the formation and physicochemical properties of struvite are optimized and controlled by temperature and organics.

Keywords: Struvite, Organic acids, Thermal decomposition