

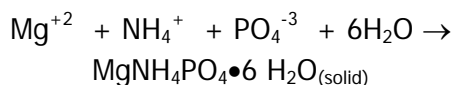


TECHNICAL BULLETIN: Wastewater

Struvite Control in Wastewater

Struvite

Struvite, chemically equivalent to magnesium ammonium phosphate hexahydrate, $MgNH_4PO_4 \cdot 6 H_2O$, can create problems in process pipes, pumps and other equipment in wastewater, due to crystal formation on critical surfaces. The formation of struvite occurs under favorable conditions, including when concentrations of soluble magnesium (Mg^{+2}), ammonium (NH_4^+), and orthophosphate (PO_4^{-3}) exceed levels which promote the formation of crystals, sometimes referred as supersaturation. The reaction of struvite formation is as follows:



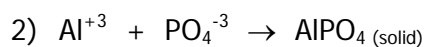
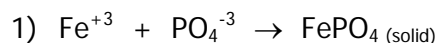
Wastewater pH and temperature are also factors in determining the solubility and formation rate of struvite. Alkaline and increasing pH levels of the wastewater increases the potential of struvite crystallization. As with most crystals, the build up of struvite begins with the seeding and eventual growth of the crystal, as long as conditions remain favorable for continual crystal growth. This will depend on the availability of the three major ions in a molar ratio of 1:1:1 of $Mg^{+2}:NH_4^+:PO_4^{-3}$.

The most common locations for initial struvite formation and subsequent buildup are at points in process flow systems with high turbulence, such as elbows of pipe connections, valves, aeration assemblies, and pump internal components exposed to

wastewater. Carbon dioxide is released at these localized zones of turbulence, which is also known as degassing. This will have the effect locally of increasing the pH, thus creating a more favorable condition for struvite formation. Struvite will also have a greater tendency to form on rough surfaces.

Struvite Control

Control of struvite formation can be obtained by minimizing the concentration levels of any of the three main soluble ions. By complexing the orthophosphate ion with a trivalent metal, such as ferric iron (Fe^{+3}) or aluminum (Al^{+3}), the precipitation of metal orthophosphate will reduce the soluble phosphorus levels in wastewater, thus lowering the potential of struvite crystallization. These precipitation reactions are as follows:



Ferric and aluminum salts include ferric sulfate, ferric chloride, aluminum sulfate, and aluminum chloride, typically available as liquid solutions. Aluminum salts are the most efficient at orthophosphate removal based on the weight of aluminum metal needed to remove soluble phosphorus. The efficiency of these reactions depends on pH, uniform mixing during chemical addition, and, in the case of ferric iron, the oxygen level in the wastewater. Anaerobic environments, such as anaerobic digesters, are also favorable for struvite formation,

mainly due to pressure drops from the digester to the process pipes.

The additional benefits of aluminum and ferric salts include the depression of the wastewater pH, which can create an environment where the struvite is less soluble, thus lowering the potential of crystal formation. The localized reduction of pH, either through the use of an inorganic coagulant or an acid, prior to the areas of actual or potential struvite formation may counteract the effect of carbon dioxide degassing. The reduction in pH of a water system by addition of a soluble metal is commonly known as hydrolysis.

Hydrolysis reactions are multi-step reactions in which the soluble metal in the presence of water, under favorable pH and alkalinity conditions, will create a metal hydroxide floc. The creation of hydrogen ions (H^+) through each of the hydrolysis steps increases the overall molar concentration of hydrogen ions in the wastewater, lowering the overall pH. With the lower pH, the struvite crystal becomes more soluble.

Other steps to take to minimize struvite formation include using the proper pump design and size, pipe diameter and material of construction, and design of pipe connections. The emphasis is to minimize the turbulence in the flow systems by keeping volumetric flow rates to an optimum level and reducing the residence time in flow systems by keeping piping distances to a minimum.

References

1. *"Struvite Formation and Control"*, Scale and Corrosion Research, School of Water Sciences, Cranfield University, United Kingdom, 2003.
2. *"Managing Livestock Waste Facilities Controlling Crystal Formation in Recycle Flush Systems"*, Ohio State University Factsheet AEX-709-92, Karen Mancl and Michael A. Veenhuizen.
3. *"Removal and Re-Use of Ammonia and Phosphate by Precipitation of Struvite"*, Brian A. Dempsey, Pennsylvania State University

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