Observation of Struvite in the Mixed Algae Biofilm Matrix of a Rotating Algal Biofilm Reactor during Nutrient Removal from Municipal Anaerobic Digester Filtrate

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Full Abstract

Central Valley Water Reclamation Facility (CVWRF) is the largest municipal wastewater treatment plant in Utah and must meet new and rigorous nutrient effluent standards. Filtrate from CVWRF anaerobic digesters contains high levels of nitrogen, phosphorous, magnesium, and calcium. Anaerobic digester (AD) filtrate was traditionally recirculated to the headworks of the facility causing supersaturation of magnesium, ammonium, and phosphate over time. Supersaturation of these constituents led to nuisance struvite precipitation that clogged belts, pumps, and pipes downstream of anaerobic digesters. Struvite is a crystalline precipitate that is 1:1:1 molar ratio of magnesium, ammonium, and phosphate. An outdoor pilot-scale rotating algal biofilm reactor (RABR) was implemented at CVWRF as a potential alternative for nitrogen and phosphorous removal from AD filtrate. Struvite was observed within the algae biofilm matrix of the RABR system at CVWRF.

Despite RABR influent component ion molar ratios with potential for various magnesium and calcium precipitates, algae biofilm provided pH, temperature, and nucleation sites favorable to struvite precipitation. The measured average biofilm pH was 8.1, which is favorable to struvite precipitation. Struvite could potentially form in the RABR tank water at pH 7.9, but little struvite was detected in the settled sludge. Therefore, the biofilm may also provide nucleation sites that favor struvite precipitation within the biofilm.

East/West biofilm orientation and biomass harvesting interval influence struvite content within the biofilm matrix. Three harvesting intervals were evaluated: 1-week growth, the bottom layer that developed over 2.5 months and served as the base layer for 1-week growth, and a top layer that developed over a 2.5-month period. The East bottom layer had the highest struvite content with 5% by weight of total solids. West bottom and 1-week growth contained 4.3% and 4.1% struvite, respectively. East 1-week growth and East/West 2.5-month top-layer growth ranged from 1-1.4% struvite. A higher struvite density was correlated with higher biofilm density.

Nitrogen and phosphorous were removed from municipal anaerobic digester pressate through biofilm growth and struvite precipitation. Algae biofilm can then be harvested and pelletized into fertilizer, and the struvite content will add fertilizer value to the product.