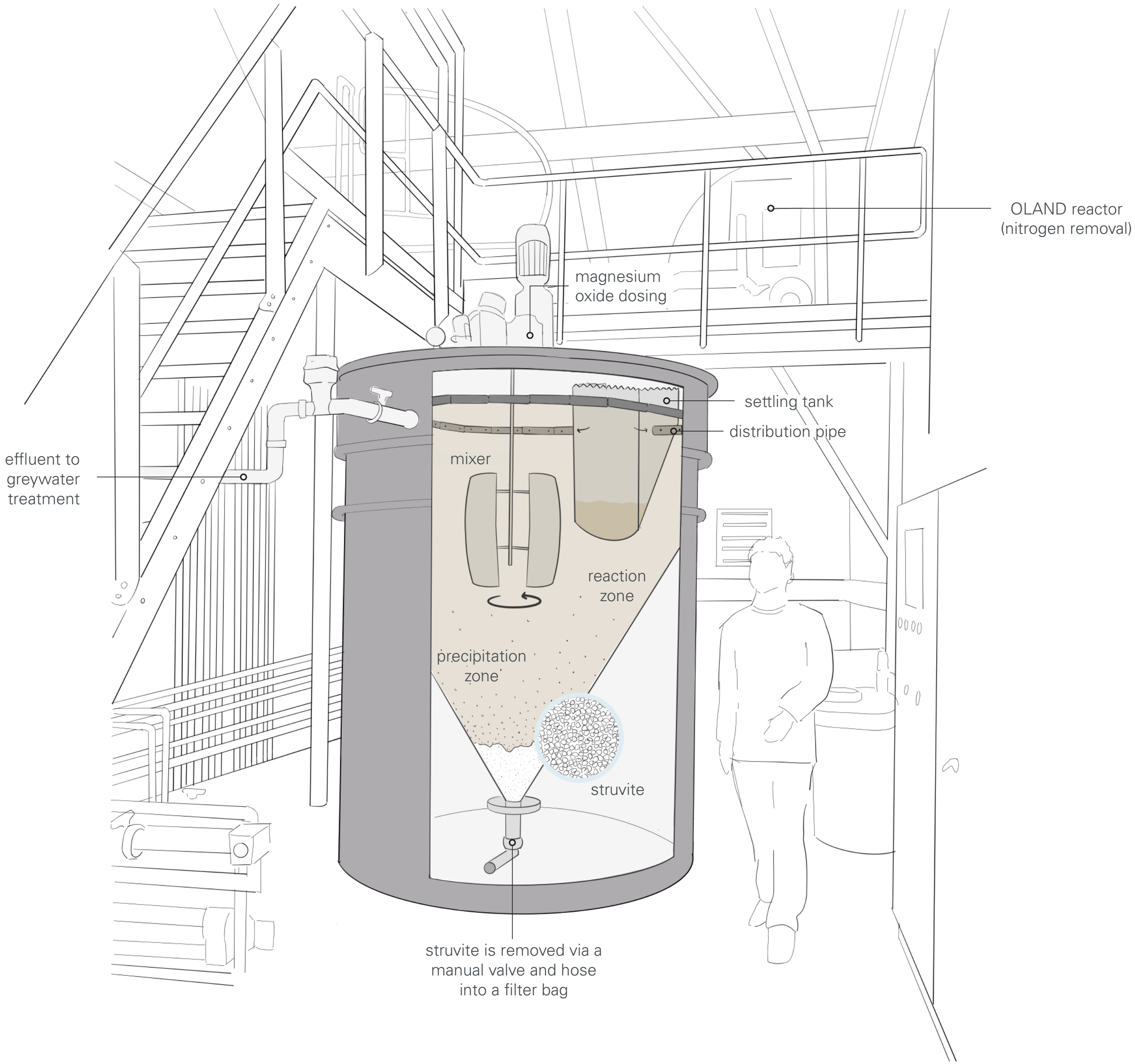
T.4 STRUVITE PRECIPITATION

TECHNOLOGY

eawag aquatic research



Struvite precipitation is a nutrient recovery technology that uses a chemical reaction to form magnesium ammonium phosphate hexahydrate ($MgNH_4PO_4 \cdot 6H_2O$), or MAP. To induce and increase precipitation in a nutrient-rich solution, such as urine or wastewater, magnesium is added to the reactor. Mixing inside the tank provides contact between the solution and magnesium. Struvite can be removed from the tank after settling or via sieving. High recovery of phosphorus (90%) can be achieved in many applications. The solid struvite crystals can be easily separated from the solution and dried, to render an odorless powder. Struvite is a bioavailable, slow release fertilizer that can be stored, transported and easily applied to fields. Alternatively it can be an input for the production of conventional NPK fertilizers.

The precipitation of MAP is chemically favored. However, in the absence of ammonium, magnesium potassium phosphate $MgKPO_4 \cdot 6H_2O$, or MPP, is formed. Both can be reused as fertilizer; MPP is more soluble than MAP.

INPUT STREAMS

- Urine
- Blackwater, effluent
- Mixed wastewater, effluent

TARGET OUTPUT(S)

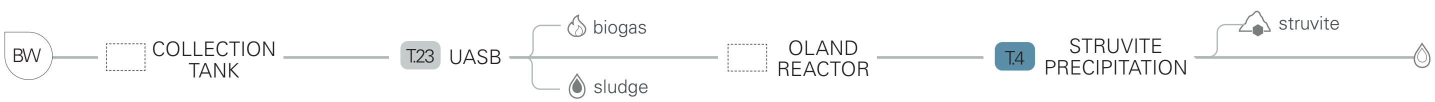
- Struvite

NOORDERHOEK

Sneek, the Netherlands | 2008

Struvite recovery from blackwater and kitchen waste

In a neighborhood of 232 households (~400 residents), vacuum-collected blackwater and kitchen waste are transported together via a vacuum sewer to a treatment facility. The concentrated stream is anaerobically treated in a UASB followed by an OLAND (Oxygen Limited Autotrophic Nitrification Denitrification) reactor for nitrogen removal. Lastly, phosphorus is recovered via struvite precipitation, in a semi-batch struvite reactor with magnesium oxide dosing.



SPECIFICATIONS

INFRASTRUCTURE

Struvite precipitation requires pipes, tanks and storage systems that are resistant to scaling and corrosion. The reactors are usually placed in a mechanical room and need to be equipped with magnesium dosing, mixing mechanisms and struvite harvesters or settlers. To optimize precipitation, pumps, valves, and monitoring instruments help to adjust the flow rate, pH, temperature and chemical dosing.

OPERATION & MAINTENANCE

Operation of struvite precipitation includes the monitoring of optimal conditions for precipitation, including monitoring pH, magnesium dosing, and flow rates. The relevant pumps and control units also need periodic maintenance. Handling and storage of magnesium salts needs to be ensured. Struvite can cause scaling and blockages in pipes and equipment if not well maintained, especially caused by spontaneous precipitation upstream of precipitation reactors. Periodic inspection and cleaning is required.

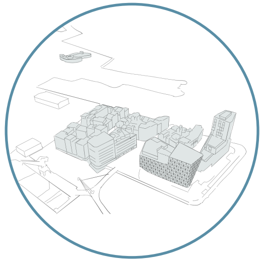
TARGET OUTPUTS

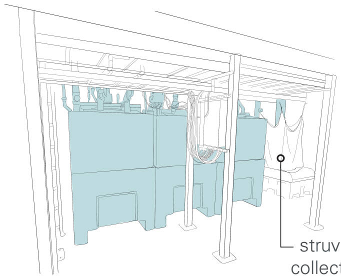
Struvite precipitation is the targeted recovery of phosphorus, which under optimal conditions can result in more than 90% recovery. Struvite can be used for crop fertilization. It provides phosphorus, magnesium, and ammonium in a slow-release form. Struvite can contain pathogens and heavy metals that were present in the input stream. Further treatment of struvite (e.g., washing, drying) can further remove pathogens. Heavy metal levels are usually low, especially when struvite is precipitated from source-separated streams, like urine or blackwater. Farmer acceptance is generally positive if product quality is consistent, granulated and easy to apply, however, market development and regulatory readiness are needed for broader struvite adoption.

Struvite can be directly used in agriculture as a slow release fertilizer, though the low nutrient solubility and nutrient ratios may not meet full crop nutrient requirements. Struvite application rates may need to be adjusted compared to conventional phosphate fertilizers. Alternatively, struvite can be used in industrial fertilizer manufacturing to produce standard NPK fertilizers.

SELECTED CASE STUDIES

OCEANHAMNEN
Helsingborg, Sweden | 2021

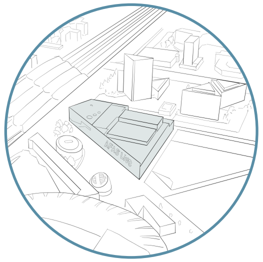


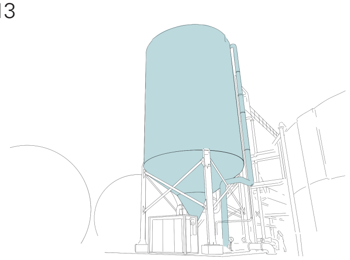


Struvite recovery from effluent from two anaerobic digesters

Oceanhamnen is a waterfront development that has a "three-pipes out" collection of greywater, vacuum-collected blackwater and kitchen waste scaled for 2100 p.e., treated at the Recolab building. The blackwater is digested in a UASB, the kitchen waste in an anaerobic CSTR. The effluent undergoes struvite precipitation and ammonia stripping for nutrient recovery. The struvite will be used together with hygienized sludge to produce fertilizer pellets. The Swedish national sludge certifications and EU end-of-waste regulations have facilitated the production and use of such pellets.

AFAS LIVE
Amsterdam, the Netherlands | 2013

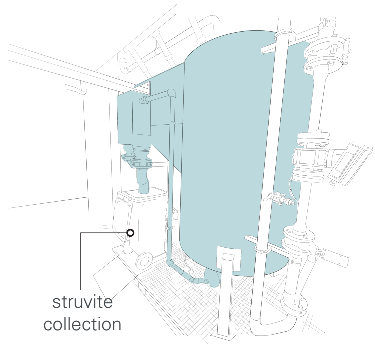




Struvite recovery from urine at centralized location

At an event complex, 54 waterless urinals divert urine to a collection tank (13 m³) in the parking garage. When the tank is full, it is transported to the centralized wastewater treatment plant for struvite recovery, used in fertilizer production.

NIEUWE DOKKEN
Ghent, Belgium | 2012



Struvite precipitation after anaerobic treatment

The residential and commercial district is situated in a former industrial area. The vacuum-collected blackwater is treated in an underground mechanical room in several UASB reactors, together with ground kitchen waste. The aerobic sludge from the greywater treatment also goes into the digester. The produced biogas is converted to energy (~600 MWh/year) via a combined heat and power (CHP) unit and fed into the district heating network. The effluent from the digester undergoes struvite precipitation, for struvite recovery (~ 1.2 tons/y).