Recovery and utilisation of nutrients for low impact fertiliser

Technology fact sheet – Struvite precipitation

Phosphorus recovery from domestic wastewater

Struvite precipitation is a well-known technology for phosphorous recovery from phosphate containing wastewaters. At the Run4Life project demo sites Ghent, Helsingborg and Vigo it is applied to the effluent of different domestic wastewater treatment processes (e.g. UASB and AnMBR). Struvite ($MgNH_4PO_4 \cdot 6(H_2O)$; MAP) is a crystalline mineral consisting of magnesium, ammonia and phosphate in equal molar amounts and can be used as a slow-release fertiliser in agriculture.

Several factors influence the process, such as the wastewater pH, supersaturation of struvite constituents, mixing energy, temperature and presence of other ions (e.g. calcium). The pH is considered to be one of the main factors influencing the crystallisation process. Crystal size and shape are influenced by the process conditions. In anaerobically treated black water and kitchen waste, ammonia is available in excess. Therefore, to recover struvite magnesium is added and the pH adjusted: an excess of magnesium and pH>8 is required for optimal precipitation of struvite. The magnesium sources in the Run4Life demo sites are magnesium oxide (MgO), magnesium hydroxide ($Mg(OH)_2$) and magnesium chloride ($MgCl_2$) and the pH is controlled by the addition of sodium hydroxide (NaOH) and/or by $Mg(OH)_2$. The energy requirement for struvite precipitation is low, and the process is generally stable.

Key facts

- High removal efficiency of phosphorus
- Simple and stable process
- Low energy input
- Proven and well-known technology

Application in Run4Life demo sites

- Input: UASB/AnMBR effluent, $MgO/Mg(OH)_2/MgCl_2$, NaOH
- Output: struvite, P-free liquid effluent
- Applied in Ghent, Helsingborg and Vigo

Image by Ekobalans Fenix AB.
A similar reactor is applied in Helsingborg.

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https://run4life-project.eu

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Different reactors at different demosites

The crystallisation plant in Vigo demosite is composed of a two-phase fluidized bed reactor (FBR) connected in series to a settler, and a $Mg(OH)_2$ slurry unit following the Phosphorus RecoverY As Struvite (PRYAS) process patented by USC and Aqualia. Growing of larger crystals (pellets) of struvite is promoted inside the FBR, while fine crystals are retained in the settler and then recycled to the FBR. The FBR has different cross-sectional areas, designed for maintaining the pellets fluidized and promoting their growth. $Mg(OH)_2$ is prepared by hydrating industrial grade MgO.

PRYAS struvite crystallization plant by Aqualia/USC a) settler, b) $Mg(OH)_2$ slurry unit and c) FBR

The struvite precipitation in Helsingborg demosite (picture on front page) starts with anaerobic digestion effluent collection in an aerated tank, to degass CO_2 from the effluent and increase pH. Normally, this is the only pH control, although there is an option to dose with NaOH to increase pH if needed. After this first step, the struvite precipitation takes place in three batch reactors. There are three reactors in order to continuously run the struvite precipitation process; one reactor is being filled, one is precipitating and one is being drawn at all times. $MgCl_2$ is added as precipitant and struvite is separated using a hydro cyclone. A feature of this process is that struvite is not allowed to form larger granules but is separated as a sand-like material. This feature is needed to allow for good mixing and pelletizing of fertilisers in the downstream processing into a NPK pellet fertiliser product.

In Ghent the effluent of the UASB reactor, treating a mixture of vacuum-collected black water and food waste, flows to the struvite reactor. In the struvite reactor $MgCl_2$ is added as precipitant and no additional pH adjustments are expected. The effluent is treated in an aerobic membrane bioreactor, together with the other domestic wastewater from e.g. showers and washing machines. Treated water is reused locally as industrial process water.

Struvite precipitation, Ghent. Image by CEIP/DuCoop

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