# Biological P dissolution before P precipitation from sludge liquor


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## 1. Introduction

Dissolved P in the liquor is the main factor limiting P recovery rate from sewage sludge. At labscale, bioacidification had been proven to increase the P dissolution rate, from 15-20 to 75% of the P entering the WWTP. This simple process consists in making the **endogeneous sludge bacteria producing acid in situ from sugar rich waste co-substrates**. 3 mechanisms involved in P dissolution (figure 1):

- Acid production by lactic acid bacteria ➔pH decrease dissolving a part of calcium or magnesium P salts
- P release by the PAO due to organic acid produced
- Reduction of Fe(III) to Fe(II) by iron-reducing bacteria making the IronP salts more soluble

**The aim of the work was to demonstrate, at large scale, the feasibility of using this process in combination with the Struvia P crystallisation technology to recover P from different types of sludge liquor.**

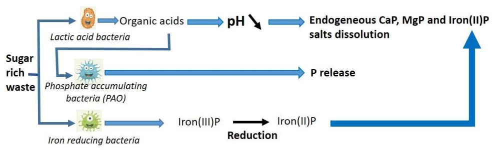


Figure 1: P dissolution mechanisms involved by feeding the endogenous microbial community with sugar rich waste (© INRAE)

## 2. P-recovery methodology

Sugar rich co-substrate (waste from food industry) is mixed with sludge in the bio-acidification tank during 24-48 hours at 35°C ➔ P is dissolved (up to 75% depending on the sludge).

Magnesium and/or calcium reactants are added to the liquid from separation in Struvia reactor ➔ pH is increased ➔ P is precipitated as struvite and/or calcium phosphate and/or hydroxyapatite according to the quality expected.

The liquid from the Struvia and the solid from the solid/separation step are mixed again to reach a pH suitable for anaerobic digestion.

See figure 2.

## 3. P-rich product

Two products can be obtained. P-salts with high plant availability (struvite) can be used directly as a fertilizer whereas P-salts with a lower plant P-availability (HAP) are suitable as intermediates in a P fertiliser production process.

A sewage sludge with a reduced P content is generated, which can be used either as organic fertiliser without P constraints or within co-incineration plants such as in the cement industry.

The end-of-waste status of some P-salts is available in some countries. A REACH registration is required in case the P-salts are to be used as ingredients in EU fertilising products.

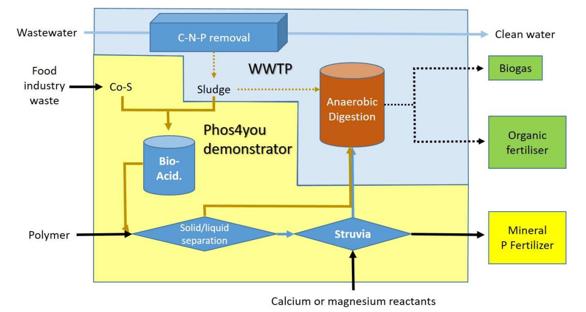


Figure 2: Implementation of the bio-acidification/Struvia technology in a WWTP (© INRAE)

Table 1: characteristics of the WWTP chosen as demonstration sites

| 2 different demonstration sites | | | | |
|---|---|---|---|---|
| | p.e | C-N removal | P removal | Sludge DM (g.Kg[-1]) |
| S1 | 620,000 | Fixed biomass | EBPR+Al | 30-55 |
| S2 | 32,000 | SBR | FeCl3 | |

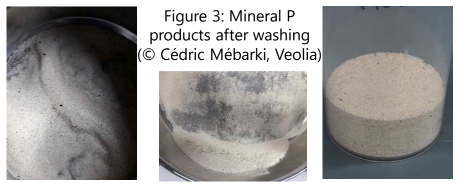

Figure 3: Mineral P products after washing (© Cédric Mébarki, Veolia)

## 4. Discussion

- This process can be applied on a large range of WWTP (size and P removal technologies) (table 1 and figure 4). However the variability of the sludge in the same WWTP required to adjust the CoS amount for strictly control the pH below_4,and dissolve more than 50% of the total P in sludge coming from EBPR+Al P removal process.

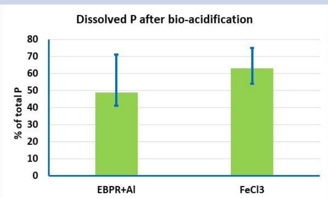


Figure 4 : P dissolution by bio-acidfication. Error bar are from the minimum to the maximum dissolution rate obtained. (© INRAE)

- The best location for the P removal process is between sludge dewatering and anaerobic digestion.
- The hydraulic retention time is short (24-48 hours) compared to anaerobic digestion and do not penalise the sludge valorisation process.

- Struvite was obtained by adding magnesium salts and ammonium and DCP by adding calcium salts, however due to high reactant cost HAP was chosen as final product. Only lime is required to precipitate P in that case.


Figure 5 : Demonstator in each location (© Cédric Mébarki, Veolia)

## 5. Conclusion

Bioacidification before P precipitation is efficient to recover P as mineral fertilizer from different type of sludge even coming from WWTP using metal salts for P removal. This process is a combination of proven technologies which make it rustic and reliable for small/medium to large size WWTP.

The economical balance of the process can be insured if an acceptable product for fertiliser industry is produced rather than a technical product whose production cost is too high. This could be achieved thanks to using sugar rich waste as co-S and to the increase in biogas production, making this process very interesting wherever P recovery is becoming mandatory.

Side benefits which could not be assessed in this project are expected as land spreading area reduction and decrease in the WWTP maintenance cost (avoiding pipes and equipment clogging by struvite).


**References**:

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