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Cost effective phosphorus recovery from biological wastewater treatment

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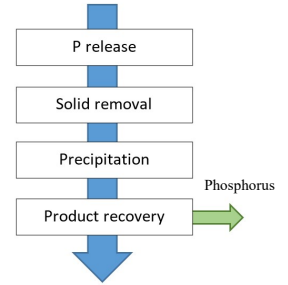
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INTRODUCTION

Phosphorus is an **environmental pollutant** and an **essential nutrient**. It is therefore necessary to remove and recycle phosphorus from wastewater to overcome the potential phosphorus scarcity. Phosphorus is often removed from wastewater by adding iron or aluminum salts which complicate the possibility for recycling or reusing the phosphorus. Phosphorus can also be removed biologically by polyphosphate-accumulating organisms (PAOs), also called enhanced biological phosphorus removal (EBPR). In the EBPR plant the PAOs will release the phosphorus under anaerobic condition e.g., in hydrolysis tanks for return sludge or in digestors. Phosphorus can thereby be recovered from the liquid phase during wastewater treatment. In the case of, recovery of phosphorus from the liquid phase is a promising method, both for phosphorus recovery but also to avoid unintentional phosphate precipitation in pipes and pumps.

The potential for recovering phosphate from the hydrolysis tank was tested as a simple method to remove and recover phosphorus, reduce the iron chloride addition, and avoid potential scaling in the WWTP. Calcium salts were used to precipitate phosphorus as calcium phosphate salts. The products were recovered from the suspension and the rest returned to the biological treatment



METHODS

A pilot-scale facility was set-up at Randers WWTP (Figure 1). Sludge was taken from the hydrolysis tank (retention time 24 h) and a cationic polymer (BoFloc P 6267 M) added. A lamella separator was used to remove >90% of the organic materials, which was returned to the hydrolysis tank. Phosphorus was then precipitated from the liquid by adding different salts including calcium hydroxide, calcium chloride, magnesium chloride, potassium hydroxide and sodium hydroxide in the ratio of 2:1 mole/mole Ca:P. A drum filter was used to remove the phosphorus precipitate.

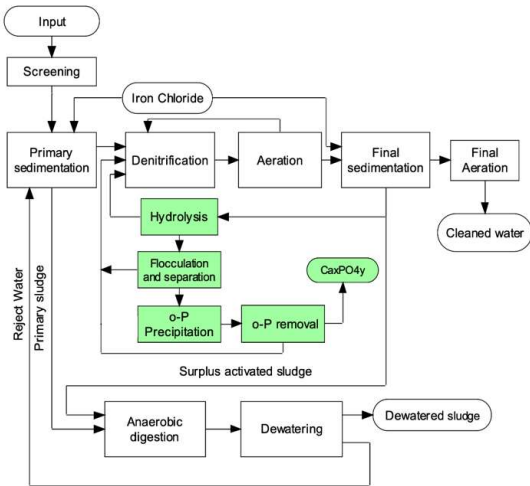


Figure 1: Wastewater treatment plant for removal of phosphorus. The green boxes shows the pilot-scale facility for removal of phosphorus

Approximately 2 mmol hydroxide per L sludge (in form of e.g., calcium hydroxide or sodium hydroxide) are required to increase pH to 8.5.

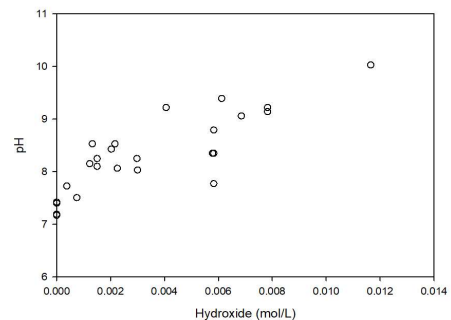


Figure 3: Alkaline consumption during precipitation process

The precipitate was analysed showing that most of the phosphate was bound as calcium phosphate (Figure 4). Sample contains around 20% organic materials and less than 5% of iron and aluminium. The precipitate could be separated from the liquid, but the precipitated particles are small (around 10 µm) – and the precipitation process must be further optimized.

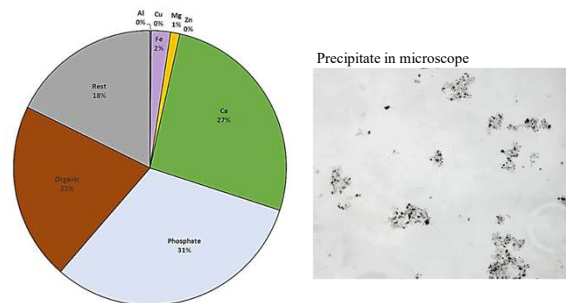


Figure 4 Composition and morphology of precipitate.

RESULTS

Different dosages of polymer were tested, and the results showed that 21 mL 0.2% BoFloc P 6267 M polymer per L sludge was sufficient to ensure a clear liquid phase after the lamella separation. More than 95% of the organic materials was flocculated and removed in the separator. The biological activity in flocculated sludge was the same as in raw sludge, so the polymer was not harmful for the microorganisms, and the flocculated sludge could be returned to the hydrolysis tank. The concentration of dissolved phosphate in the liquid phase was 50 mg/L after removal of organic materials.



Calcium hydroxide or calcium chloride and sodium hydroxide was added, and the results showed that more than 95% of the phosphate were removed at pH 8.5 (Figure 2).

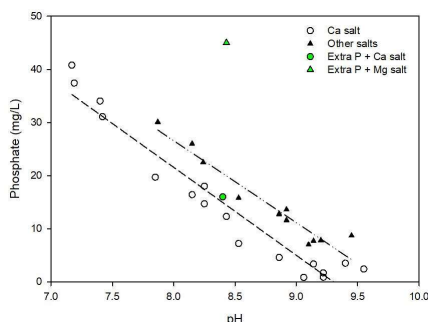


Figure 2: Dissolved phosphate in liquid at different pH

CONCLUSIONS

At the pilot-scale facility, it was possible to remove 90% of the phosphate by adding calcium salt and adjusting the pH to 8.5

The required apparatus for flocculation, separation, precipitation and recovery of phosphorus are relatively simple to establish

The precipitation process are simple to control, which can be done by simple measuring and controlling pH

The phosphorus yield depends on the concentration of dissolved phosphate in sludge are comparable with other method, where phosphorus are recovered from wastewater.

Amorph calcium phosphate are obtained (Ca:P ratio is 2:1 mole/mole)

Size of the precipitate particles should be increased and the organic content in the precipitate lowered before the method is implemented

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