Collaboration for Environmental Evidence

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Struvite precipitation is an effective technology for nutrient recovery from anaerobic digestate, while there is limited evidence to conclude the effectiveness of ammonia stripping

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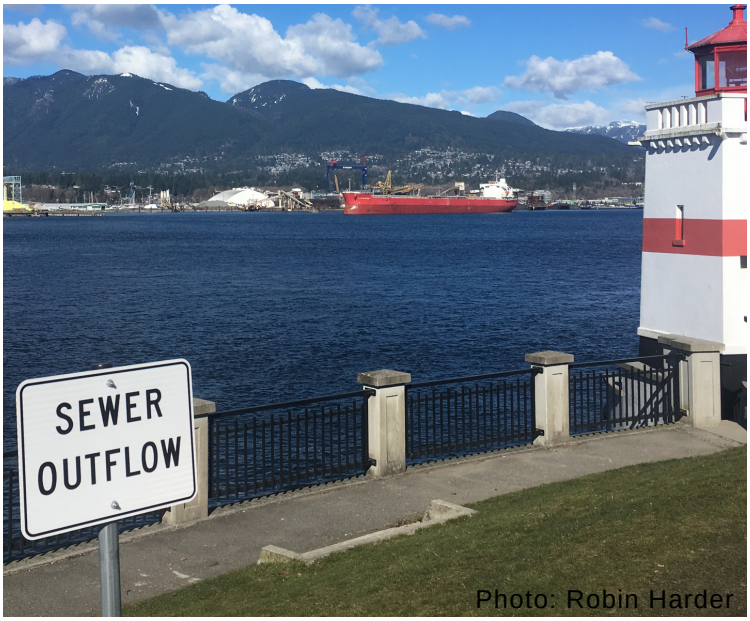

Photo: Robin Harder

Struvite precipitation was found to be an effective technology for nutrient recovery from the liquid phase of anaerobic digestate. The precipitation process is most efficient at a pH of around 9.5 and higher molar ratio of magnesium to phosphate (up to 4:1) in liquid phase of anaerobic digestate. These conditions have a positive effect on phosphorus removal. The evidence base for ammonia stripping was limited and therefore no conclusive results about appropriate conditions for the most efficient nitrogen extraction could be made.

Why is this Evidence Synthesis Needed?

A regular supply of nutrients such as nitrogen and phosphorus to agriculture is needed for global food security. At the same time, protecting water quality requires that emissions of these nutrients to water bodies are minimized. The recovery and reuse in agriculture of nutrients in organic waste streams can make important contributions both to mitigating problems with future nutrient supplies and current water quality. Anaerobic digestion of sewage sludge and agricultural wastes is widely applied to stabilize the substrate and capture some of its energetic value via biogas production. Anaerobic digestate is also a concentrated source of nutrients to which nutrient recovery technologies can be applied. By combining anaerobic digestion and nutrient recovery technologies on the nutrient rich digestate both energy and nutrient recovery can be achieved. The normal practice however is to recirculate the digestate back into the inlet of the wastewater treatment plant, which contributes to a significant load on the plant.Two technologies that could increase nutrient recycling from different types of wastewater are struvite precipitation and ammonia stripping. Struvite precipitation is a technology that is used mainly for recovery of phosphorus. Struvite (obtained from the precipitation process) is a crystalline mineral composed of equimolar concentrations of magnesium, ammonium and phosphate. Ammonia stripping is applied to liquids containing high concentrations of ammonia. The resulting product is a low pH ammonium sulphate. Both struvite and ammonium sulphate can be used as a fertiliser. This review examined the effectiveness of the two technologies for the recovery of nitrogen and phosphorus from anaerobic digestate.

This Collaboration for Environmental Evidence systematic review examines if and under which conditions struvite precipitation and ammonia stripping are efficient in recovering phosphorus and nitrogen from anaerobic digestate. The review summarizes evidence from 30 studies on struvite precipitation and 8 studies on ammonia stripping.

Main Findings

What studies are included?

This review includes studies that evaluate the effectiveness of struvite precipitation for phosphorus recovery and ammonia stripping for nitrogen recovery from anaerobic digestate. A total of 38 studies from the period 2013 to 2019 were deemed to be of sufficient methodological quality to be included in the final analysis. These studies were mostly carried out in Asia (China especially). The evidence base for struvite precipitation included 30 small scale studies (laboratory or bench scale operations) with 298 experiments that used sewage sludge and different types of manure as an input streams. The 8 included studies on ammonia stripping were mainly conducted in Europe, and consisted of 42 experiments in total.

Is struvite precipitation an effective technology for recovery of phosphorus from anaerobic digestate?

The recovery of struvite was substantial regardless of the type of substrate in the performed experiments. Moreover, when performed under the right conditions where the pH of the input stream is around 9.5 and the Mg:PO4 ratio is at least 1:1, available evidence suggests that struvite precipitation is an effective technology for the recovery of nutrients from the liquid phase of anaerobic digestate.

Is ammonia stripping an effective technology for recovery of nitrogen from anaerobic digestate?

Studies on ammonia stripping were relatively heterogeneous. Due to the small size of the evidence base, and the heterogeneity between studies, no conclusions are presented regarding the influence of different process parameters on the outcome of ammonia stripping.

What are the Implications of the Review Findings?

Photo: Criniger kolio

By examining two of the currently most mature technologies for recovery of nutrients from anaerobic digestate, this review contributes to a knowledge base necessary for the transition to a circular economy, nutrient circularity and food security. The review findings suggest that struvite precipitation is an efficient technology for nutrient recovery from anaerobic digestate. As such, struvite precipitation could be applied to recover nutrients within wastewater treatment. It can also be used to produce easy-to-transport fertilizers from manure, which may prove useful for reducing nutrient loads and eutrophication in regions with intensive animal farming. Given that evidence base was small and heterogeneous for ammonia stripping process, no policy implications can be drawn from this evidence base. To assure meaningful syntheses of this body of evidence, we call on researchers to present at least the following parameters when performing experiments on ammonia stripping: pH of the inflow to the stripping process, liquid and air flow rates, temperature of both the liquid and the air in the inflow, concentrations in terms of ammonia or total ammonia nitrogen and total nitrogen, both removal and recovery in the stripping column as well as recovery in the acid scrubber.

Photo: BMJ

Synthesis Time Frame

The review authors searched for studies published between 2013 and 2019. This CEE Systematic Review was published in November 2020.

Full Citation

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