Phosphorus Roadmap II: Pilot Scale Demonstration

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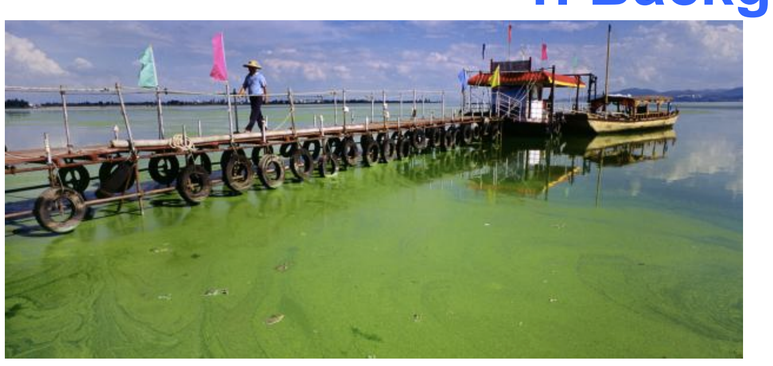
stream

The Industrial Doctorate Centre for the Water Sector

1. Background



Phosphorus is the main source of eutrophication in natural water bodies. Water framework directive is expected to impose a new final effluent consent of 0.1 mg P/l to match concentration in natural water.

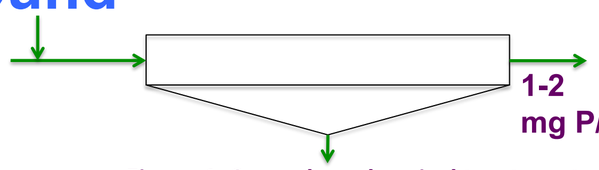


Figure 1. Secondary chemical treatment

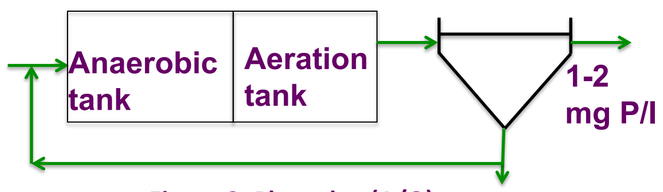
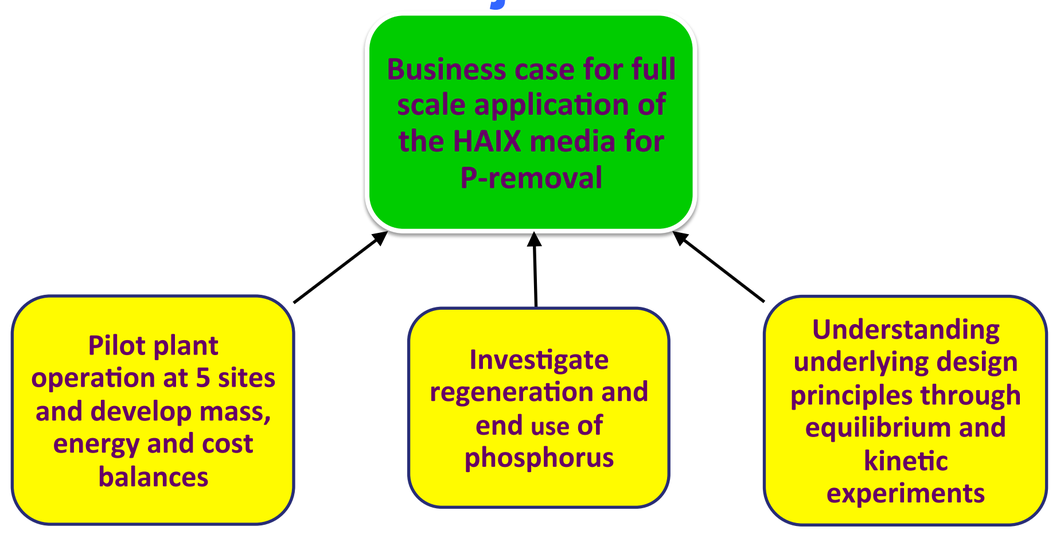


Figure 2. Phoredox (A/O) process

Existing technologies will not be able to meet future consents .

2. Objectives



2. HAIX media

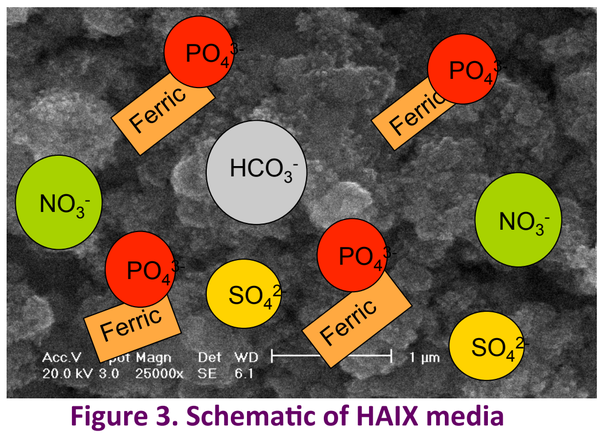


Figure 3. Schematic of HAIX media

Conventional ion exchange media is not selective for phosphorus removal. Hybrid anion exchanger (HAIX) is a standard polymeric strong base anion exchanger into which ferric oxide nanoparticles have been dispersed. This makes the media highly selective for phosphorus removal from wastewater.

3. Initial findings

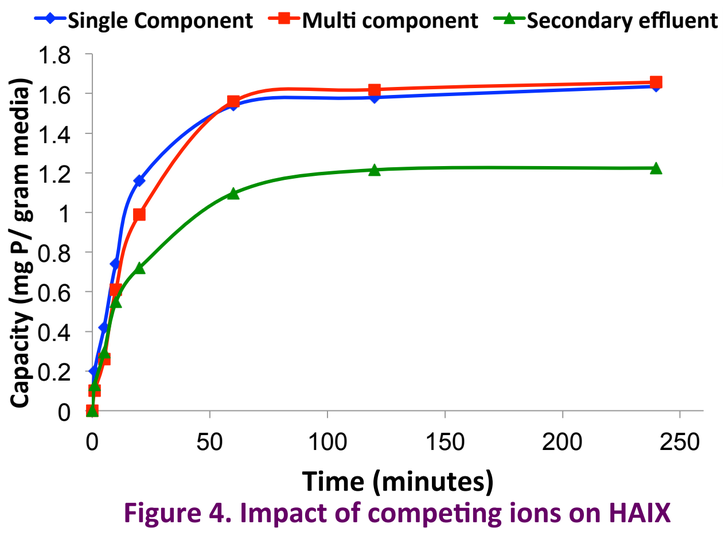


Figure 4. Impact of competing ions on HAIX capacity and kinetics

Single Component	Multi Component	Secondary effluent
Phosphorus = 8.5 mg/l	Phosphorus = 8.5 mg/l Sulfate = 61 mg/l TOC = 40 mg/l	Phosphorus = 6.6 mg/l Sulfate = 58 mg/l TOC = 16 mg/l

Batch kinetic experiments have shown that 60% of adsorption of phosphorus takes place in the first 20 minutes. Even in the presence of competing ions, HAIX is still highly selective for phosphorus and the capacity is reduced by only 23% .

4. Pilot plant trial

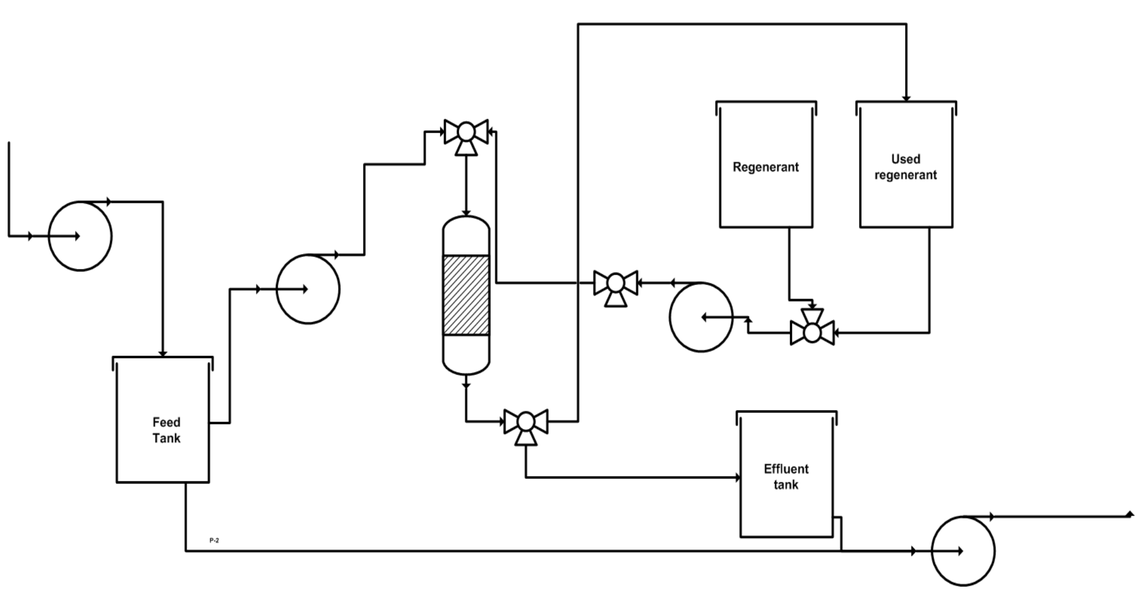


Figure 7. Pilot plant

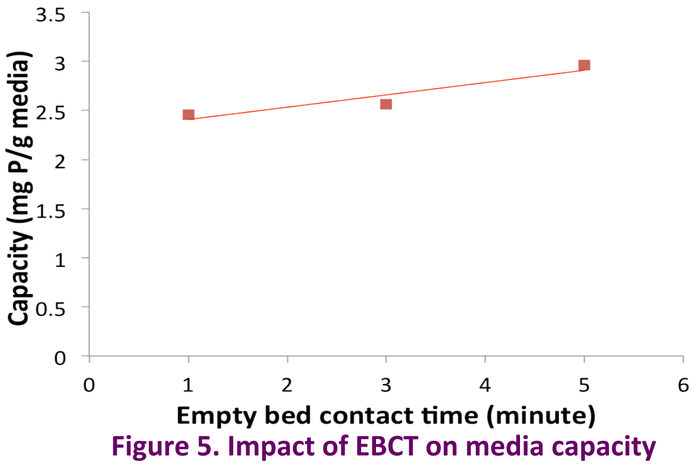


Figure 5. Impact of EBCT on media capacity using secondary effluent

Lab scale column experiments have shown that phosphorus removal can take place at empty bed contact times (EBCT) of <5 minutes. HAIX capacity is reduced by 15% between empty bed contact times of 5 minutes and 1 minutes, showing that the media is efficient at low EBCT.

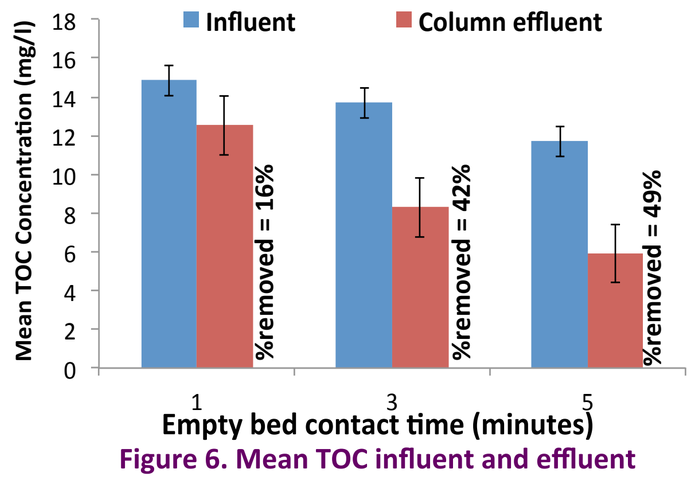


Figure 6. Mean TOC influent and effluent concentrations for column experiments

Although HAIX is highly selective for phosphorus, it has also shown a capacity for organics in wastewater. Forty-nine percent of total organic carbon (TOC) removal was achieved at an EBCT of 5 minutes over the course of the experiment.

- A mobile pilot plant has been designed and will be operated at 5 different wastewater treatment works for secondary effluent P removal.
- The types of wastewater treatment sites include treatment works with phosphorus removal so that the HAIX media can be tested for treating full phosphorus load. HAIX media will also be tested be for phosphorus polishing at treatment works with existing phosphorus removal processes either biological or chemical.
- Regeneration will be completed with sodium hydroxide when breakthrough of 0.1 mg P/l and 1 mg P/l is reached in the treated effluent for phosphorus polishing and full phosphorus treatment sites respectively.

5. Outcomes

1. Develop a design guide for using HAIX media systems for treating full phosphorus load as well as P polishing at wastewater treatment works
2. Future proof solution to managing phosphorus.
3. Propose suitable end product uses of the recovered phosphorus (struvite, phosphoric acid).

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