Removal of key pollutants from wastewater by adsorption: N, P and COD

Professor Ana Soares

Ion exchange processes for nutrient removal

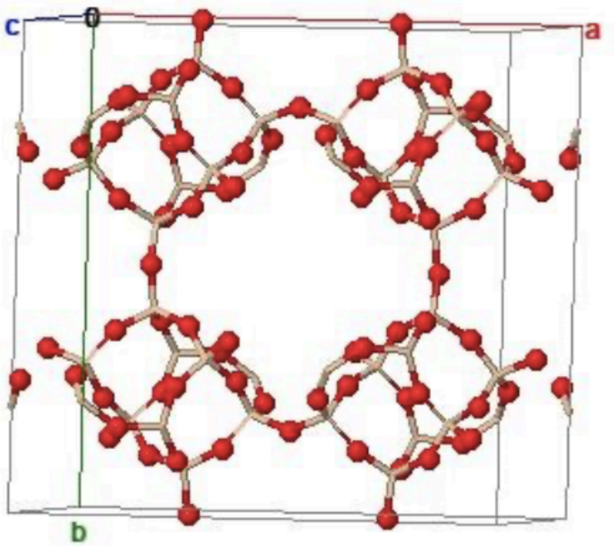
10 m^3/day
P removal 5 min contact time
N removal 10 min contact time

Ammonia removal: Zeolite-N
Exchange of ammonia with potassium or sodium

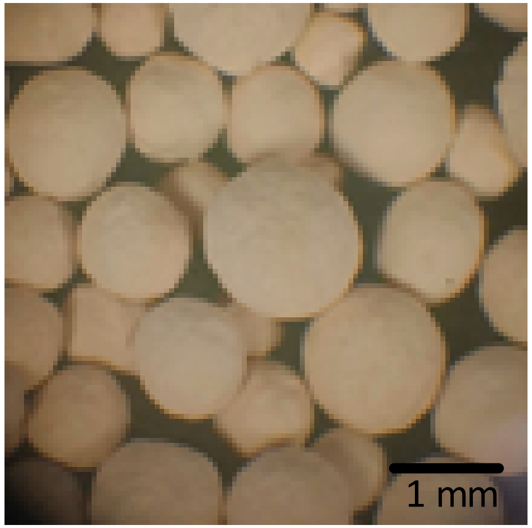
Phosphorus removal: hybrid anion exchange
Adsorption of P to iron nanoparticles. Can be reversed by an increase in pH

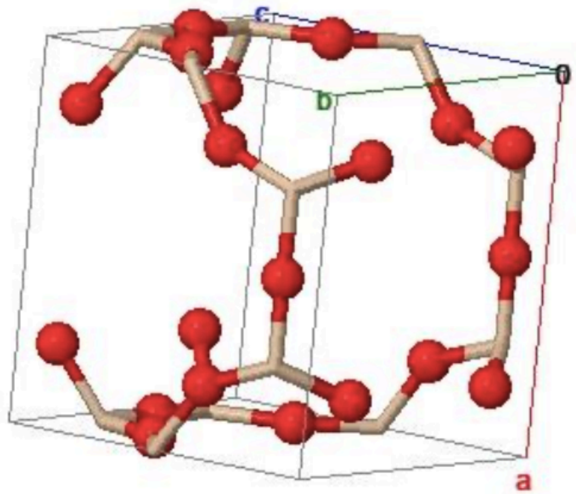
Zeolites

Clinoptilolite



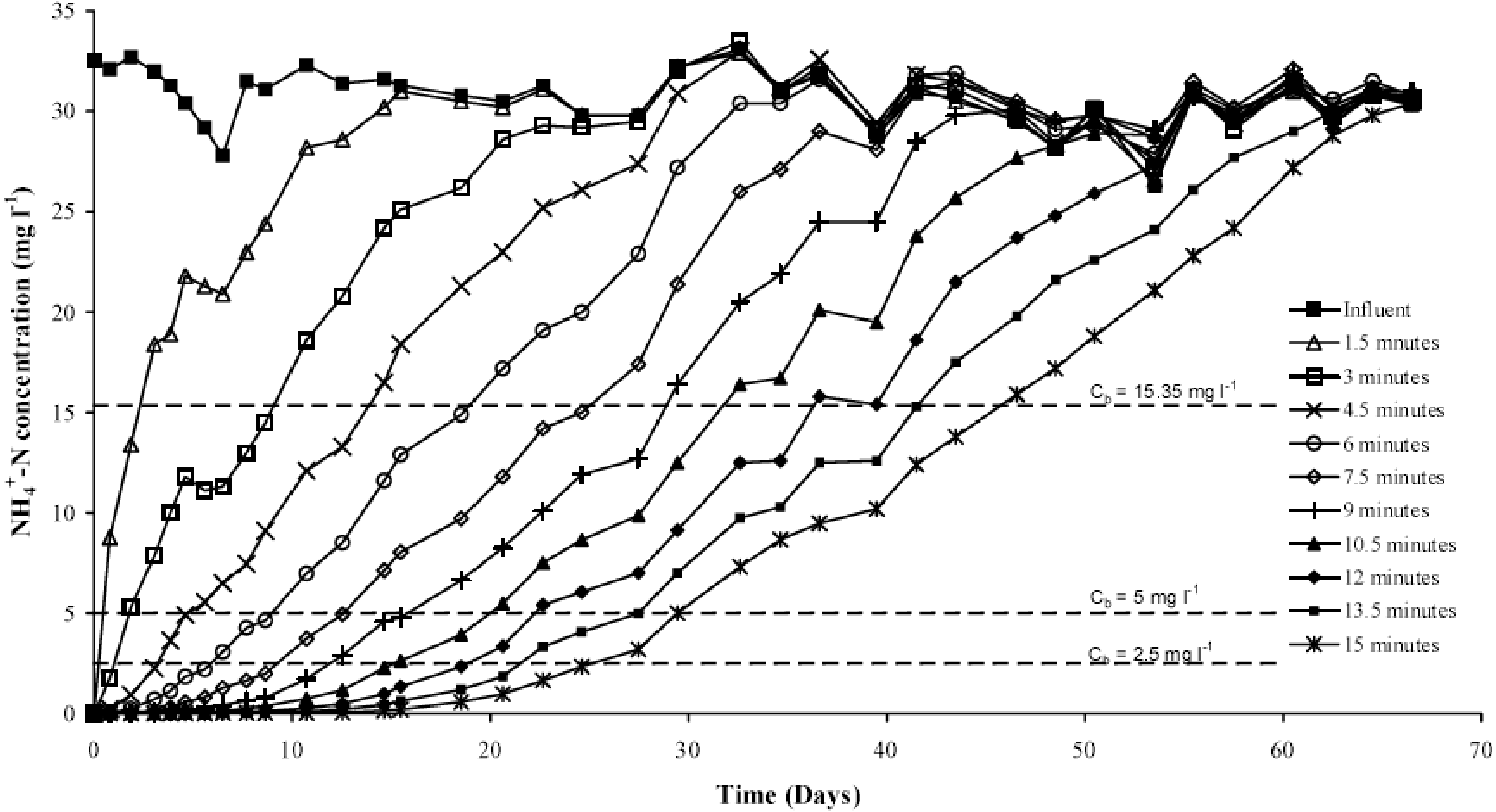
Zeolite-N





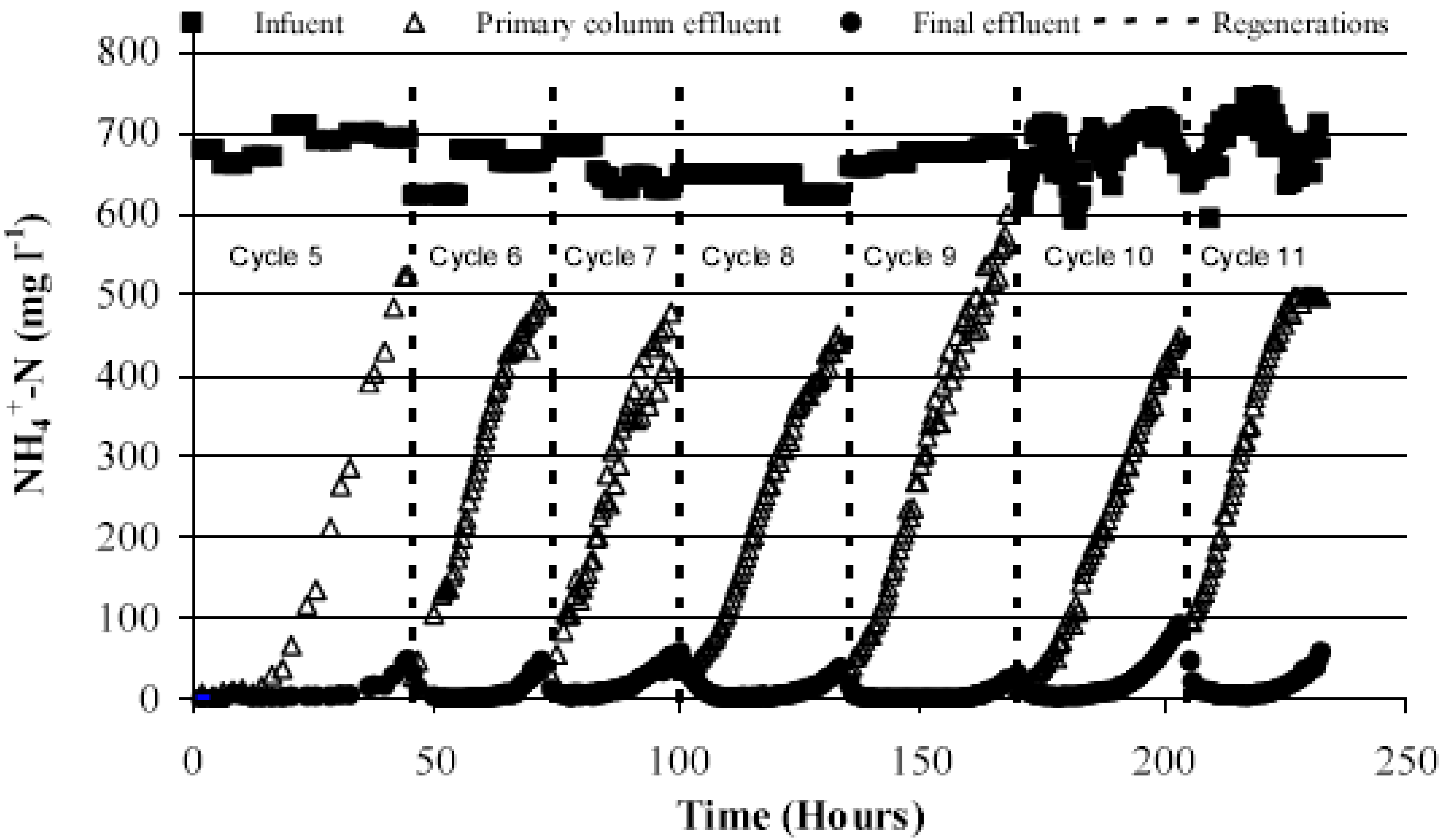
Zeolite-N

Breakthrough time is dependent on EBCT – this example is for a raw wastewater of ~30 mg/L of NH_4



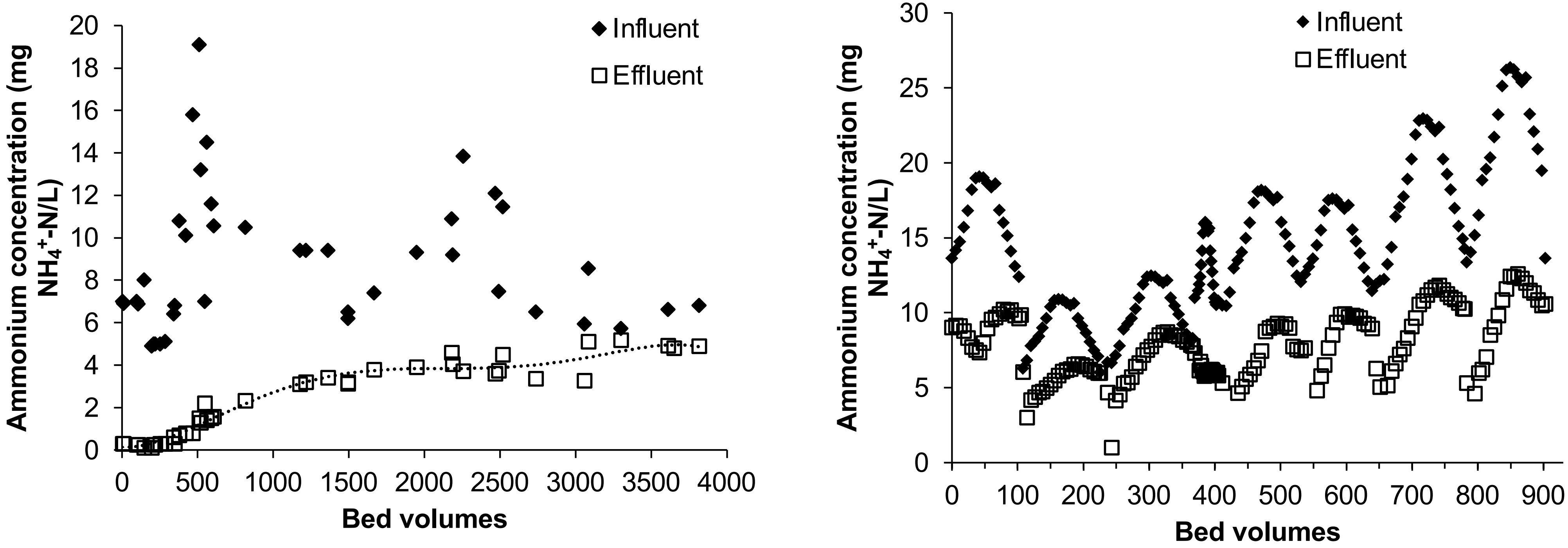
A. Thornton, P. Pearce, S.A. Parsons. Ammonium removal from digested sludge liquors using ion exchange. Water Res., 41 (2007), 433-439

Process developed for sludge liquor treatment is very effective



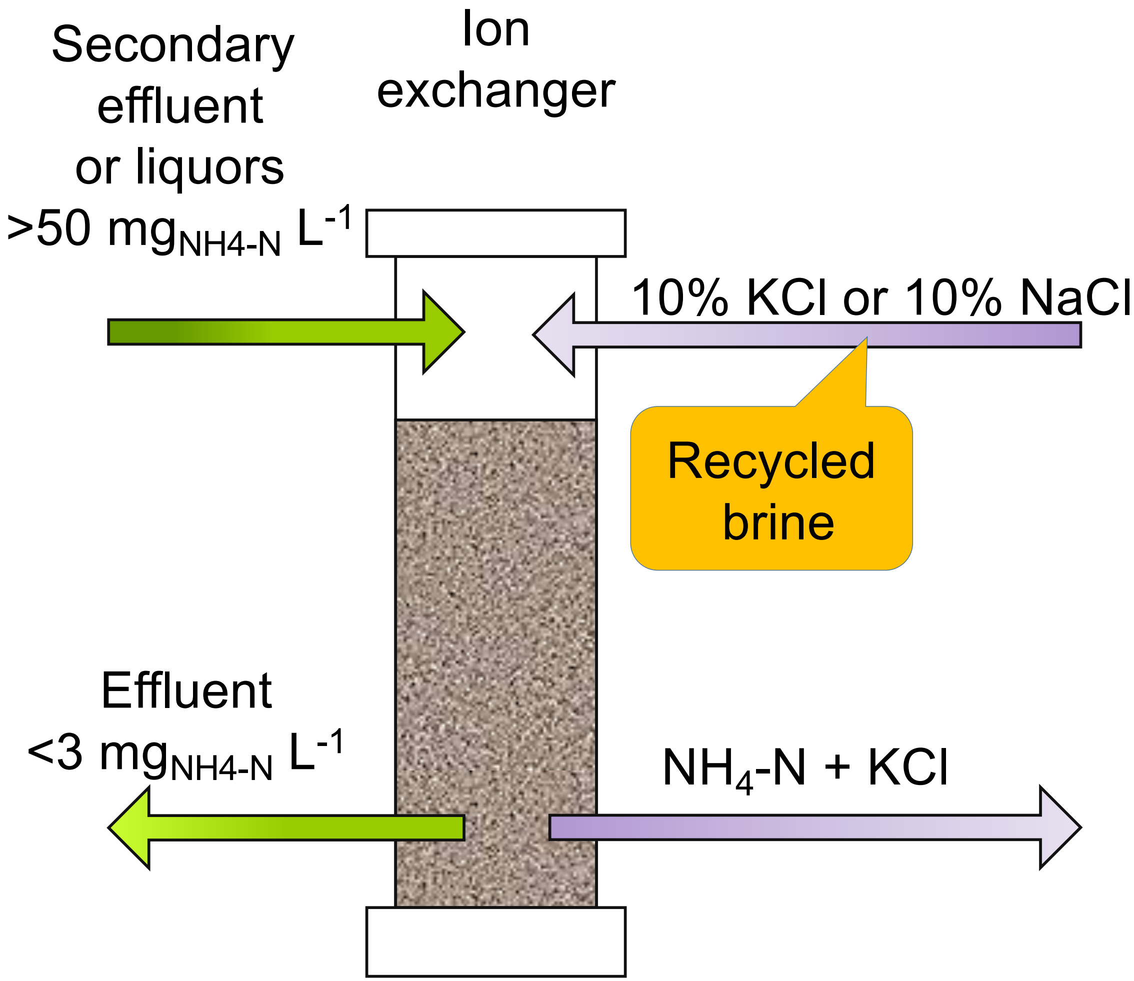
A. Thornton, P. Pearce, S.A. Parsons. Ammonium removal from digested sludge liquors using ion exchange. Water Res., 41 (2007), 433-439

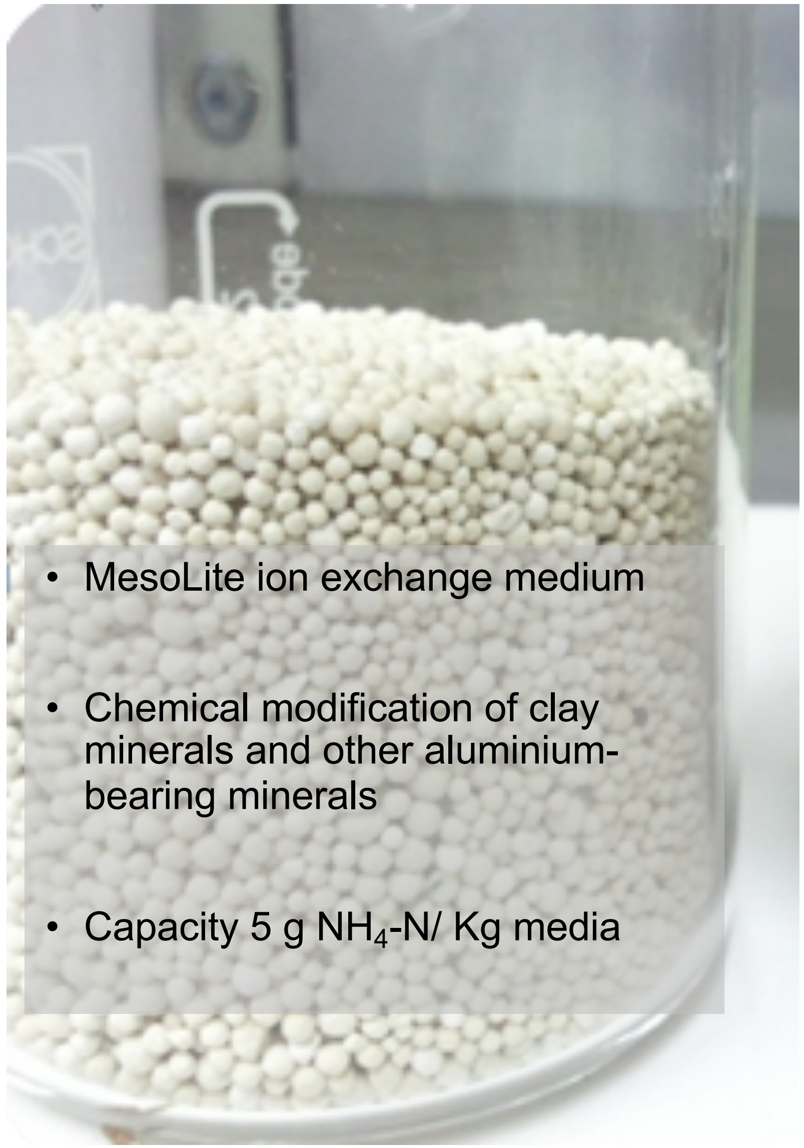
Process developed for tertiary treatment



Guida S, Conzelmann L, Remy C, Vale P, Jefferson B, Soares A. 2021. Resilience and life cycle assessment of ion exchange process for ammonium removal from municipal wastewater. Science of the Total Environment. https://doi.org/10.1016/j.scitotenv.2021.146834

But what about the brine?





- MesoLite ion exchange medium
- Chemical modification of clay minerals and other aluminium-bearing minerals
- Capacity 5 g NH_4-N/ Kg media

Regenerant and ammonia recovery using commercial products

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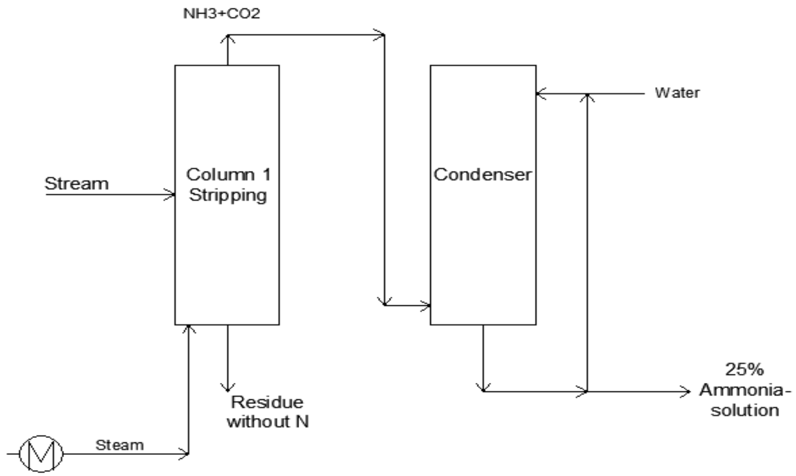
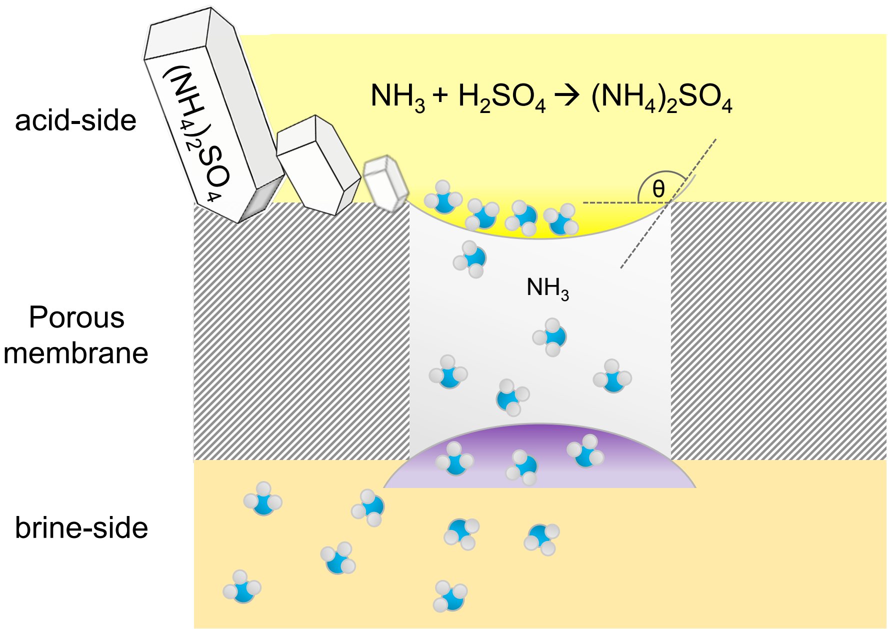
Cranfield University

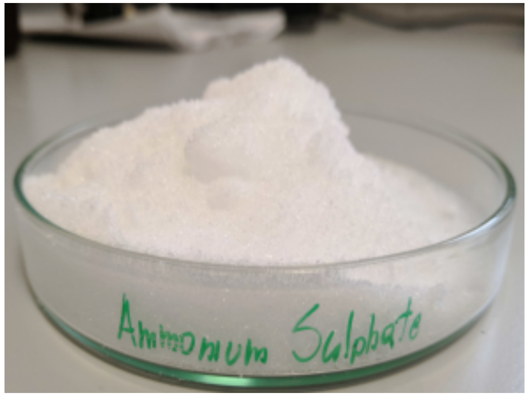
Ammonia steam stripping process



Ammonia water (25%)

Hollow fibre membrane contactor





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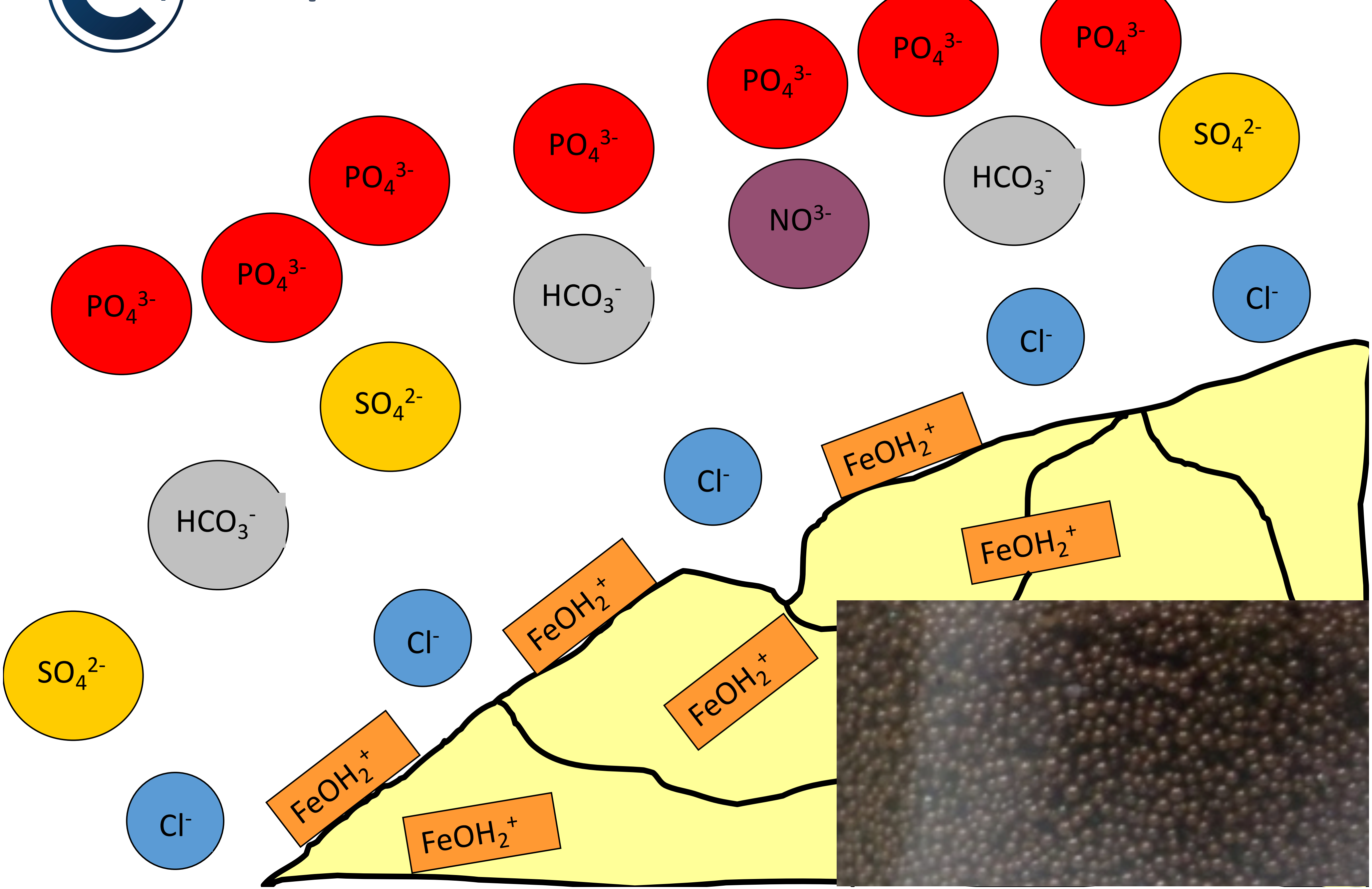
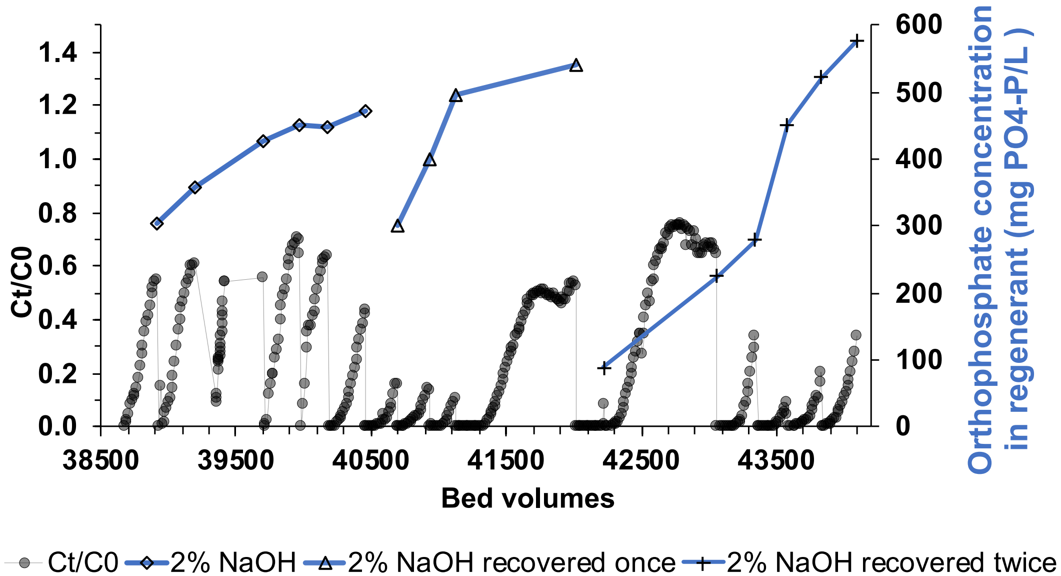
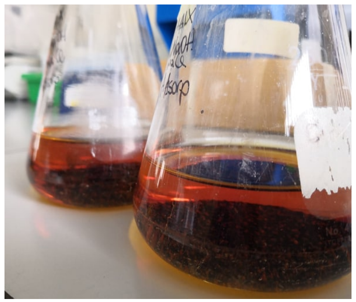
Phosphorus removal media



Operation of the phosphorus removal IEX



-The HAIX removed an average of 6 mg PO_4-P /L to >0.3 mg PO_4-P/L, within 430 bed volumes
-To manage the regenerant (NaOH 2%) efficiently, this was reused up to 8 times, reaching 785 mg PO_4-P/L
-Process was stable over 2- year operation, although some carbon fouling was observed



Recovered products

CaOH Impurity	Result (µg/g)
Cadmium	<12.5
Copper	42.5
Lead	4
Mercury	<0.125
Zinc	77.5
Non-ionic surfactants	<500
Bis(2ethylhexyl)phthalate	<25
Bisphenol A	<2.5
Nonylphenol	<25
PAHs	<0.05
Tributyltin	<0.05

Up to 30% COD removal

Guida S, Rubertelli G, Jefferson B, Soares A. 2021. Demonstration of ion exchange technology for phosphorus removal and recovery from municipal wastewater. Submitted.

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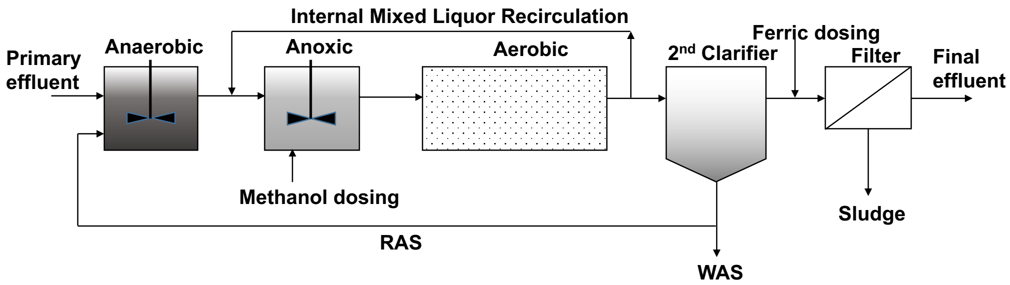
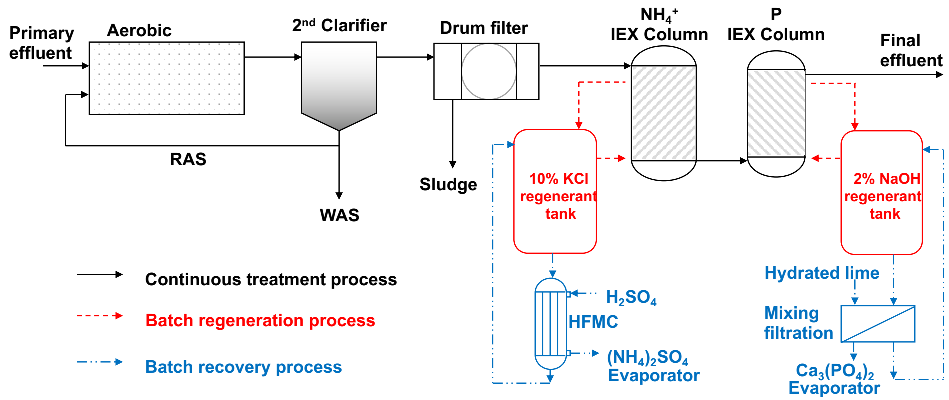
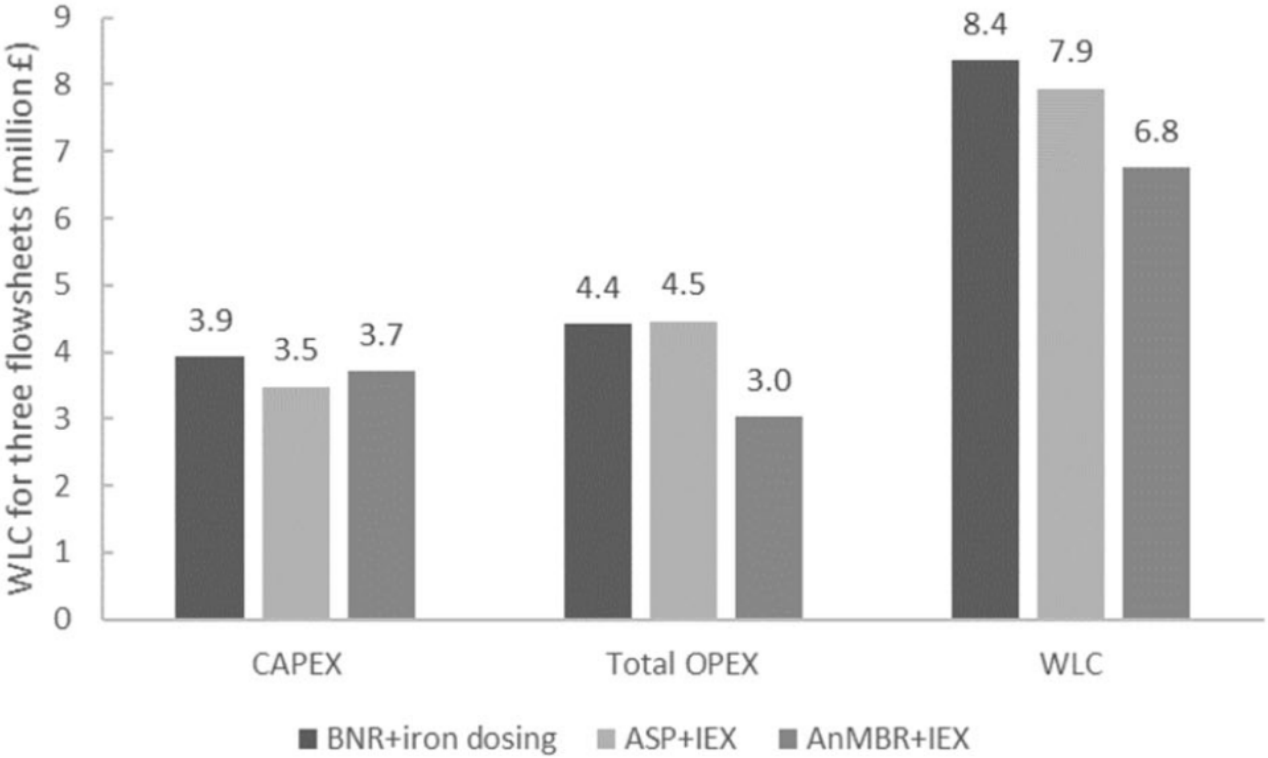
A resource recovery strategy can have economic (and environmental) benefits







Huang H, Guida S, Jefferson B, Soares A. 2020. Evaluation of performance and economics of ion exchange processes for ammonia and phosphorus removal and recovery from municipal wastewater. NPJ Clean Water. 30:7

H2020 NEXT-GEN

Spernal (UK)

Waste Water Treatment Plant

Circular solutions for

Water **Materials** **Energy**

Relevant data

Waste water plant serving the town of Redditch (Birmingham, UK): 92.000 PE

Relevant sectors

Agriculture **Domestic sector** **Energy sector**

Lead partners

Cranfield University

Resource recovery and innovation centre

WONDERFUL ON TAP SEVERN TRENT

Spernal WWTP serves as Severn Trent Water's "Resource Recovery and Innovation Centre" where emerging technologies compatible with a low energy, circular economy approach will be evaluated.

A multi-stream test bed facility was constructed in 2019 and this will incorporate **an anaerobic membrane bioreactor (AnMBR) to be commissioned in Summer 2020. The AnMBR will also comprise a membrane degassing unit to recover dissolved methane and ion exchange processes to recover nitrogen and phosphorus from the effluent.**

AnMBR combines several benefits such as:

- no aeration energy for removal of Chemical and Biological Oxygen Demand (COD/BOD)
- low sludge production and hence reduced downstream sludge treatment costs
- biogas production (production of electricity/heat
- pathogen and solids free effluent which can be re-used in a number of applications (e.g.: farming and industrial use).

Thank You