Resource Container, Concept for nutrients recovery

Jätevesien ravinteet kiertoon -webinar
October 23rd, 2020

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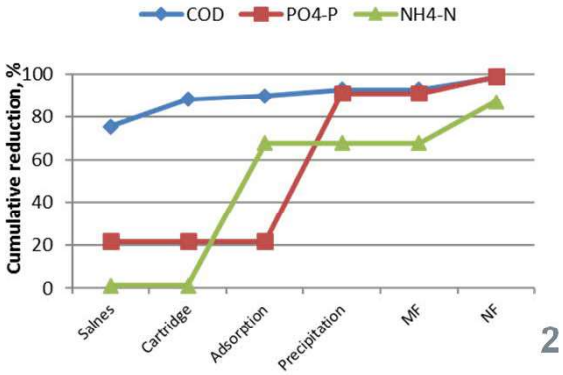
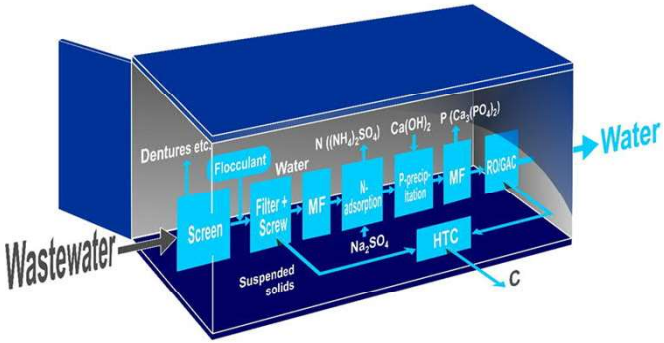
Resource container –project 1

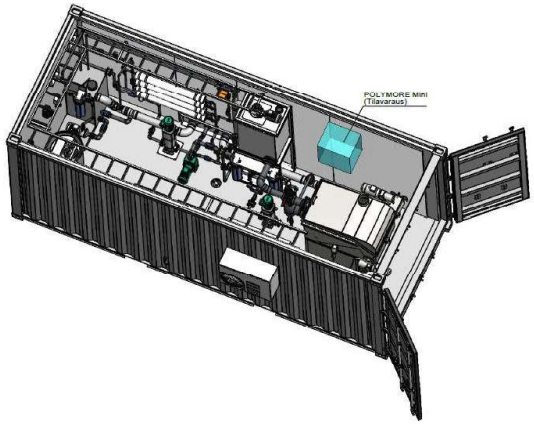
- Target: New solutions for wastewater treatment and nutrient recovery, and for better usability of the recycled products
- Actions: Concept development, pre-piloting at Parainen WWTP, and the first TEA calculations
- Financing: Raki 2, YM and VTT
- Running time: Dec 1st , 2016 – Dec 31st 2017
- Cooperation: Sofi Filtration, Aquaminerals, OWACO, Kemira, Dewaco, Watman, BSAG, Parainen, Pöyry, Turku AMK
- Result: 99% reduction/recovery for suspended solids, COD, phosphorous, and 87% for nitrogen



Resource container –project 2

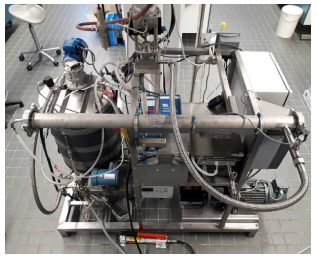
- Target: Plug-and-play resource container to be implemented in various scales locally or as seasonal solutions
- Actions: Two pilots of water purification and products recovery from wastewater using resource container with physico-chemical units applicable for varying wastewater loads and temperatures
  - Chipsters Food and PSSry
- Financing: Business Finland, VTT, companies
- Running time: Apr 2nd, 2018 – Mar 31st, 2020
- Cooperation: Watman, Sarlin, Aquaminerals, Chipsters Food, Pidä Saaristo Siistinä ry, Nordkalk, Bluet, Ecomation

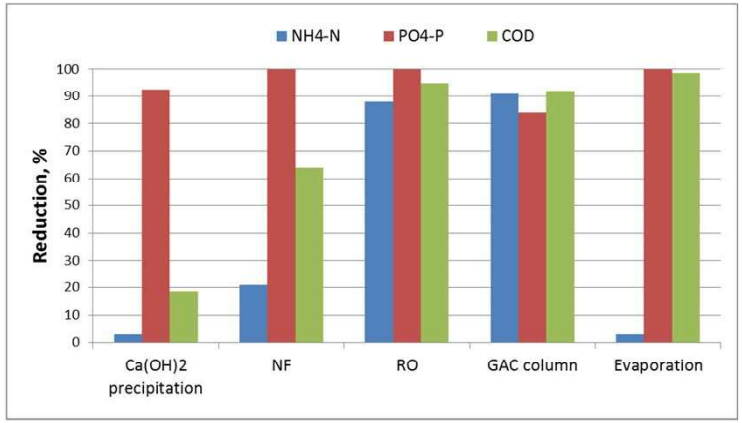




Nutrients recovery technologies studied in Resource container -projects

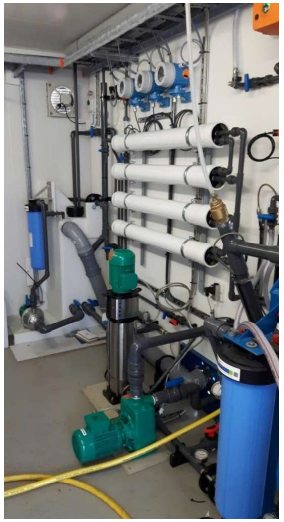
- Phosporous
  - Precipitation using calcium products
  - Nanofiltration, reverse osmosis
  - Evaporation
  - Adsorption using adsorbent and GAC
- Nitrogen with and without pH adjustment
  - Evaporation, stripping
  - Nanofiltration, reverse osmosis
  - Membrane contactor
  - Adsorption using adsorbent and GAC

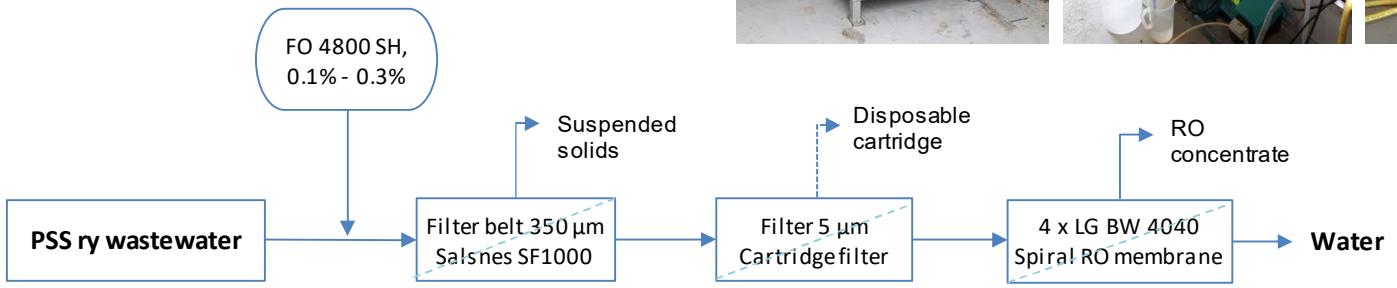




Resource Container = Mobile pilot equipment

- Belt, *e.g.* 350 µm, in Salsnes SF1000 filter
- Cartridge filter SPE-5-9¾BB, *e.g.* with 5 µm pore size (nominal rating)
- RO membrane elements, *e.g.* LG BW 4040 ES

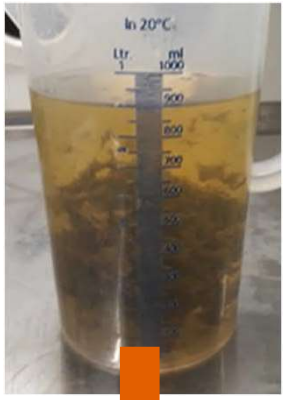




Main elements of Resource Container

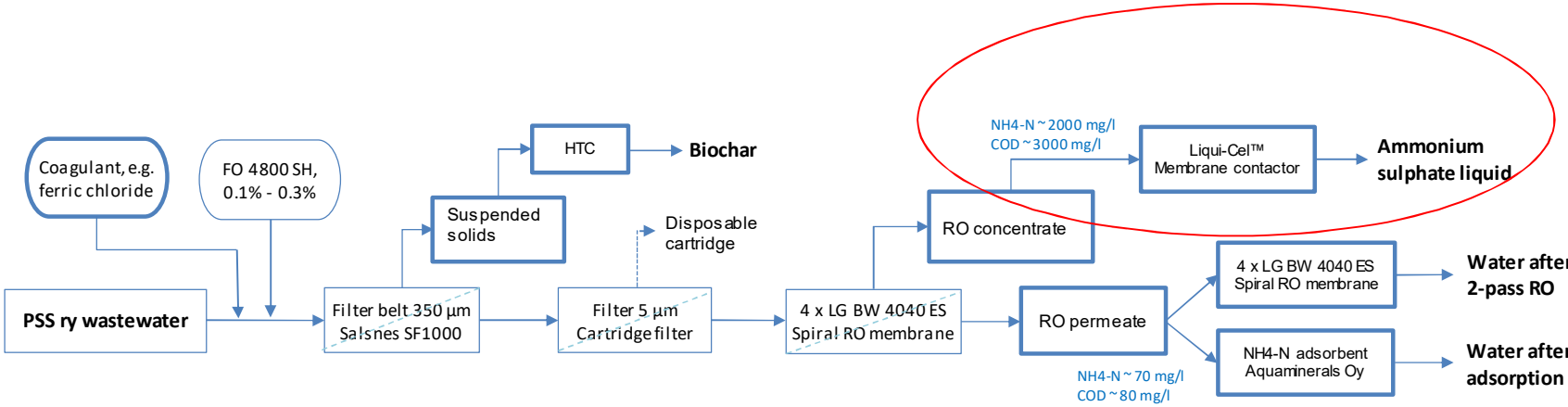
Suspended solids removal

- Septic tank wastewater
  - Dry solids content ~8 g/l (8 kg/m^3)
- Flocculant SNF Floerger FO 4800 SH
  - Dose increased until successful floc formation
  - Optimal dosage about 90 l/m^3 of 0.1% polymer, i.e. ~11 kg/t_{DS}
- Belt 350 µm performed well if flocculation was successful
- Cartridge filters functioned depending on success at belt

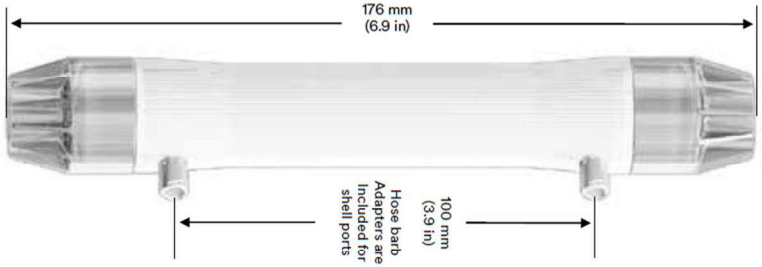


Belt 350 µm

Recovery of nitrogen by membrane contactor



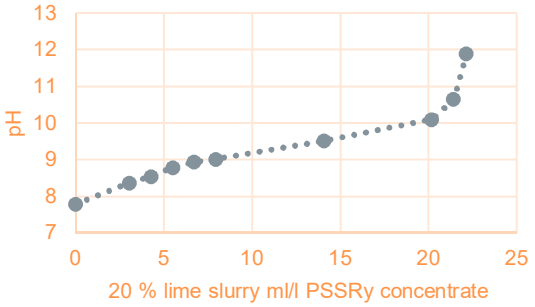
- 90 l feed solution: BWRO concentrate
- 9 kg adsorption solution 5.5 w-% H_2SO_4
- Membrane contactor (MC): 3M™ Liqui-Cel™ MM-1x5.5 Series
  - X50 fiber, 0.5 l/min flow rate (30 l/h)



Pre-treatment to MC

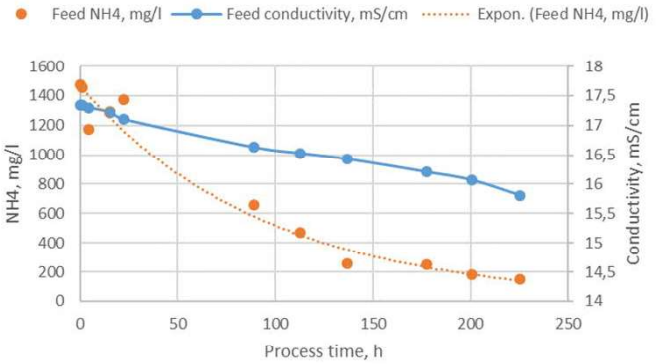
- pH was increased to improve ammonia gas permeation through the membrane
- Increase of pH precipitated phosphate from the feed to be recovered
- Precipitation of phosphate was carried out using 20% lime-water slurry
  - 5 l lime slurry per 100 l concentrate
  - pH increased > 12
- Some ammonia vaporized during phosphate precipitation since pH was too high
- Feed to MC was filtered using cartridge MF

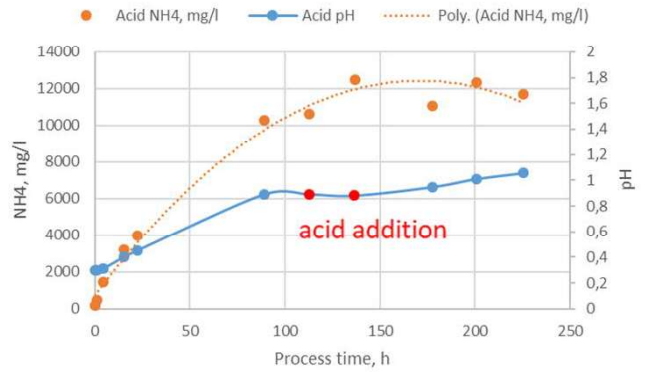
	pH/ temperature	Suspend solids	NH_4^+	PO_4^{-3}
Concentrate	7.7 / 15°C	0.2 g/l	2420 mg/l	6.41 mg/l
After lime addition	12.3/ 16.5C	1.6 g/l		
After 2 hours settling	12.2 /16.8C	0.3 g/l	1692 mg/l	
1 µm cartridge filtrate (feed to MC)	12.4	0.1 g/l	1690 mg/l	0.04 mg/l



MC pilot

- 82 % of ammonia was removed from feed to acid
- When NH_4 content of feed was < 500 mg/l, removal of ammonia was slow
- pH of acid increased and conductivity of feed decreased
  - Ammonia neutralized acid: $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$
  - Removing ammonia from feed decreased it's ion content
- Acid weight increase was minor (1-3,5 g/h)
  - No significant water transportation
  - Ammonia content increased the weight mostly
- Minor fouling was seen





Conclusions

1. PSS ry wastewater
2. Belt filtrate
3. Cartridge filtrate
4. RO concentrate
5. RO permeate

- Concept worked well for nitrogen and phosphorous recovery as well as pure water production
  - Suspended solids removal was important step for successful nutrients recovery
  - Phosphate precipitated well and could be recovered when pH was increased for ammonia recovery
  - 12 g/l ammonia solution, 44 g/l $(NH_4)_2SO_4$, could be obtained
    - 82 % of ammonia could be absorbed from feed to acid by membrane contactor

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beyond
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21/10/2020