Treatment of anaerobically digested pig manure with membrane processes for nutrient recovery and antibiotics removal

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CONTENTS

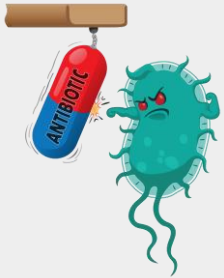
Digestate as a fertilizer

- **Circular economy**
- Waste reuse
- Anaerobic digestion: digestate as a by product
  - Nutrient rich
  - Mineral fertilizer replacement
  - Cost reduction
  - Eco friendly

Digestate issues

STORAGE

TRANSPORTATION COSTS



Approach

Compact combined membrane technologies on wheels

Reduce digestate volume

Recover value added products

Antibiotic-free water

Biogas plant

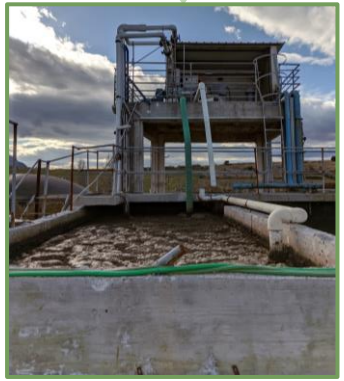
Digestate origin: Animal faeces, urine, manure and corn silage

Process feedstock: Liquid fraction from screw press

Electric power generation: 100 kWe

Process scheme

SCREW PRESS → MICRO FILTRATION → ULTRA-FILTRATION → SED → RO



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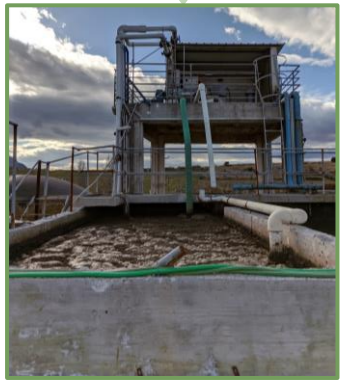

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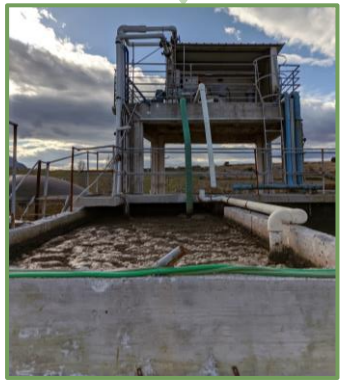

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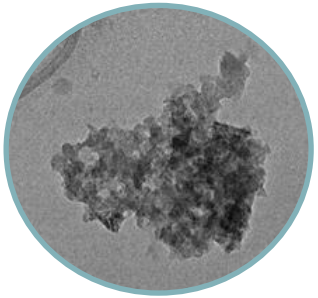
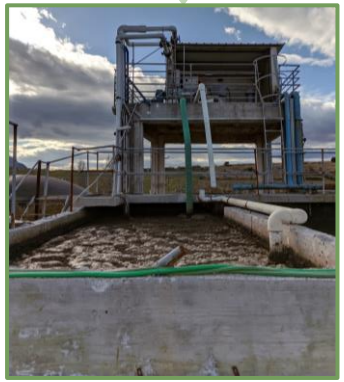


NUTRIENTS

SCREW PRESS → MICRO FILTRATION → ULTRA-FILTRATION → SED → RO



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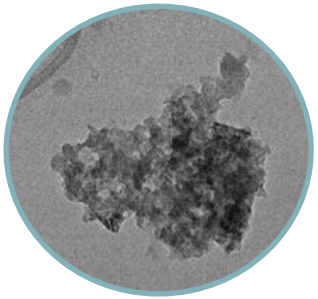

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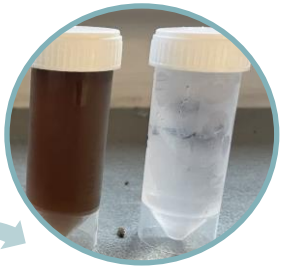

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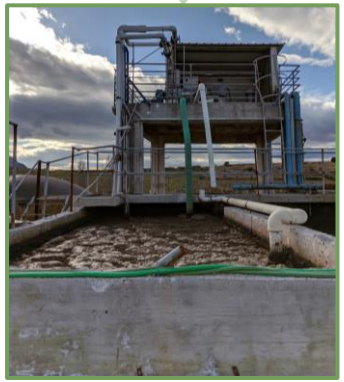


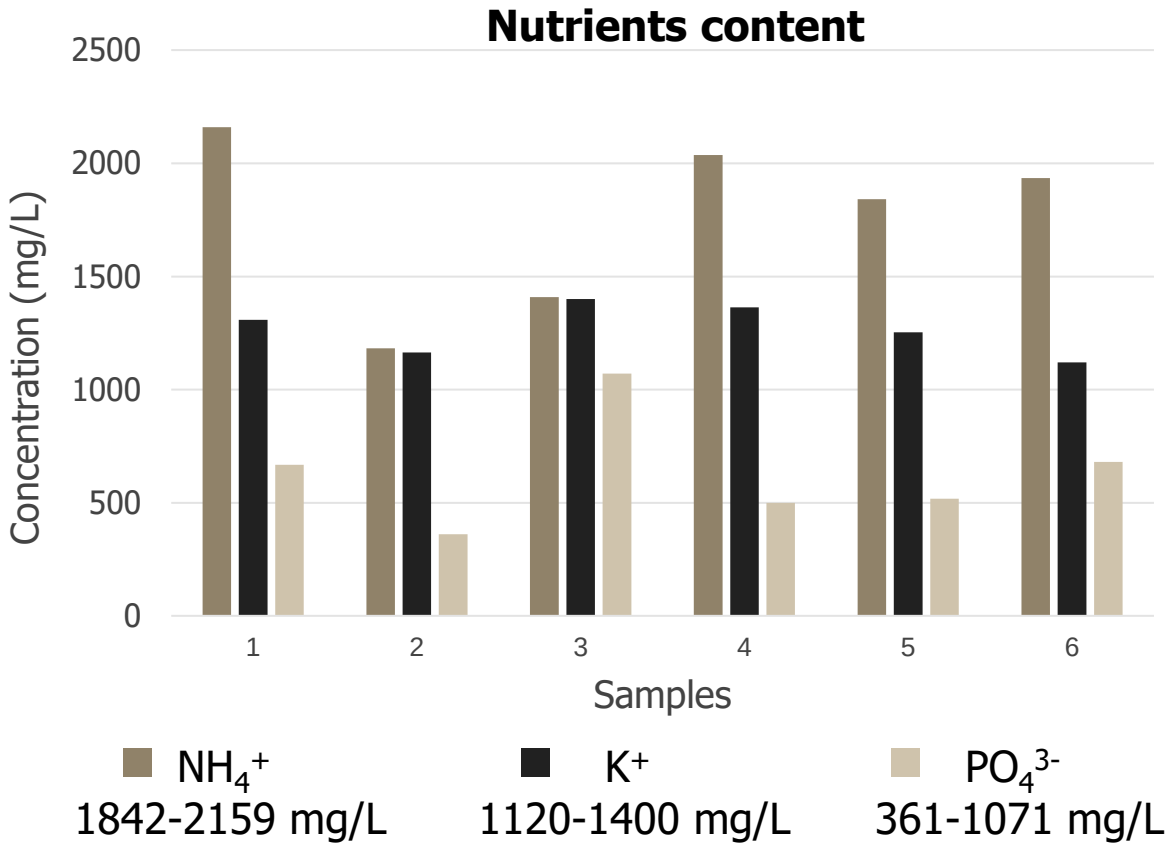
Analytical methods

Standard Methods for the Examination of Water and Wastewater

Analytical equipment:

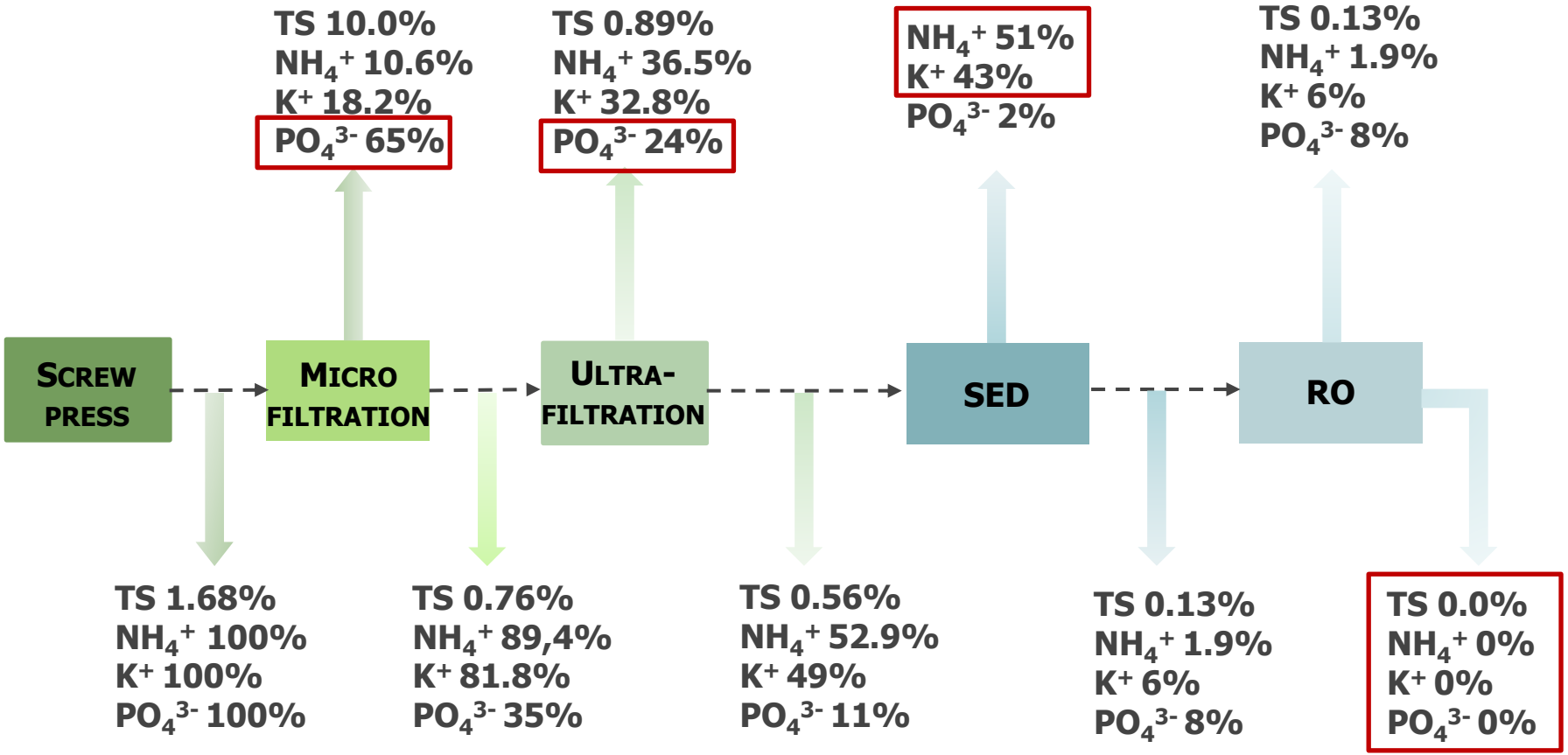
- pH & EC - Portable multimeter Multi 3510 IDS
- Phosphates - Spectroquant Pharo 300
- NH_4^+, K^+ - Ion chromatography (Prominence, Shimadzu)
- Antibiotics - QExactive™ Focus Orbitrap LC-MS/MS, Thermo Fisher Scientific, Bremen, Germany

Digestate characterization

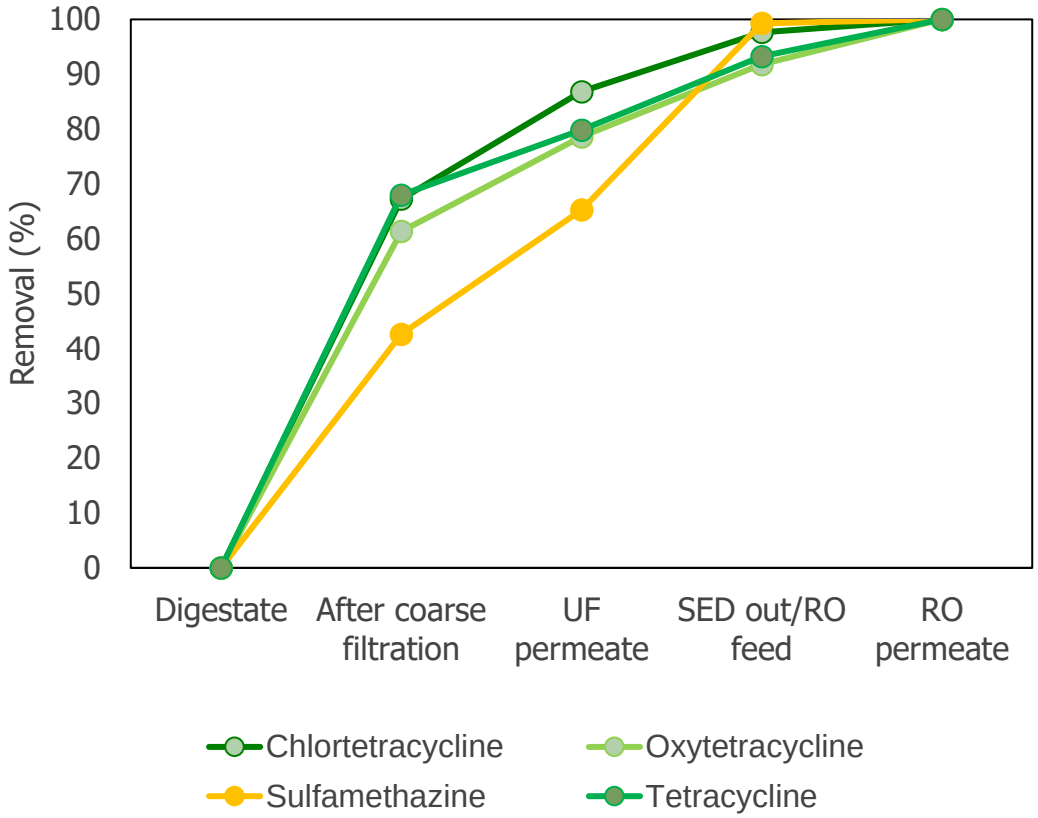


- 6 samplings within a year
- Nutrients & solids fluctuation
- Total solids 1.4 – 3.8%

Solids & Nutrients flow



Antibiotics removal



- 60 different antibiotics tested
- 2 main classes detected
- ~65% removal of Tetracyclines after coarse filtration
- ~65% removal of Sulfamethazine after UF
- Complete removal of Sulfamethazine after SED
- Antibiotic-free water after RO

Recovered products

50% antibiotic free water

33 %

UF concentrate

6%

RO concentrate

Ammonium recovery
Salts precipitation (Struvite, hydroxyapatite)

Conclusions

- Pig manure digestate processing was achieved with the proposed **compact technology**
- Conversion of a "waste" to **added value** products
- **Volume reduction**
- Recovery of nutrients for **fertilizers** production
- 50% antibiotic-free **water recovery**
- Process by-products (UF & RO concentrates) require further processing

Our Team

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artemis

Advanced **R**enewable **T**echnologies & **E**nvironmental **M**aterials in **I**ntegrated **S**ystems

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https://www.cperi.certh.gr/artemis/

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THANK YOU

Does anyone have any questions?

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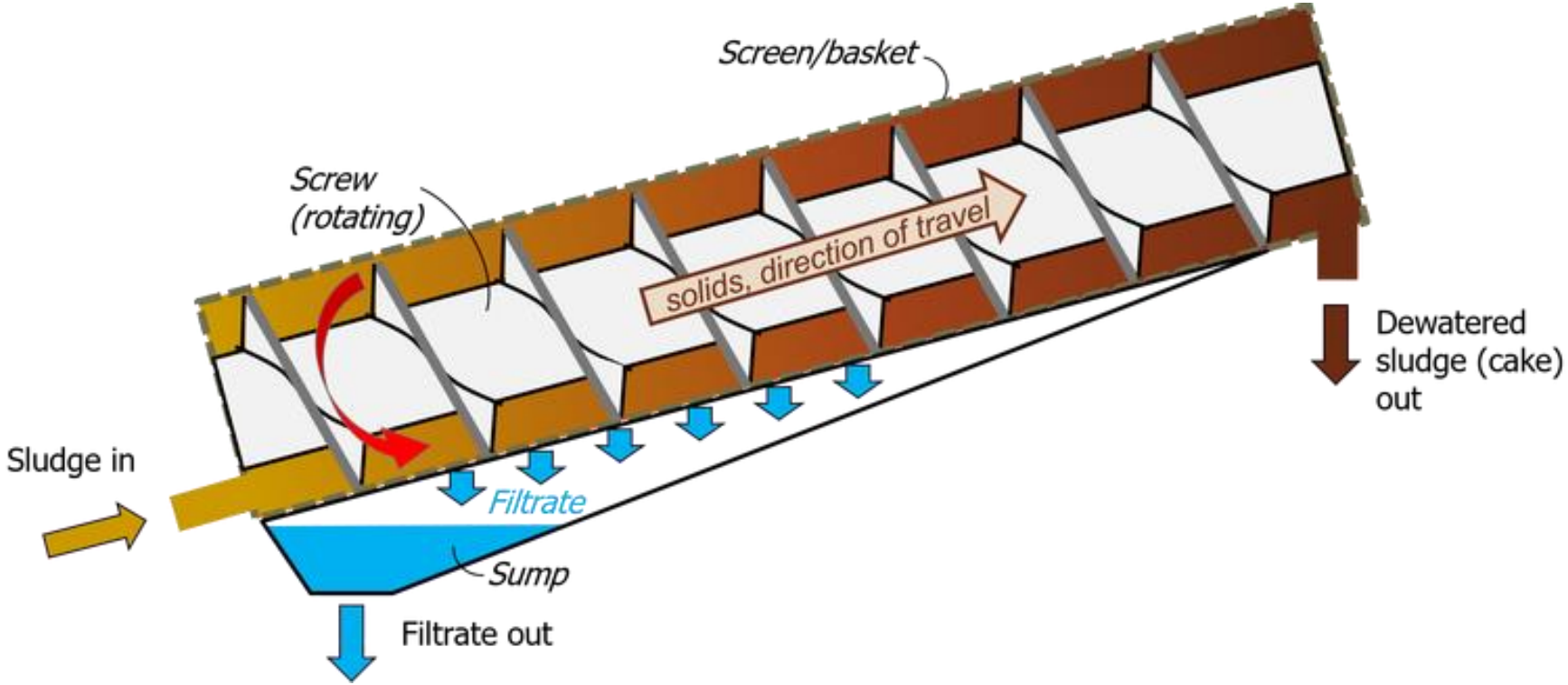
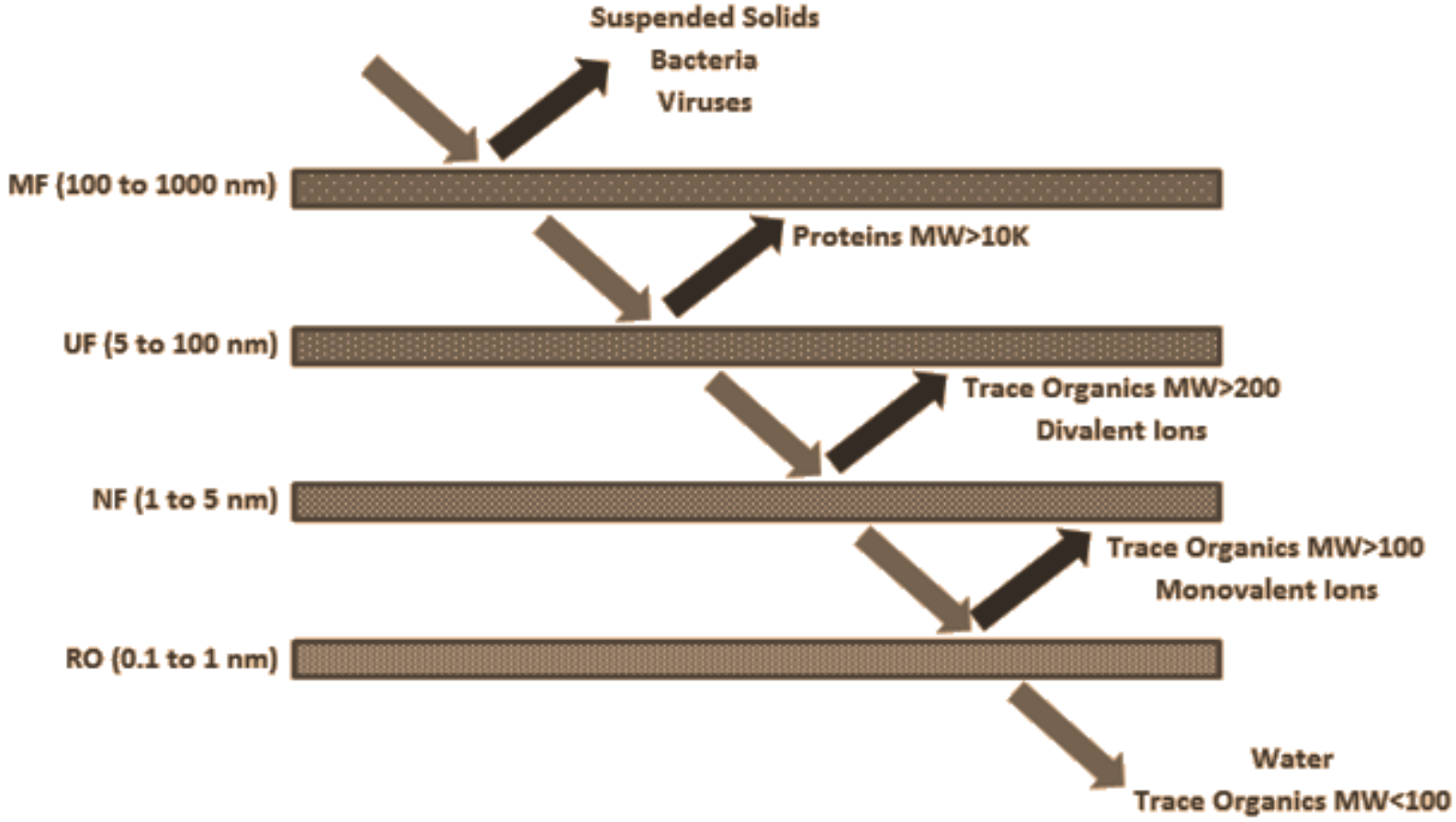
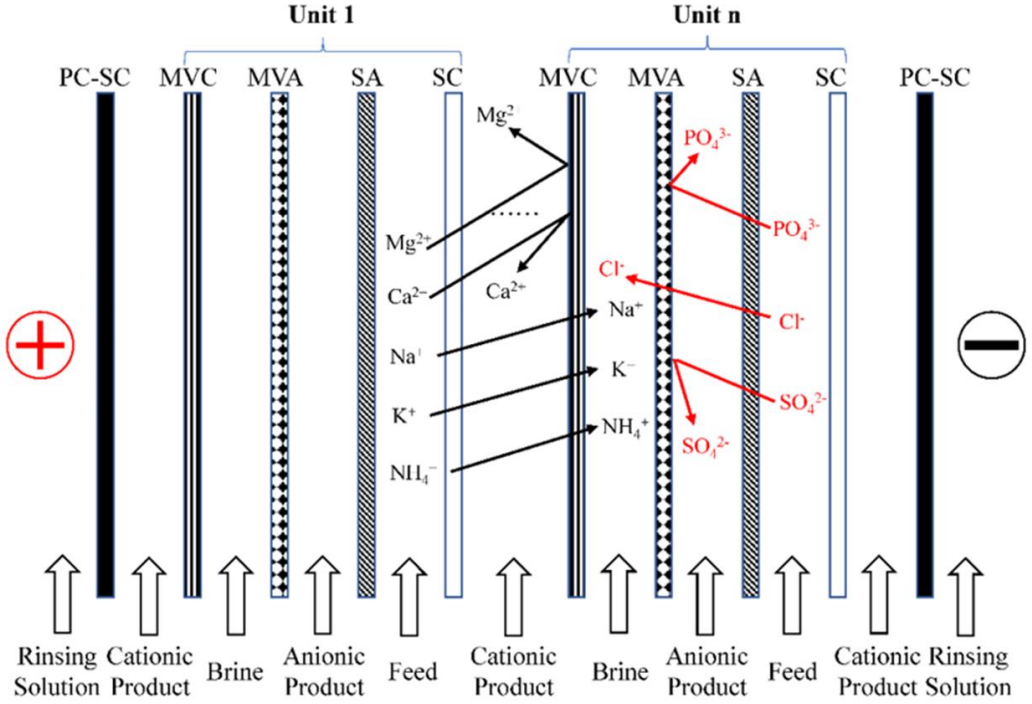
Screw press


Screen/basket
Screw
(rotating)
solids, direction of travel
Dewatered
sludge (cake)
out
Sludge in
Filtrate
Sump
Filtrate out

Membrane classifications



Nutrient Recovery
Selective Electrodialysis, SED



Feed: Liquid fraction (<0.1µm)

Products:

1. Fraction free of ions
2. Cationic fraction: Ca^{2+}, Mg^{2+}
3. Anionic fraction: PO_4^{3-}, SO_4^{2-}
4. Monovalent ions fraction: K^+, NH_4^+, Na^+, Cl^-