IWA Wastewater

Water and Resource Recovery Conference
10 – 13 April 2022, Poznan, Poland

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Optimization of the pilot-scale NPHarvest process in field tests using digester reject water

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inspiring change

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N & P RECOVERY

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- P is limited resource
- P natural resources are controlled by just few countries
  - Conflicts can have volatile effects on availability & prices
- N capture from air is energy intensive
- N removal in biological process is energy intensive and produces N_2O
- -> we should recover both!

GOAL OF THE STUDY AND TESTS IN VIIKINMÄKI WWTP

- Understand process conditions' effects on performance in real conditions
- Ammonia transfer efficiency

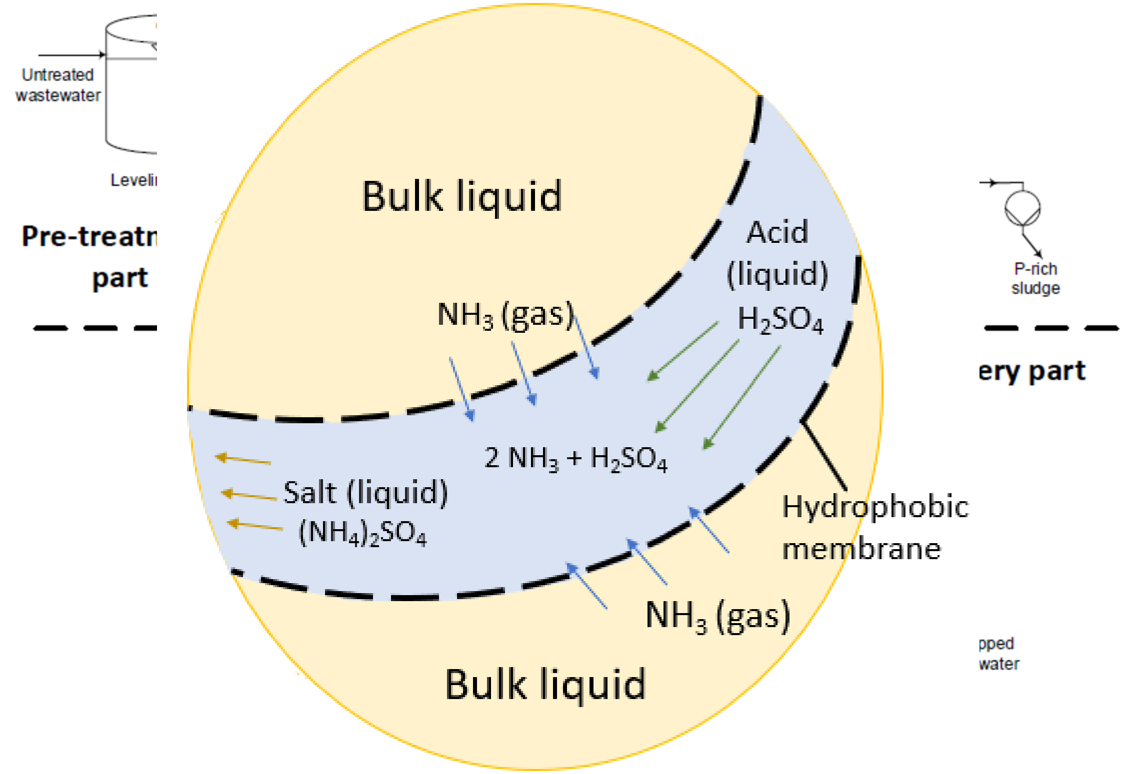
- Hydraulic retention time (HRT)
- Acid strength and type
- Bulk liquid pH

- Tests were conducted with Viikinmäki WWTP digester reject water
- High SS, high NH_4, low P content

Run No.	Run purpose	HRT (h)	Acid type	Bulk pH
#1	HRT	8	1M H_2SO_4	11
#2	HRT	4	1M H_2SO_4	11
#3	HRT	2	1M H_2SO_4	11
#4	Acid strength	8	2M H_2SO_4	11
#5	Acid strength	8	0.5M H_2SO_4	11
#6	Bulk pH	8	1M H_2SO_4	10
#7	Bulk pH	8	1M H_2SO_4	9
#8	Acid type	8	0.5 M H_3PO_4	11
#9	Acid type	8	0.5 M HNO_3	11

NPHARVEST PROCESS

- Pre-treatment
- P recovery & SS removal
- P product: P, Ca and C
- N recovery
- Hydrophobic membranes
- N product: ammonia salt

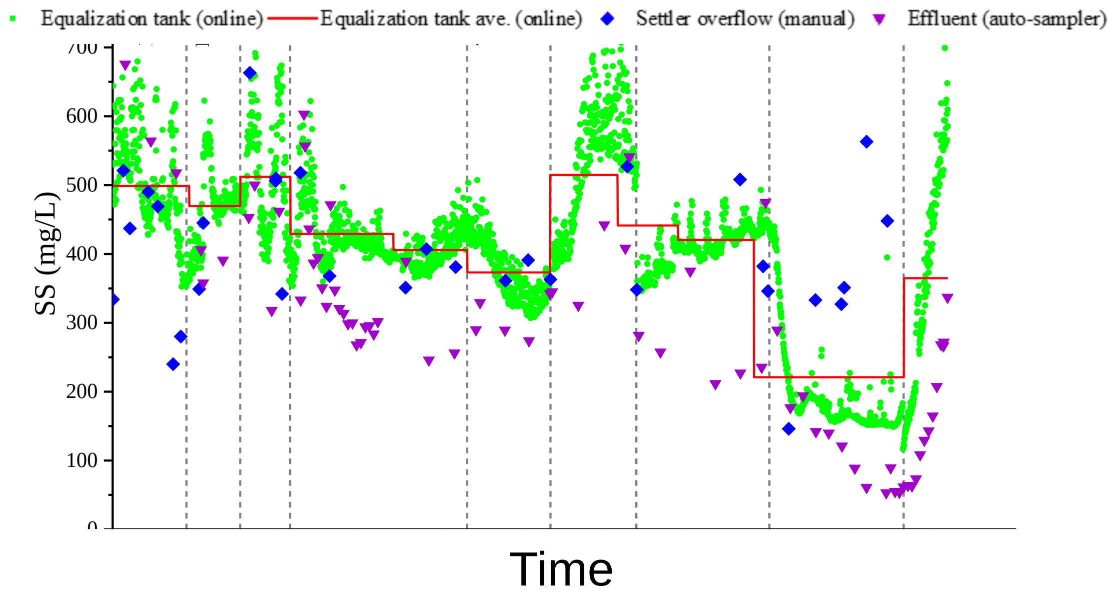


Benefits:

- Low energy consumption
- Robust SS tolerance

SUSPENDED SOLIDS TOLERANCE

- Membrane contactor has robust SS tolerance
- ~500 mgSS/L does not interfere with ammonia recovery
- Lowest SS concentration was when organic polymer was used instead of PAX and polymer



HYDRAULIC RETENTION TIME

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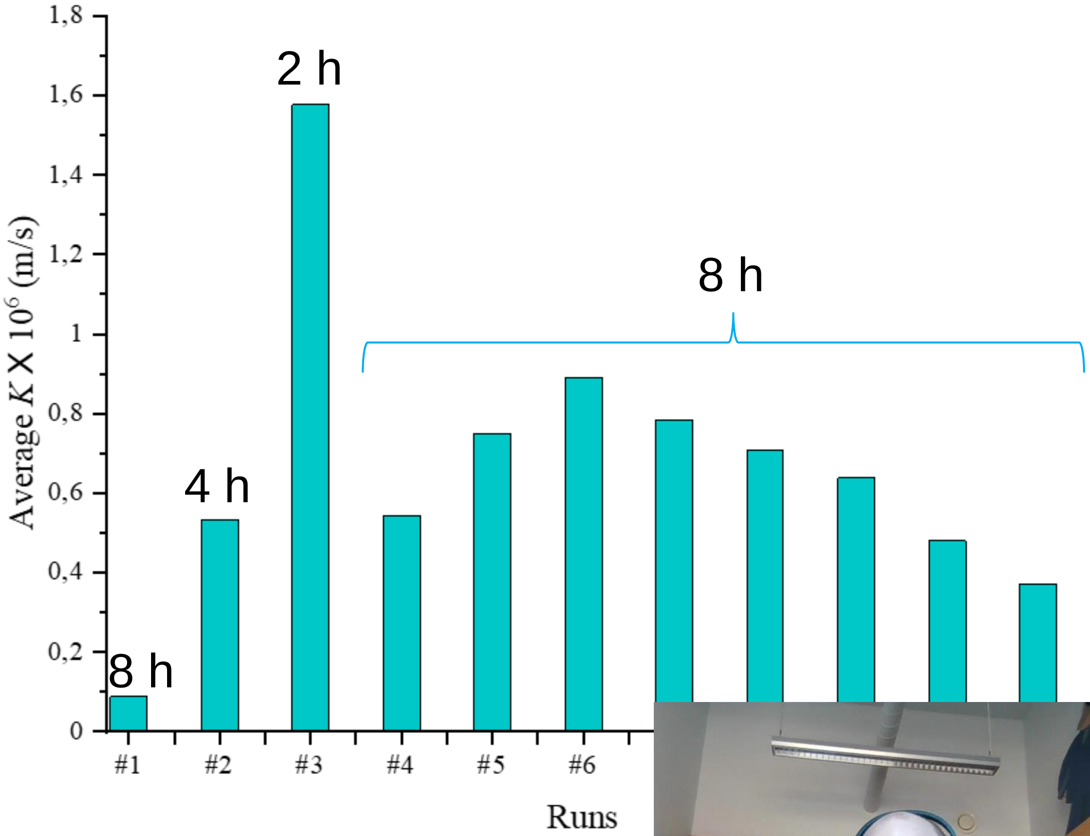
- Short HRT = high flow rate
- Shorter HRT demonstrated better ammonia transfer rate
- Higher flow rate decreases ammonia concentration polarization
- -> promotes ammonia mass transfer rate



HRT & RECOVERY EFFICIENCY

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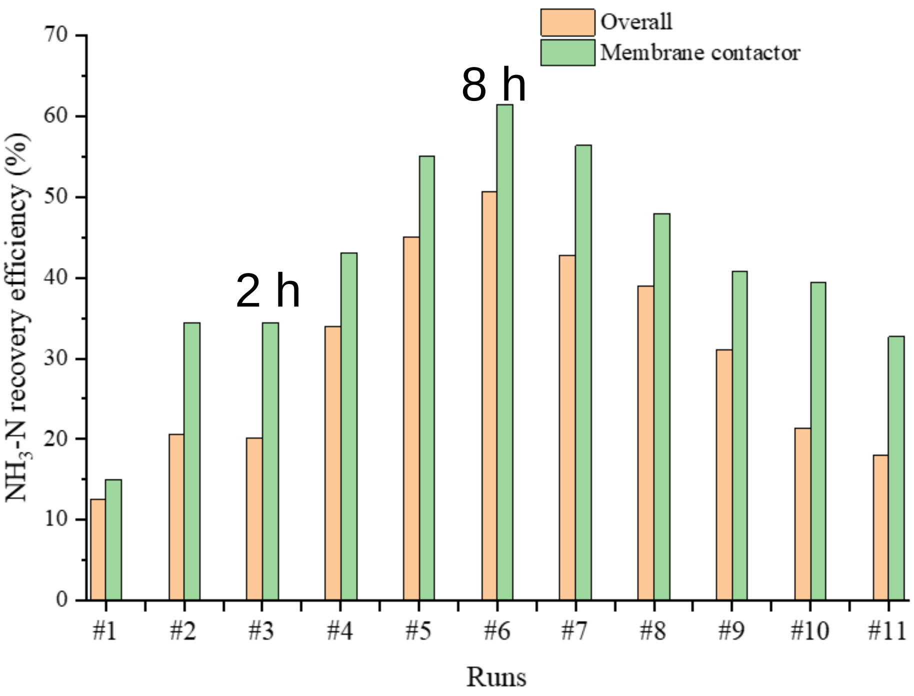
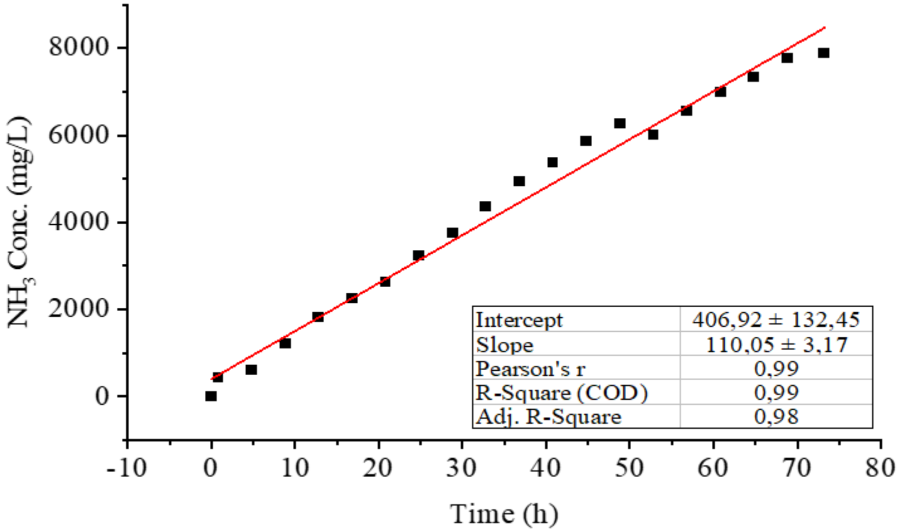
- Note! High transfer rate does not automatically mean high recovery efficiency
- Longer HRT promotes recovery efficiency
- -> Overall process design is a balance between recovery efficiency and transfer rate
- Also note: goal of the study was not to maximize recovery efficiency



BULK LIQUID PH

- Ammonia balance shifts towards NH_3 when pH increases
- The slope of ammonia concentration shows transfer efficiency
- pH 9 slope: 87
- pH 10 slope: 110
- pH 11 slope: 51

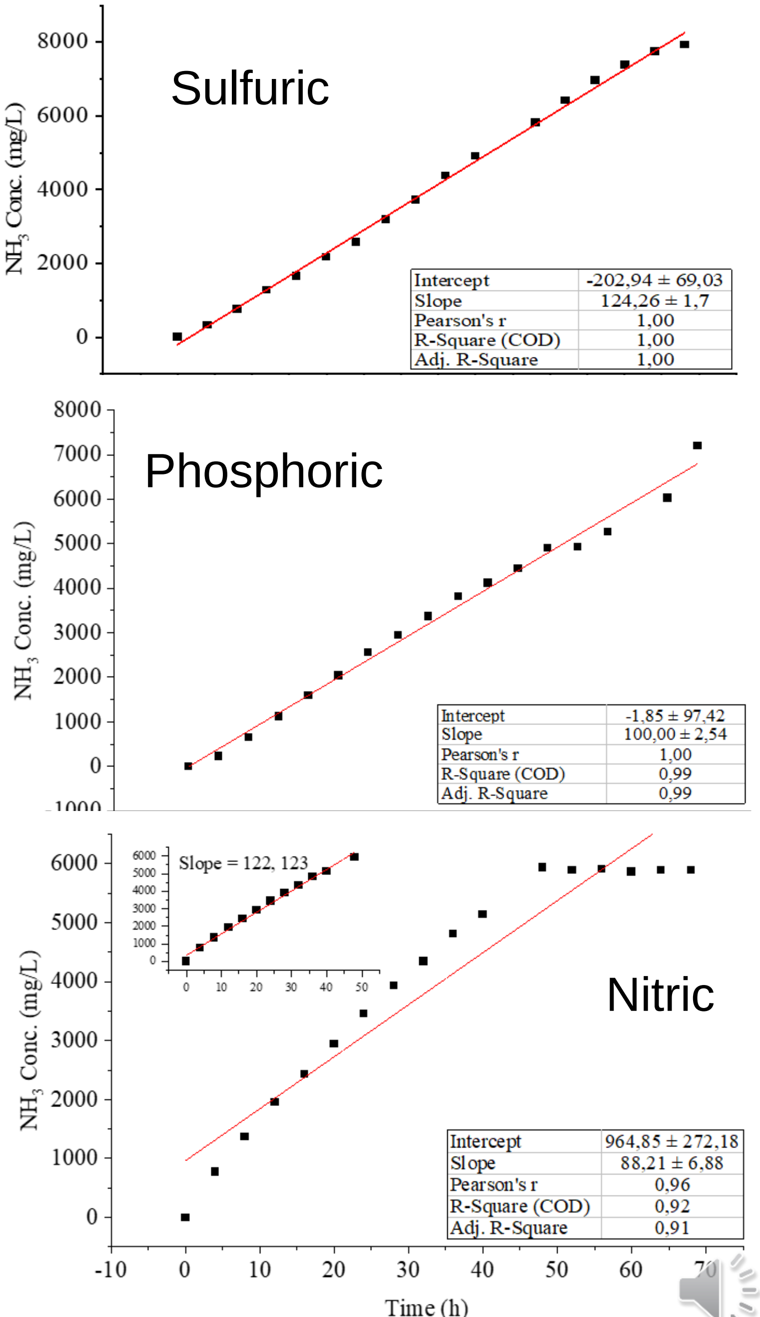
- pH 10 is the most efficient in terms of ammonia transfer (and chemical consumption!)



AMMONIA STRIPPING ACID

- 0.5 mol/L showed highest transfer rate
- Sulfuric acid and nitric acid had similar transfer rate
- Phosphoric acid was slightly lower

- Acid choice is further affected by desired end product



CONCLUSIONS

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- Tests in real environment were conducted to understand the process conditions' effect on ammonia transfer rate
- The best conditions for ammonia recovery are:
- Low HRT while maintaining good recovery efficiency
- Bulk liquid pH 10
- 0.5 mol/L acid concentration
- Nitric and sulfuric acid had better transfer rate

THANK YOU!

- For you interest!