JÄTEVEDEN KÄSITTELYTEKNIIKOIDEN PROFESSUURI

Palaveri 2 10.9.2019

Aalto University School of Engineering

Anna Mikola, Professor of Practice, Aalto University
anna.mikola@aalto.fi

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Asialista

- Aallon tutkimus – uusia tuloksia ja alkavia hankkeita
- Aallon opetus – nykyiset kurssit ja tarpeet
- Uuden professuurin viestintä
- Kakolanmäen puhdistamo ja ajankohtaisia hankkeita siellä
- Lounas ja puhdistamovierailu

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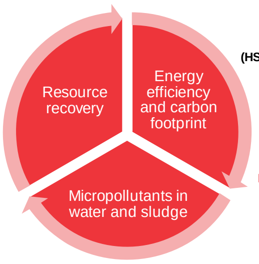
Research focus areas

NPHarvest and P recovery, water reuse

(Water utilities, SYKE, Northwestern University, Helsingborg)

Organic micropollutants and antibiotic resistance

(Water utilities, Cadiz, HY, Gdansk, Harbin)



GHG and N2O –project

(HSY, Irvine California, Gdansk, Irstea, Dynamita)

Microbial communities in low temperature

(HSY, DTU, Granada)

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HSY Gasum Nordkalk SULZER

NPHarvest – Innovative nitrogen and phosphorus recovery process

HyXo Oy SOIL FOOD VEOLIA Kemira Teollisuuden Vesi Outotec

J. Uzkurt Kaljunen
Team: D. Sc. (tech) A. Mikola, M. Valtari, I. Konola

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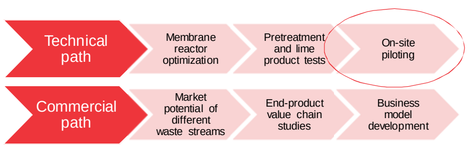
Our approach to nutrient recovery



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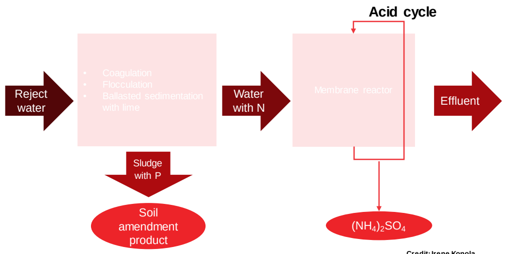
NPHarvest Pilot



Credit: Irene Konola

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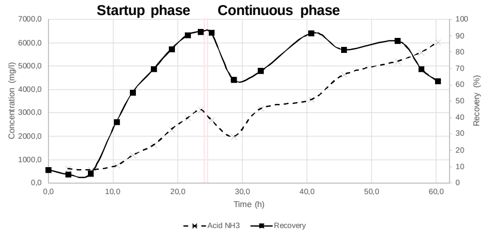

- SS concentration in effluent varied between 100 and 500 mg/l
- NH_3 recovery efficiency was ~80 %

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End product quality

Nitrogen

- **End product is pure ammonium sulphate**
  - Ready product!

Phosphorus

- **P-rich sludge was hygienized with lime and dewatered**
- **Quality analysis showed that overall quality is acceptable**

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Growth tests

- **Both products were used for the tests**
- **Growth enhancing effect is visible**
- **Further process optimization is needed to increase the impact and value of the products**

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Utilization of chemically precipitated phosphorus

- **Early phase dissertation**
- **Phosphorus is not recycling efficiently**
  - hygienic concerns, imago problems, phosphate solubility controversy
- **Aim is to enhance the recyclable P utilization from chemical precipitation systems (wastewater treatment)**
- **Currently working on review article on the topic**
- **Lab tests for recovery using lignin and biochar are starting this month**

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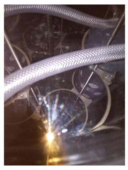
See you in IWA-NRR 2020!

IWA Nutrient removal and recovery conference
8 – 12 June 2020 I Helsinki – Espoo, Finland I iwa-nrr.org

A! Aalto University HSY IWA the international water association

Submission deadline extended to 15.10.2019!



Thank you for your interest!

More information:

www.aalto.fi/en/npharvest/

juho.uzkurtkaljunen@aalto.fi

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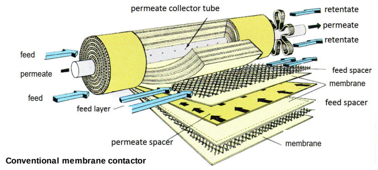
Innovative contactor design

- Robust design to tolerate suspended solids
  - Reject water treatment
- Low energy consumption



Conventional membrane contactor

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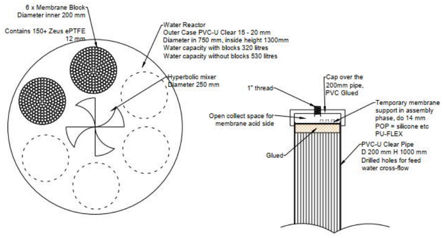

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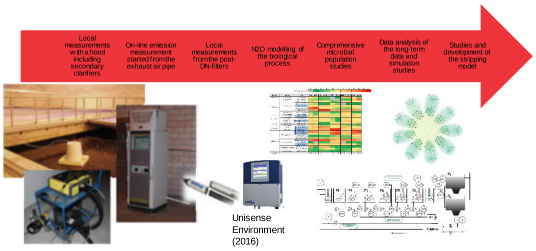
N2O project timeline in Viikinmäki WWTP

2010 2012 2013 2014 2015 2016 2017 2018 2019



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Spring&Summer 2019 Master thesis by Shanna Myers:

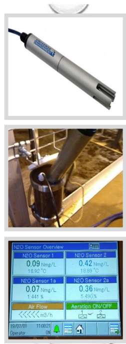
Depth Profile

Materials

- Ruttner sampler device
- Unisense N_2O probe (Clark-type microsensor)
- pH probe

Methods

- Test performed twice: 2 April and 1 July 2019
- N_2O probe and Ruttner lowered to set distance
  - 2 April: 3 & 5m, successive measurements
  - 1 July: 1, 3, & 5m, concurrent duplicate measurements
- Compared values from Unisense Environment display, online data



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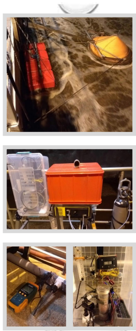
Gas Transfer

Materials

- Floating hood and/or Alphameter connected to:
  - Gasmet FT-IR analyser
  - AMI oxygen analyser
  - Extech hot wire thermos-anemometer
- Unisense and DO probes for dissolved N_2O, O_2

Methods

- Line 5: 7.-13.5.2019 ; Line 9: 13.-20.5.2019
- Simultaneous gas measurements: zones 4, 5, and 6
- Hood near Unisense probes to compare gas, liquid measurements



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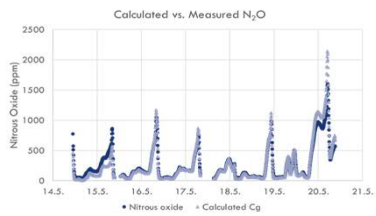
RESULTS

Nitrous Oxide Transfer:

- Clear correlation off-gas & probe N_2O concentrations
- Average αK_La 1.6-2 h^{-1}
  - Foley Equation K_La 0.2-0.5 h^{-1}, α: 2.5-4



- Underestimates at start of week, overestimates at end of week
  - wastewater composition changes daily

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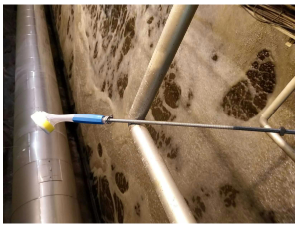
Finnish nitrifiers
Collaboration with DTU / Barth Smets

- Comprehensive sampling in March and in April in Viikinmäki WWTP including depth profiles and biofilm samples
- Sequencing and microbial population analysis using conventional approach mostly finished at DTU
- Results confirming that non-identified nitrifiers are present



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How to avoid the antibiotic resistance risk in resource recovery from sewage sludge?

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Maria Valtari
September 9th 2019

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Are WWTPs accelerating the development of antibiotic resistance?

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Maybe effluent is not a problem…


yle Uutiset Areena Urheilu Valikko

UUTISET Tuoreimmat Urheilu Sää Kotimaa Ulkomaat Talous Politiikka Kulttuuri Kolumnit

Tutkimus: Modernit jätevedenpuhdistamot poistavat antibiooteille vastustuskykyisiä bakteereja tehokkaasti jätevedestä

Luonnossa antibiootit voivat ohjata mikrobeja kehittämään vastustuskykyä antibiooteille.

Jäteveden käsittely 23.4.2019 klo 14:46

SCIENCE ADVANCES | RESEARCH ARTICLE

HEALTH AND MEDICINE

Antibiotic resistance in European wastewater treatment plants mirrors the pattern of clinical antibiotic resistance prevalence

Katariina M. M. Pärnänen[1*], Carlos Narciso-da-Rocha[2*], David Kneis[3*], Thomas U. Berendonk[3], Damiano Cacace[3], Thi Thuy Do[4], Christian Elpers[5], Despo Fatta-Kassinos[6], Isabel Henriques[7], Thomas Jaeger[8], Antti Karkman[1], Jose Luis Martinez[9], Stella G. Michael[6], Irene Michael-Kordatou[6], Kristin O'Sullivan[10], Sara Rodriguez-Mozaz[11], Thomas Schwartz[8], Hongjie Sheng[12,13], Henning Sørum[10], Robert D. Stedtfeld[13], James M. Tiedje[14], Saulo Varela Della Giustina[11], Fiona Walsh[4], Ivone Vaz-Moreira[2], Marko Virta[1†], Célia M. Manaia[2†]

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Integrated antibiotic resistance (AR) surveillance is one of the objectives of the World Health Organization global action plan on antimicrobial resistance. Urban wastewater treatment plants (UWTPs) are among the most important receptors and sources of environmental AR. On the basis of the consistent observation of an increasing north-to-south clinical AR prevalence in Europe, this study compared the influent and final effluent of 12 UWTPs located in seven countries (Portugal, Spain, Ireland, Cyprus, Germany, Finland, and Norway). Using highly parallel quantitative polymerase chain reaction, we analyzed 229 resistance genes and 25 mobile genetic elements. This first trans-Europe surveillance showed that UWTP AR profiles mirror the AR gradient observed in clinics. Antibiotic use, environmental temperature, and UWTP size were important factors related with resistance persistence and spread in the environment. These results highlight the need to implement regular surveillance and control measures, which may need to be appropriate for the geographic regions.

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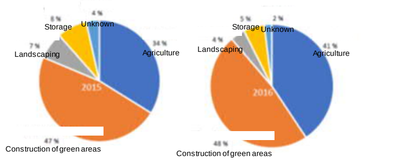
…but what about sludge?



Finnish Water Utilities Association FIWA (2017)

What about recycled fertilizing products?

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Are there antiobiotic resistant genes (ARGs) in sewage sludge?

How to analyse ARGs in sludge?

- **Sample processing protocol for sludge**

What is the effect of low temperature?

- **Sampling campaigns from several Finnish WWTPs**
  - Summertime
  - Wintertime

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What happens with ARGs during the treatment process?

What is the effect of biological treatment method?

- Quality of excess sludge (Antonina)

What is the effect of different sludge treatment methods?

- Anaerobic digestion
- Composting
- etc.

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How to avoid the antibiotic resistance risk in the treatment process?

What is the effect of different operational conditions?

- Samples from different WWTPs
- Pilot plant studies

What is the effect of advanced oxidation processes? (Irina)

What is the effect of developing nutrient recovery processes?

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Expected results

Description of transmission pathways of ARGs through resource recovery of sewage sludge

Potential solutions to control these pathways

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Thank you!

maria.valtari@aalto.fi

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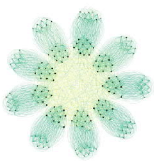
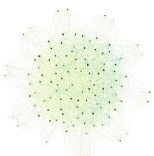
New projects – Digital wastewater

- Developing digital optimization tools for the emerging needs in wastewater treatment
- E.g. micropollutant removal processes and nutrient recovery
- Background study: Master thesis project of Sanni Eerikäinen – Knowlegde transfer from industrial processes
- Larger project under construction





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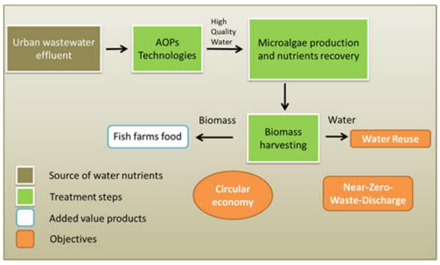
New projects – Combining wastewater resource recovery with aquaculture



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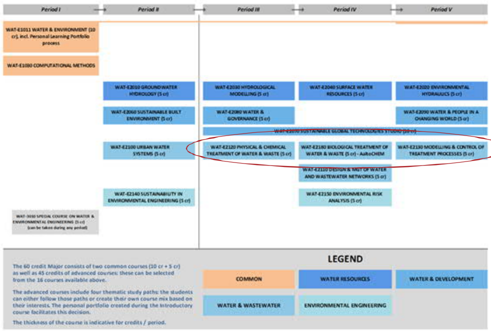
Courses now



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Physical&chemical processes – course content

- Lectures
- "Einstein" exercises

Practical knowledge

- Lectures
- "Worker" exercises
- Excursion

Hands-on knowledge

- Laboratory pilot operation
- Lab project work

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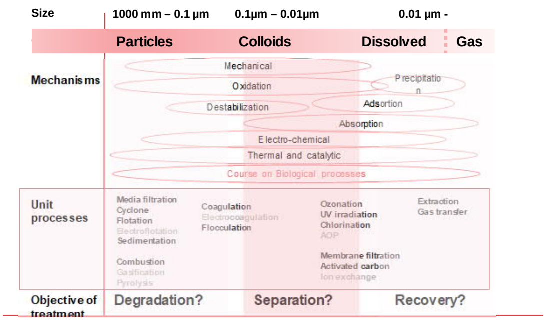

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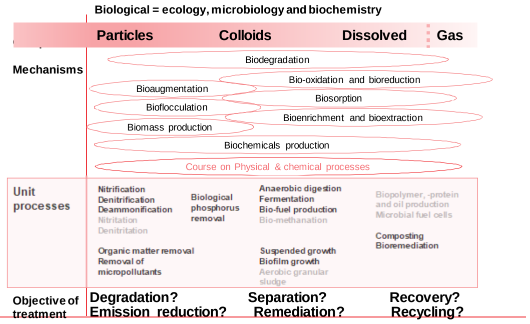

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Lab project

- Week 1: Orientation to lab project
- Week 2: Monitoring lab (4h); Group 1 operates the reactors (2h/d)
- Week 3: Mikrobiology lab (4h); Group 2 operates the reactors (2h/d)
- Week 4: Group 3 operates the reactors (2h/d)
- Viikko 5: Group 4 operates the reactors (2h/d)
- Viikko 6-7: Analysis of the results, poster and presentation



Content and objectives, linking to theory

Learning the basic monitoring, Preparing own lab toolbox

Focusing on microbiology

Presenting the results, learning from each other, feedback

Students operating the reactors independently

Conditions: 1: DO 2: Anoxic 3: Anaerobic 4: Temperature

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Timeline for the modelling&control course

Week	16	17	18	19	20	21	22
Pres&Report		HW 1&2		HW 3	HW 4		
Project Outcomes		Intro to topics	Excu	Select topic			

Lectures	**Intro**	* *		* *	* *	* * *	*
Exercise DLs				HW 1&2		HW 3	HW 4
Exams		Sumo exam		Exam 1		Exam 2	Extra 1&2
Modelling project work		Intro to topics		Select topics			
Presentation							Presentations
Written report						1st draft + feedback	Final report

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Laitoksen nimi

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Examples of special courses

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Examples of special courses

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Uudistunut kampus – vesitekniikka kaiken keskellä

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