Milieutechnologie

Dr. ir. AR (Annemerel) Mol

11 september 2024 | Bezoek Da Vinci Senioren

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Wageningen & ETE mission

Environmental Challenge focus of ETE

To explore the potential of nature to improve the quality of life

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Resume

- Dr.ir. AR (Annemerel) Mol
- BSc at UCR Middelburg (part of UU), 2014
- Bachelor thesis on Selenium Biomineralization
- MSc Environmental & Biobased Biotechnology at WUR, 2016
- Interest in biological processes for resource recovery
- PhD Environmental Technology WUR (2016-2022)
- Assistant professor Biorecovery (2022-now)
- Supervising 5 PhD candidates, various MSc and BSc thesis students and teaching BSc and MSc courses.

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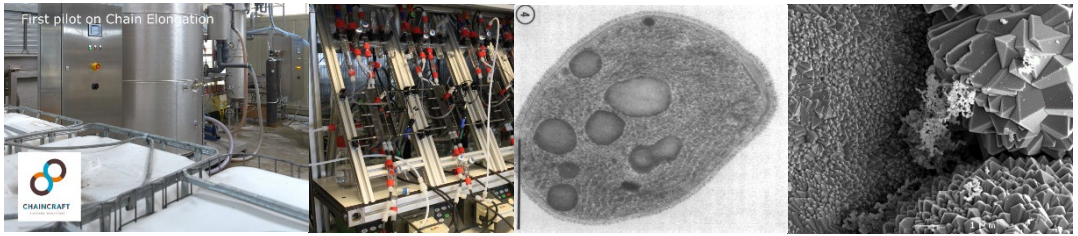
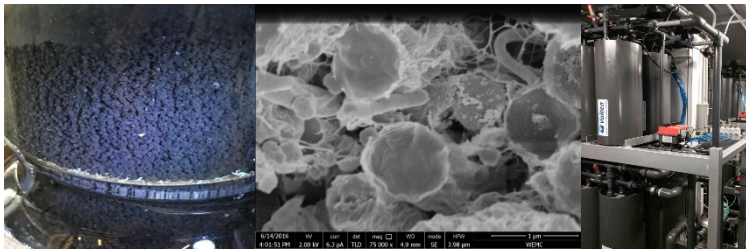
Environmental Technology

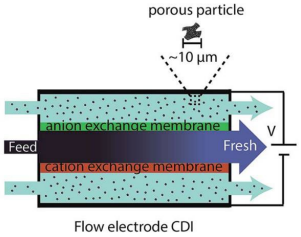
Biorecovery



Bioelectrochemistry, Novel Fermentations, biocrystallization

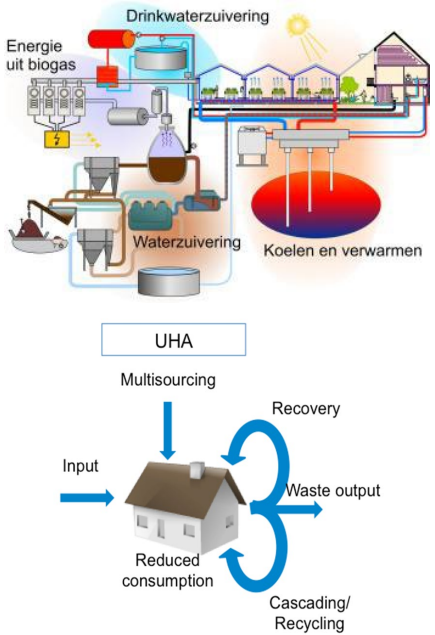
Reusable Water





Micropollutant and Pathogens, Desalinization, Granulation

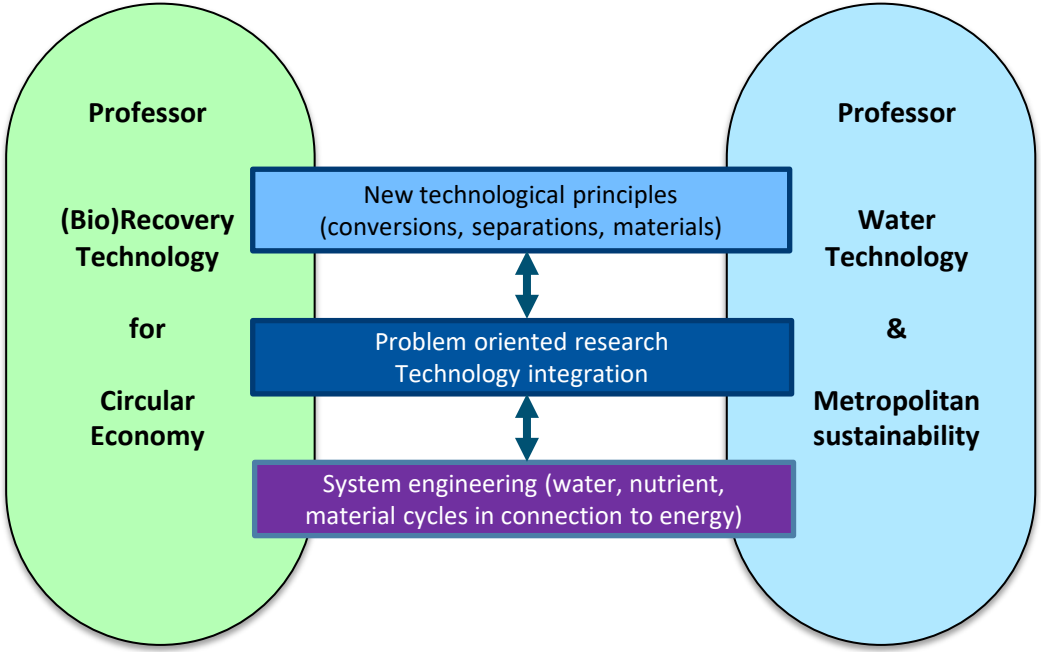
Urban System Engineering



Material Flow Modelling, Geospatial Analysis, System Design

Environmental Technology

Annemiek ter Heijne



Interim: Nora Sutton

PhD graduates: 10-15/yr

MSc & BSc graduates: 100/yr

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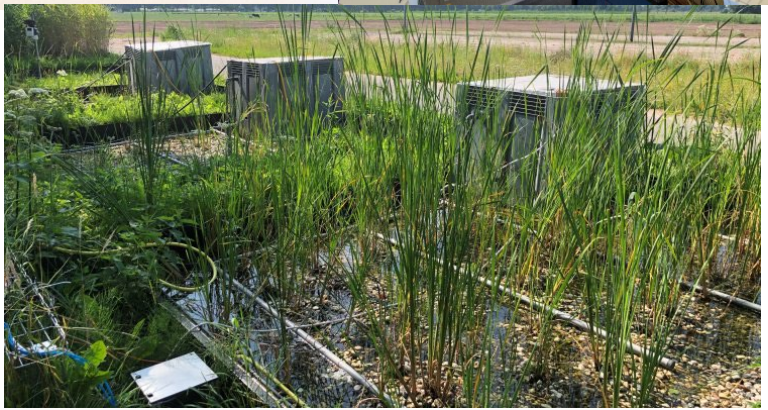
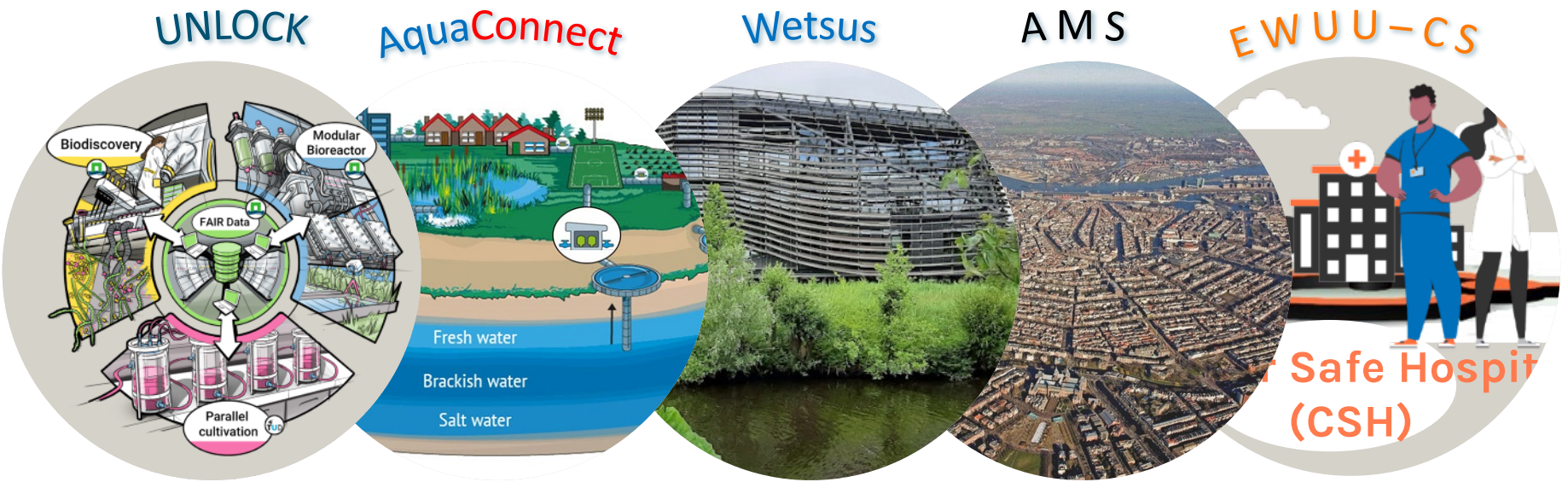
Environmental Technology; Facilities



Research Ecosystems in the Netherlands



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Biorecovery Technology for the Circular Economy

organic compounds & organic matter from waste(water)


Dr. David Strik


Dr. Miriam van Eekert

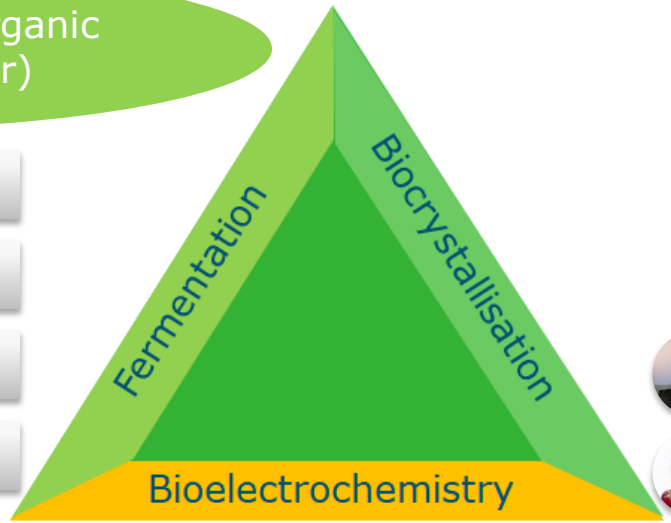

Dr. Kasper de Leeuw


Dr. Paula van de Brink


Prof. Annemiek ter Heijne


Dr. Annemerel Mol


Dr. Renata van der Weijden




Dr. Philipp Kuntke


Prof. Bert Hamelers


Dr. Sanne de Smit

renewable energy from waste(water)

minerals (e.g. N and P) and metals from waste(water) & gas

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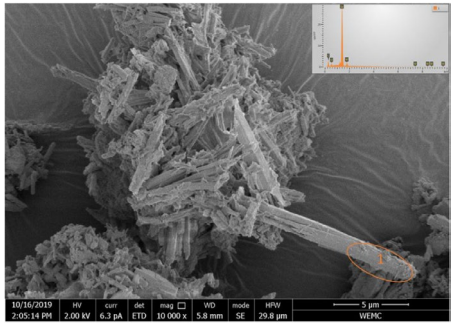
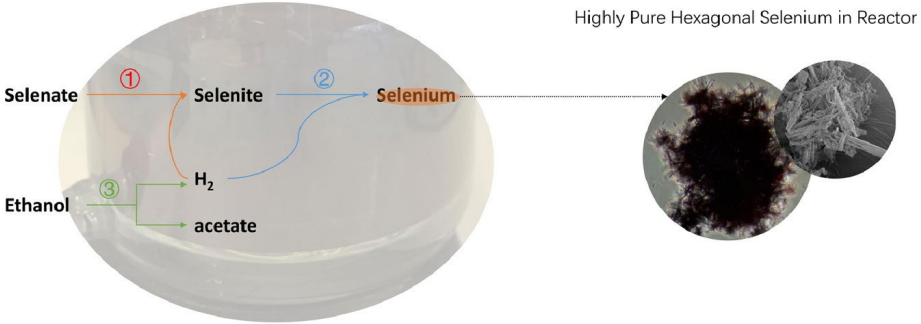
Highlights Biocrystallization group

Solid with 85% selenium from diluted stream





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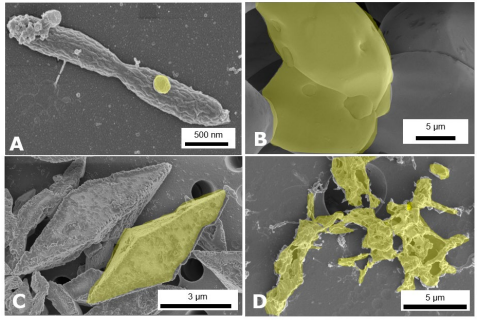
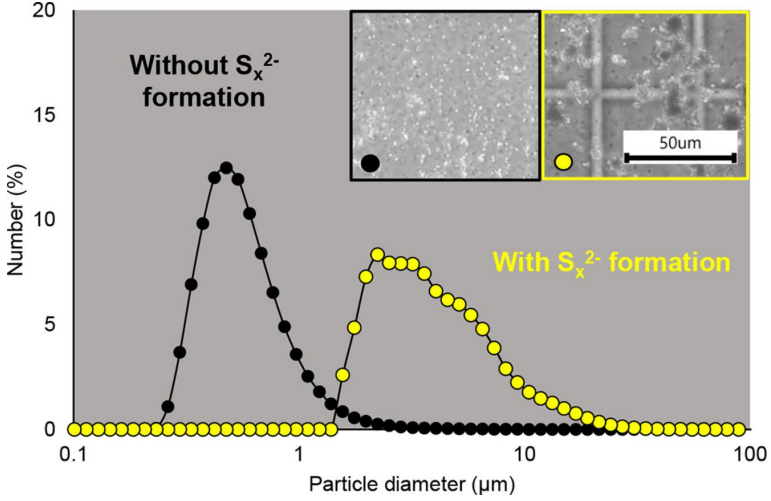
Song et al https://doi.org/10.1016/j.watres.2021.116855

Sulfur particle size and morphology control

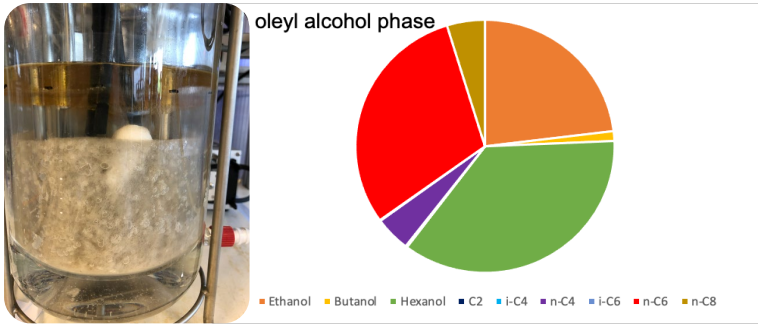




Mol et al https://doi.org/10.1016/j.watres.2022.119296

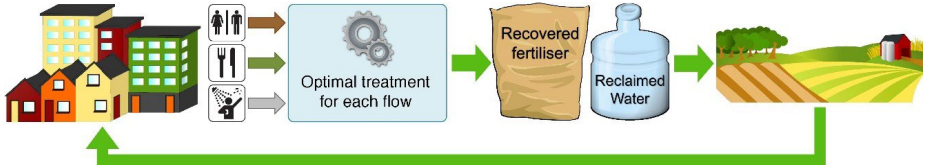
Highlights fermentation group

Microbial chain elongation for production of medium chain volatile fatty acids



Increasing organic matter in soils with organic amendments

Source separated sanitation



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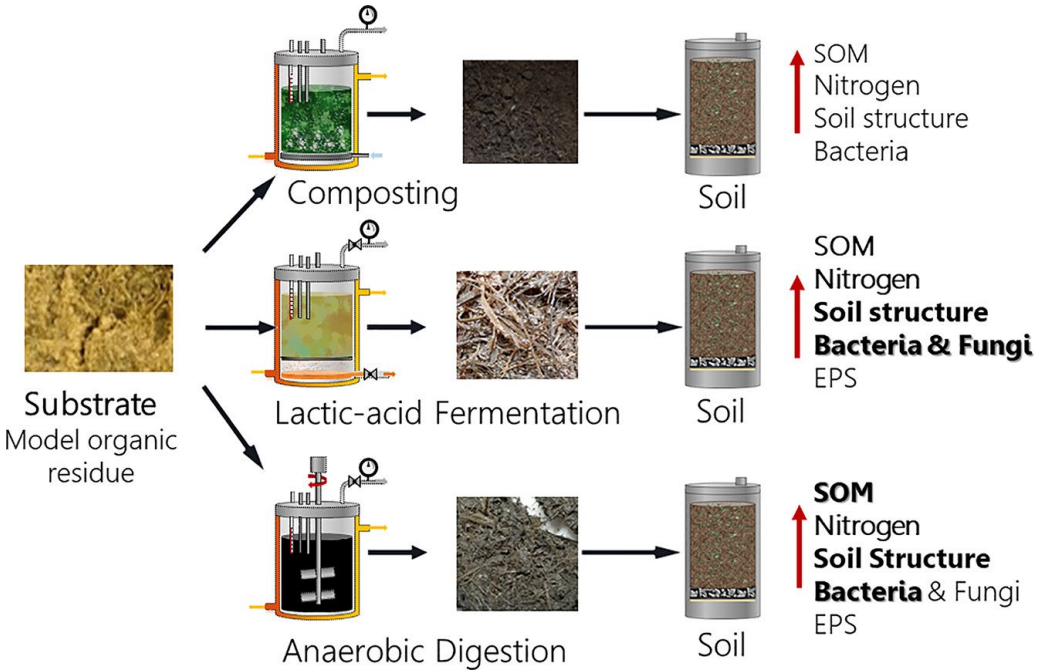
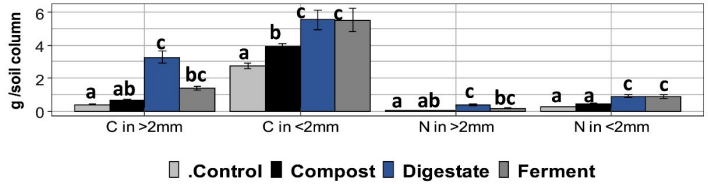
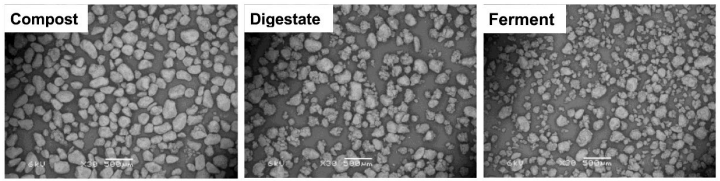
Bisschops et al https://doi.org/10.1016/j.cosust.2019.06.010

Increasing organic matter in soils



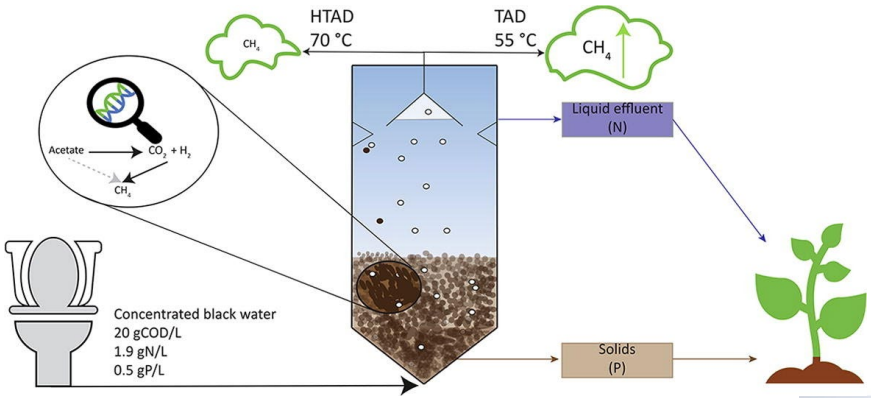




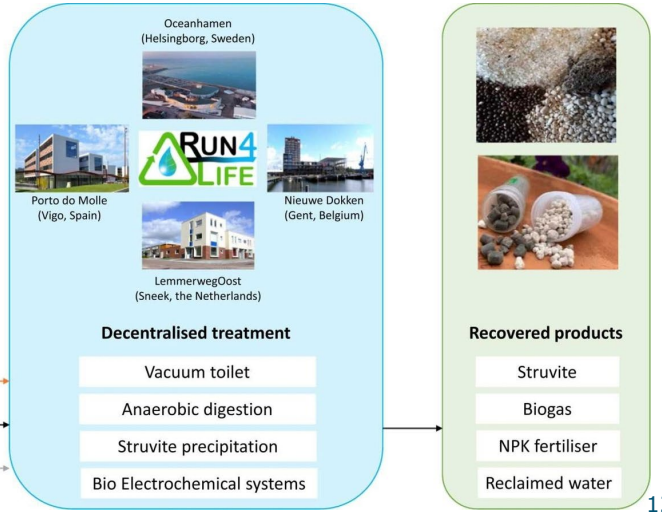
- Digestate, compost and fermented product affect bacteria:fungi ratio differently
- Digestate and fermented product addition in soil increase:
  - microbial activity.
  - EPS in soil.
  - aggregate formation.

Chavez-Rico et al https://doi.org/10.1016/j.eti.2023.103104

Source separated sanitation



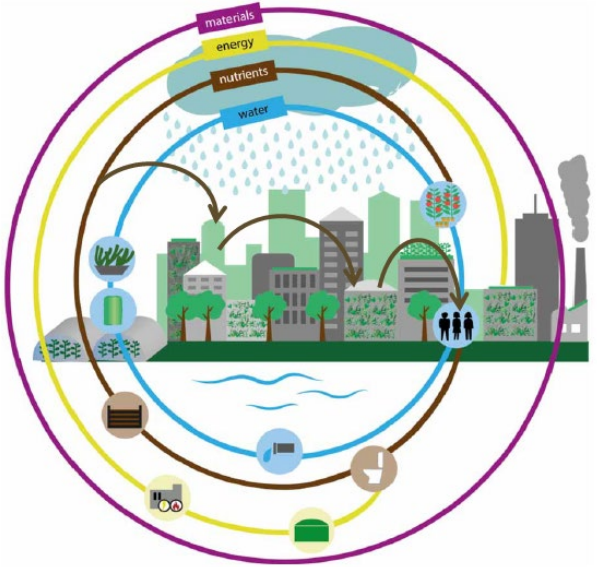
Moerland et al. 10.1016/j.biortech.2021.125705



Rey-Martinez et al. https://doi.org/10.1016/j.clwas.2024.100139

Closing nutrient and carbon cycles

Recovery of carbon (energy) and (micro) nutrients for reuse in agriculture and industry from e.g.



Adapted from doi: 10.2166/bgs.2020.930

Methods:

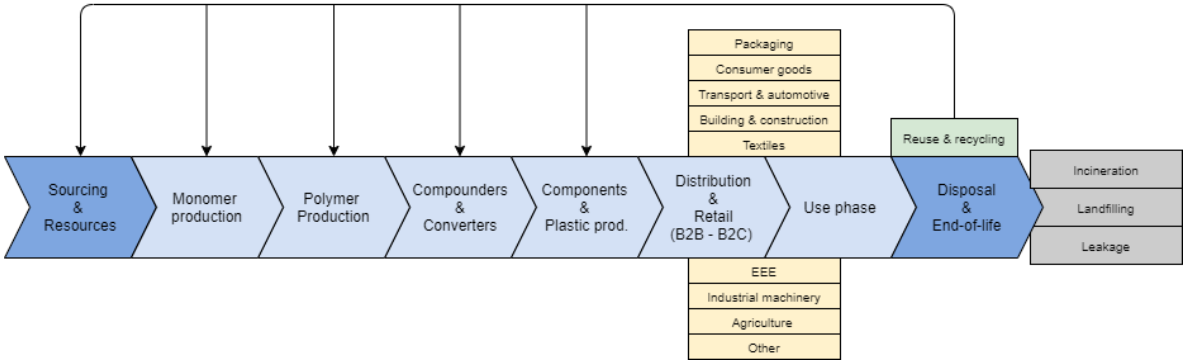
- System engineering at varying temporal and spatial scales
- Technological innovation
- Demand-supply balancing in regional Urban and Urban-Rural

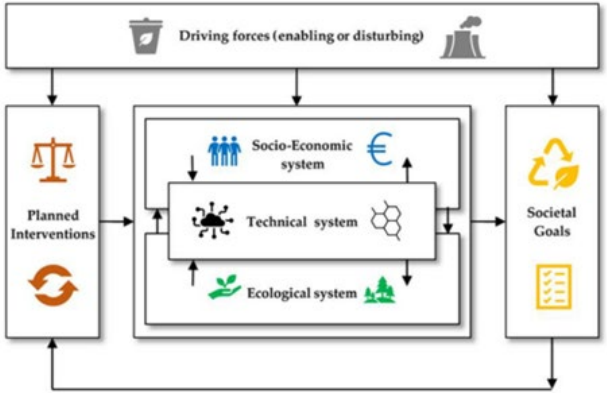
Wielemaker et al., 2019 https://doi.org/10.1111/jiec.12962
Wielemaker et al., 2020 https://doi.org/10.1016/j.jclepro.2020.120789

Plastics recycling

SUR-PLAS-PATH: Co-create **SU**stainable & **R**enewable **PLAS**tic transition **PATH**ways with stakeholders via developing and applying a novel transition design and multi-impact assessment methodology

Objective: interdisicpinary review and analysis of the status quo and current circular advances of the Dutch plastic system.





Source: Yme van Lith, 2024

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Water Technology & Metropolitan Sustainability

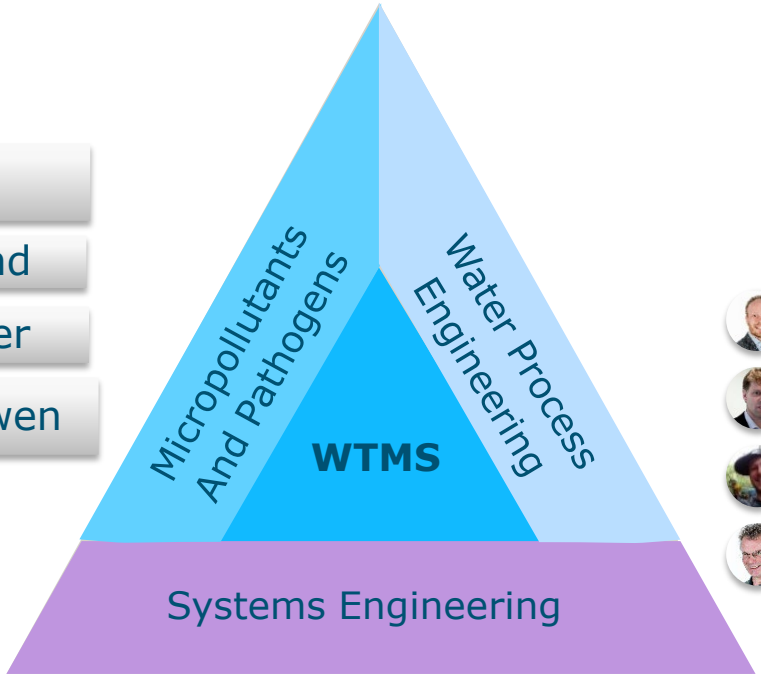
Nora Sutton/Vacancy

Dr. Nora Sutton

Dr. Gabriel Sigmund

Dr. Thomas Wagner

Dr. Stefan van Leeuwen



Dr. Jouke Dykstra

Prof. Bert van der Wal

Dr. Dainis Sudmalis

Dr. Harry Bruning

Dr. Wei-shan Chen

Dr. Shahab Torbaghan

Dr. Kasia Kujawa

Dr. Lixia Chu

Dr. Hans Cappon

Dr. Kamon. Haldar

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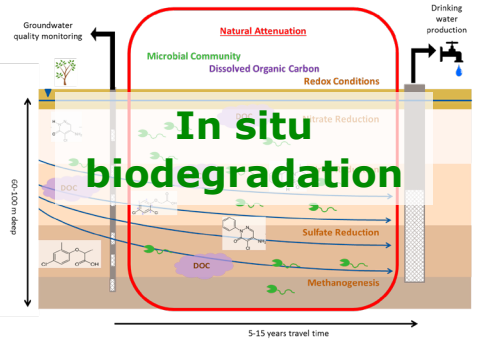
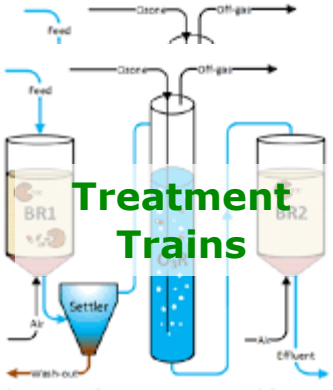
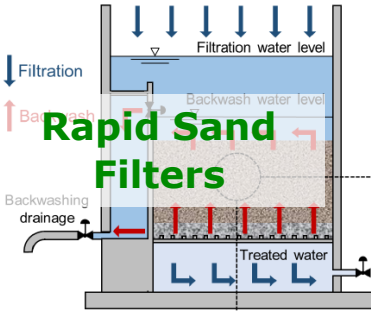
Micropollutant and Pathogen Research

Use a fundamental understanding of physical, chemical, and biological mechanisms of micropollutant and pathogen removal to design new treatment technologies







Research highlights

Contents lists available at ScienceDirect

Water Research

journal homepage: www.elsevier.com/locate/watres

Exploring organic micropollutant biodegradation under dynamic substrate loading in rapid sand filters

Jinsong Wang [a], Baptiste A.J. Poursat [a], Jiahao Feng [a], David de Ridder [b], Chen Zhang [c], Albert van der Wal [a,b], Nora B. Sutton [a,*]

Contents lists available at ScienceDirect

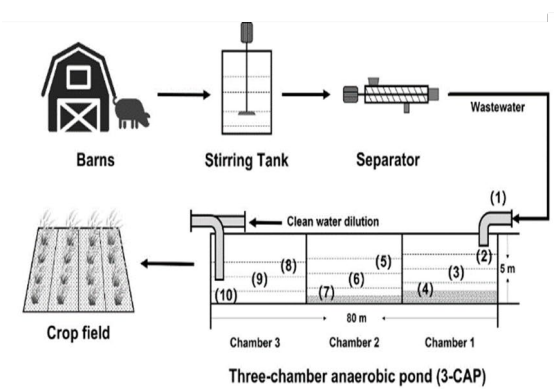
Environmental Research

journal homepage: www.elsevier.com/locate/envres

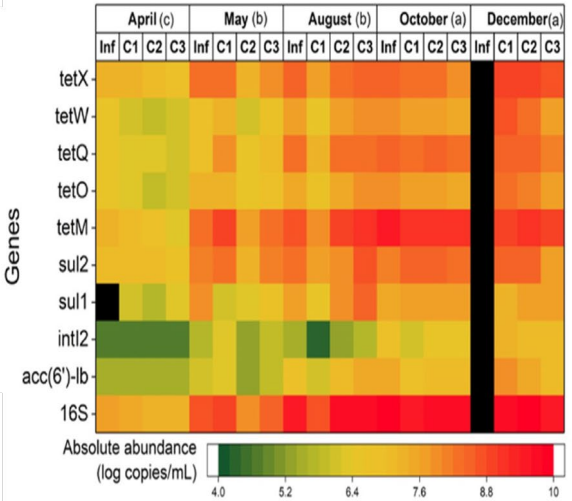
Seasonal variation in antibiotic resistance genes and bacterial phenotypes in swine wastewater during three-chamber anaerobic pond treatment

Yi Wang [a,b,c], Nora B. Sutton [c], Yunhao Zheng [a,b], Hongmin Dong [a,b,*], Huub H.M. Rijnaarts [c]

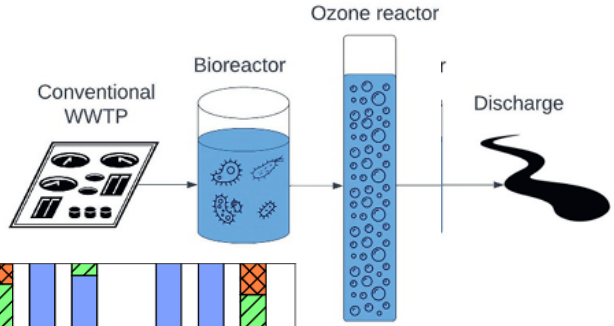
[a] Institute of Environment and Sustainable Development in Agriculture, Chinese Academy of Agricultural Sciences, Beijing, 100081, China
[b] Key Laboratory of Energy Conservation and Waste Management of Agricultural Structures, Ministry of Agriculture and Rural Affairs, Beijing, 100081, China
[c] Department of Environmental Technology, Wageningen University and Research, P.O.Box 17, 6700, AA Wageningen, the Netherlands

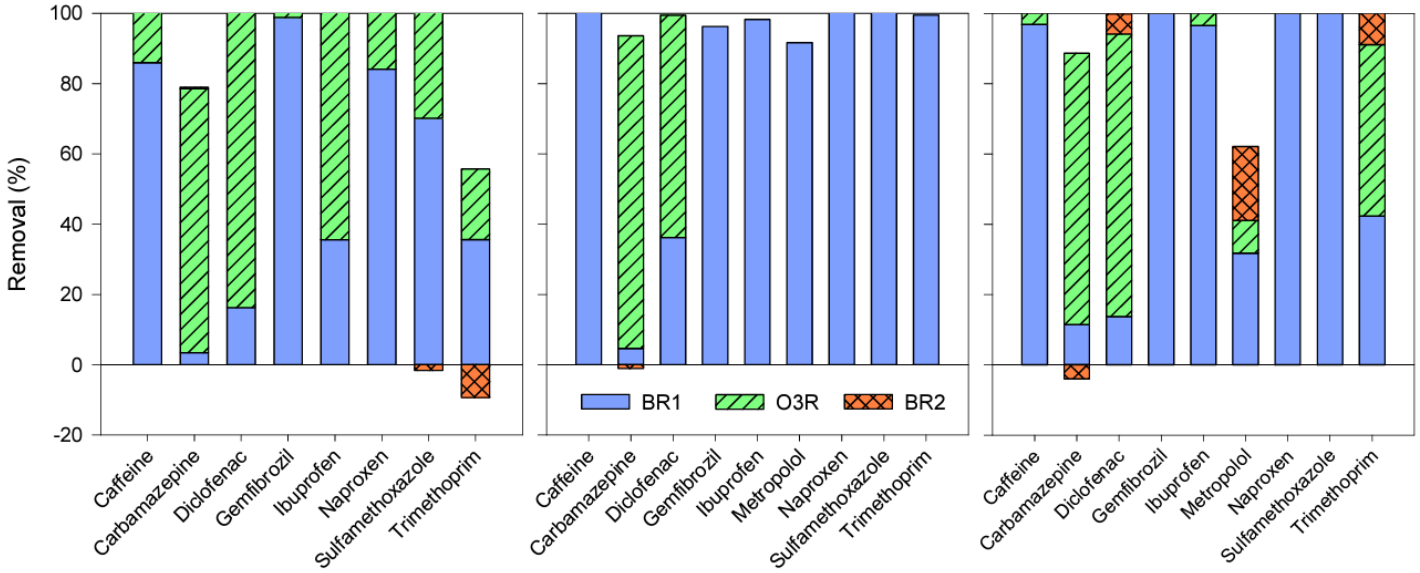


Three-chamber anaerobic pond (3-CAP)



Research highlights





Retention Time 0.3 hours

0.2 g O_3/g TOC

Retention Time 0.47 hours

0.2 g O_3/g TOC

Retention Time 1.46 hours

0.2 g O_3/g TOC

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De Wilt et al., *Water Research,* 2018.

Van Gijn et al., 2021

Research Highlights

Currently being piloted for real treatment conditions in The Netherlands

Piai, RHDHV, 2023.

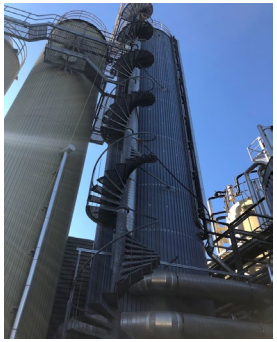
Water Process Engineering

Topics:

- Anaerobic sludge granulation
- Natural flocculants

- Electrodialysis for selective separations

- Electrochemical, membrane, adsorptive micropollutant removal/degradation (PFAS)



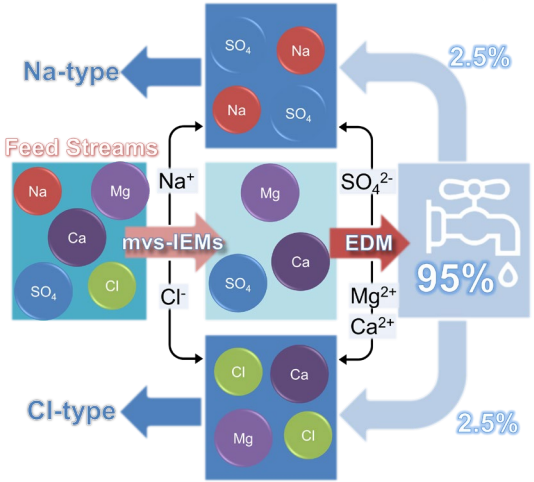
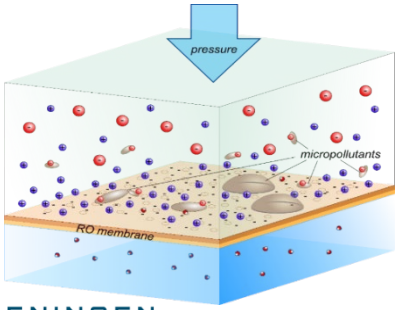


Fig 2. High-recovery and chemical-free EDM configurations: NaCl in the feed streams is used for EDM ionic rearrangement; only source water and electricity as the input.



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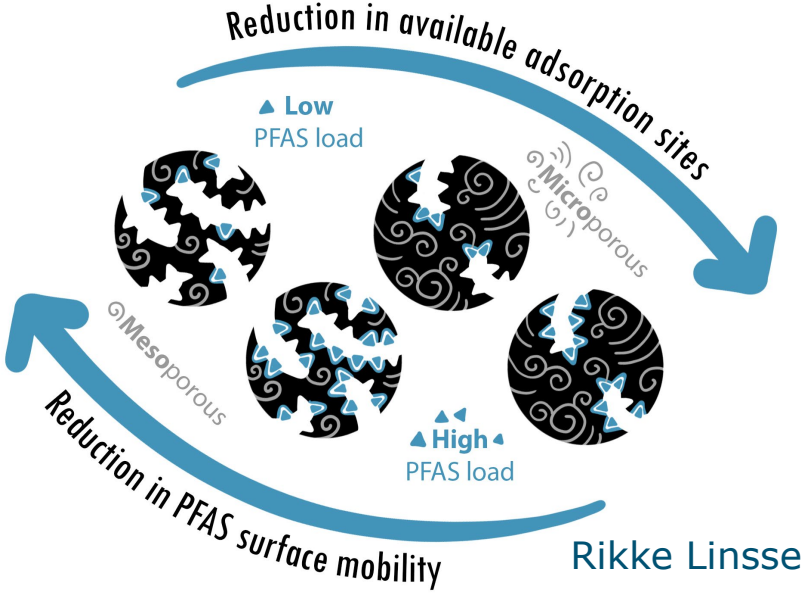
Research Highlights

Why is the adsorption of PFAS low?

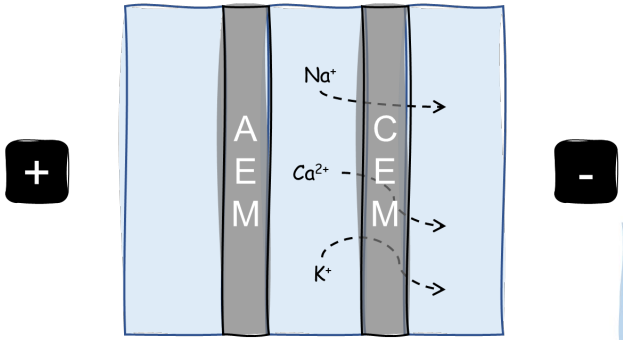
Very slow surface diffusion inside activated carbon granules

Very low adsorption capacity at low concentrations

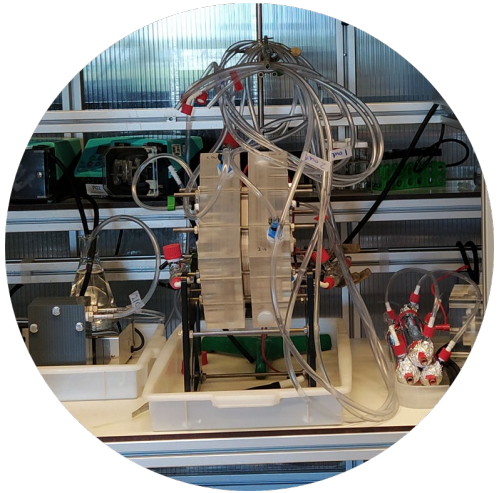


Rikke Linssen

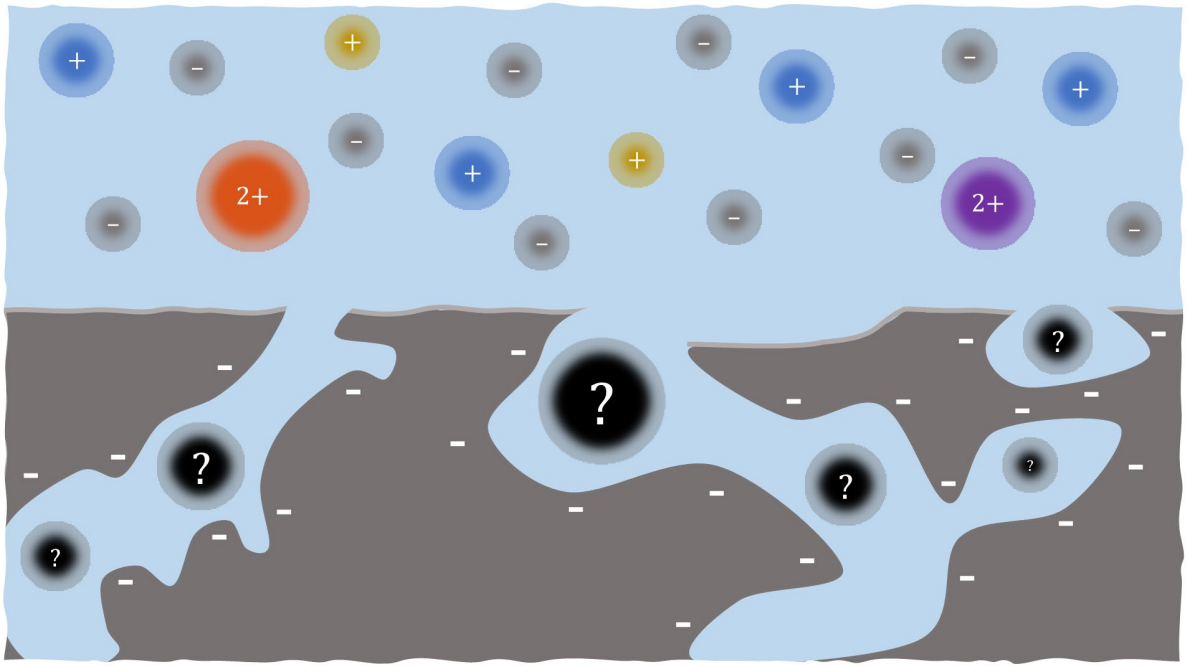
Research Highlights



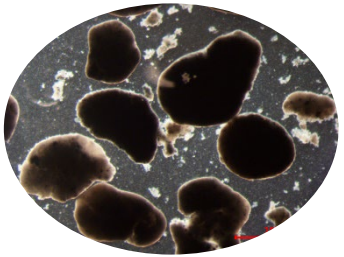
Electrodialysis:

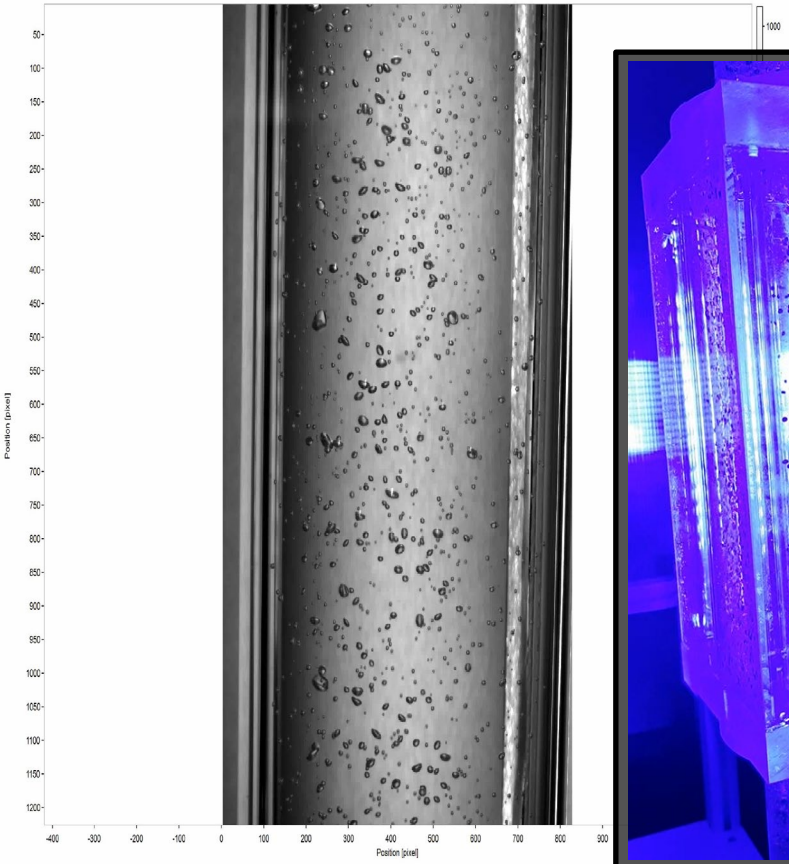


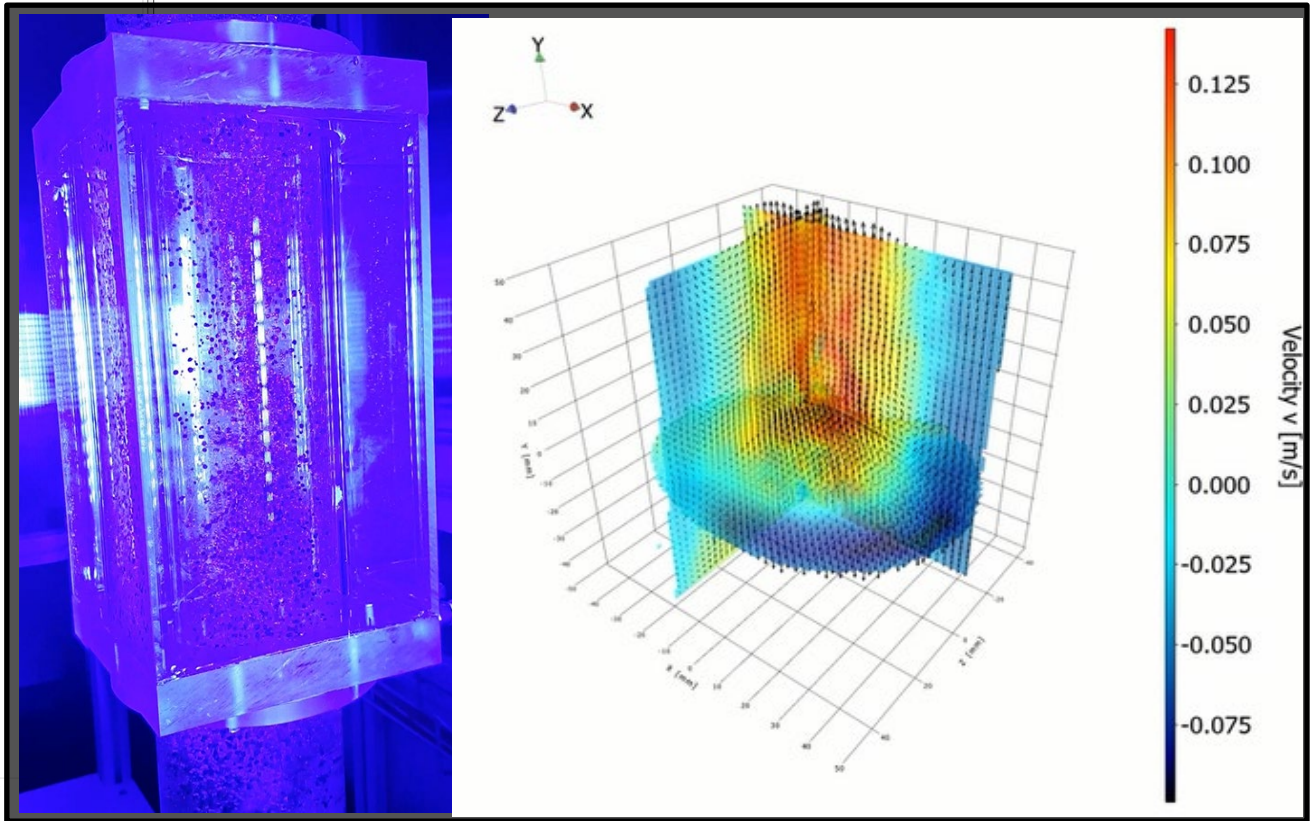
Understanding ion transport in ion exchange membranes for selective separations



How fluid flows shape anaerobic granules





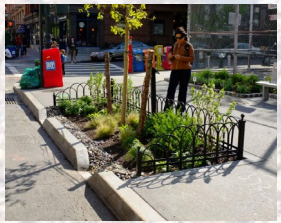


Engineer urban water system for climate adaptation

AMSTERDAM INSTITUTE FOR ADVANCED METROPOLITAN SOLUTIONS

Urban space transition via Blue-green Infra. planning using GIS (BGIS; Alida)

- ✓ How to choose BGI : Multi-objective planning via digital twin
- ✓ How to implement: Long-term adaptative & flexible planning



BGI Measures

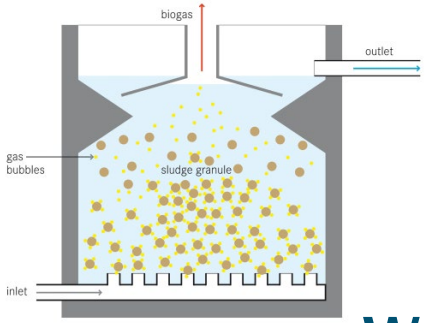
- Bioretention Area
- Constructed Wetland Area
- Grass
- Green Roof
- Infiltration Trench
- Permeable Pavement
- Rain Barrels
- Rain Garden
- Swale
- Trees
- Unsuitable Area for BGI

Sulfur removal from (bio)gas

Organic sulfur/ inorganic sulfates

Hydrogen sulfide

Elemental sulfur



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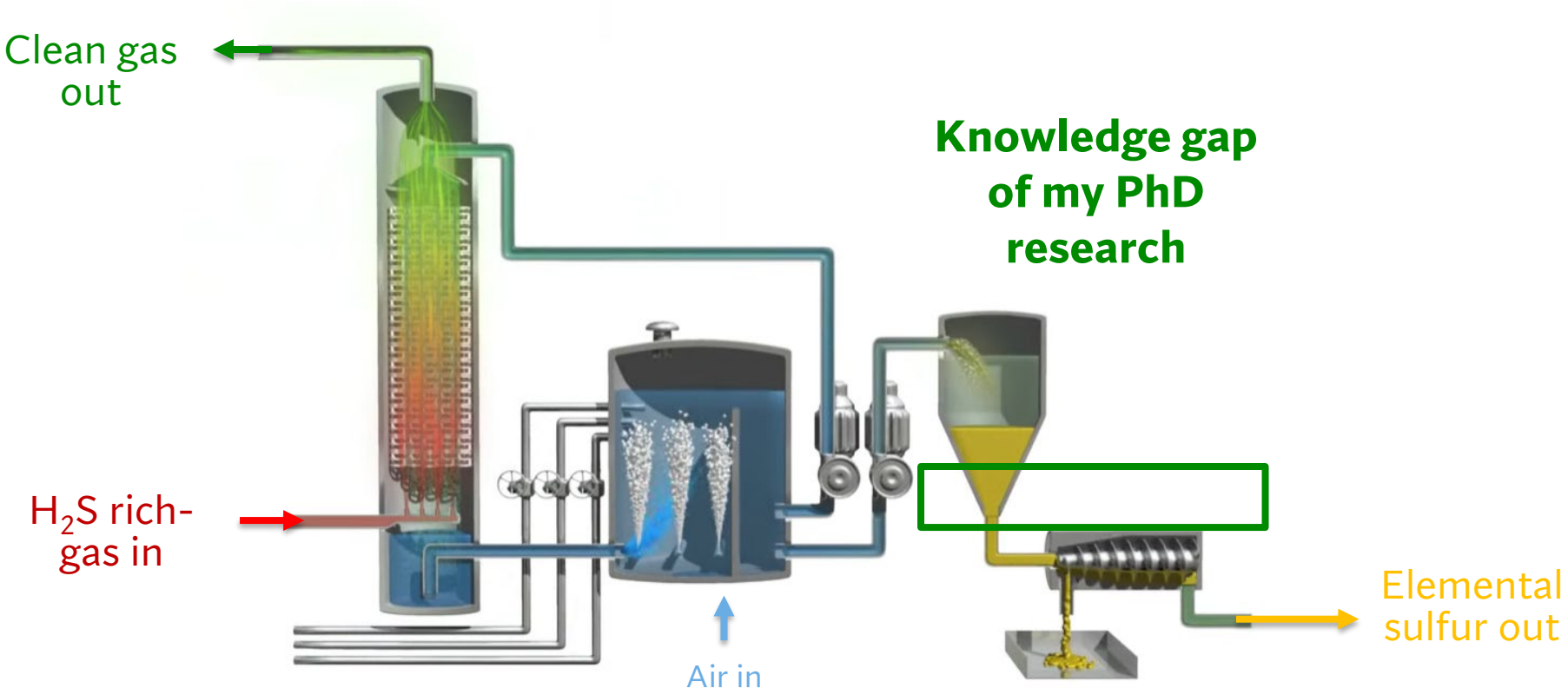
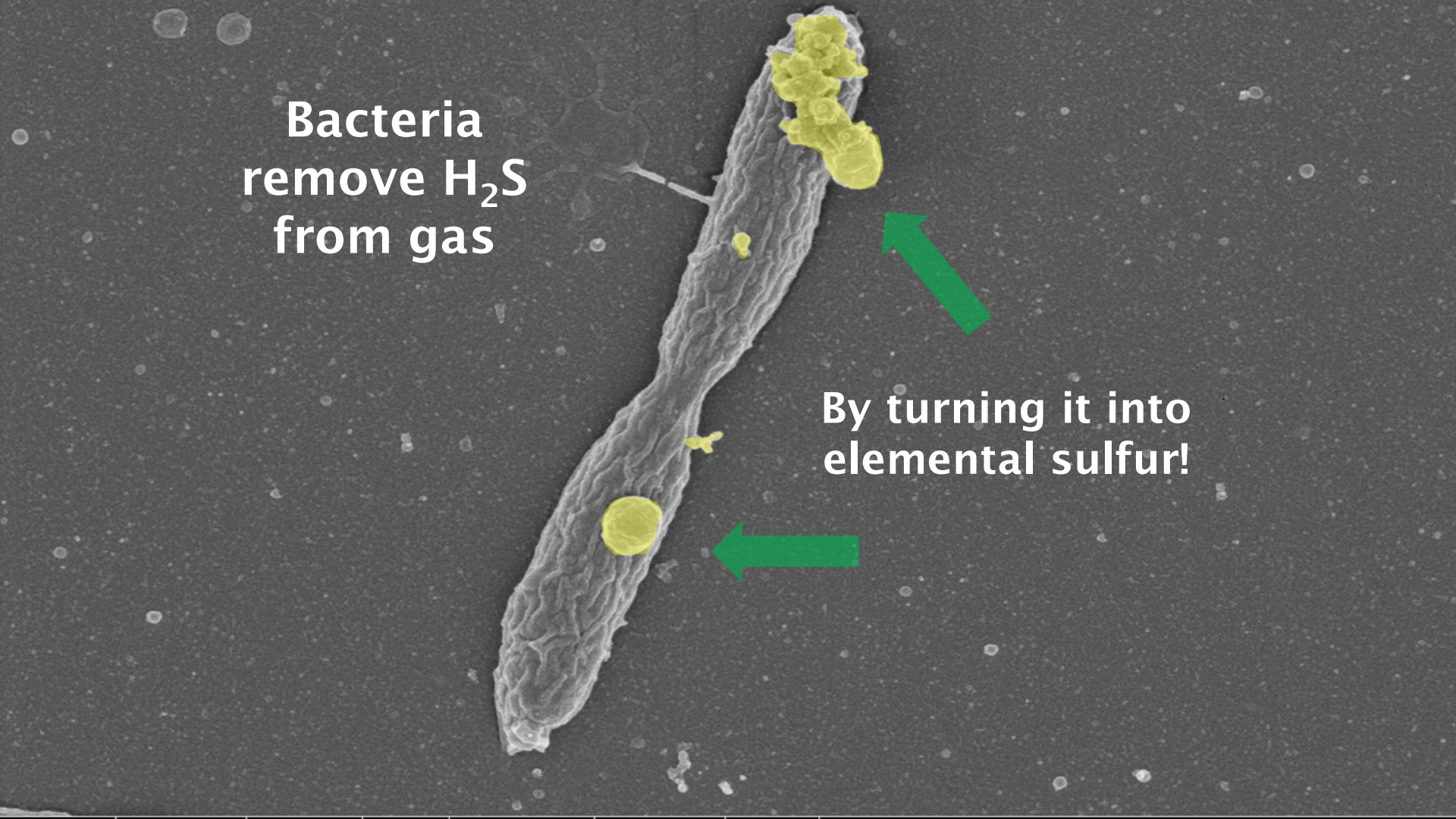
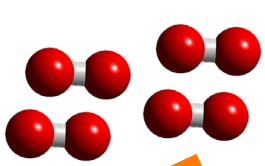
What did I research?

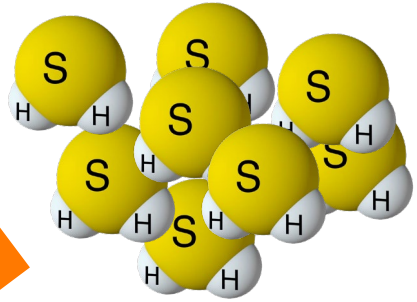
How does biological desulfurization work?




Bacteria remove H_2S from gas
By turning it into elemental sulfur!

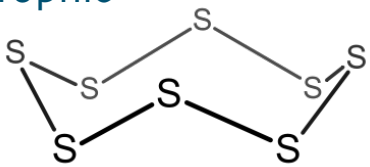
From toxic gas to useful product

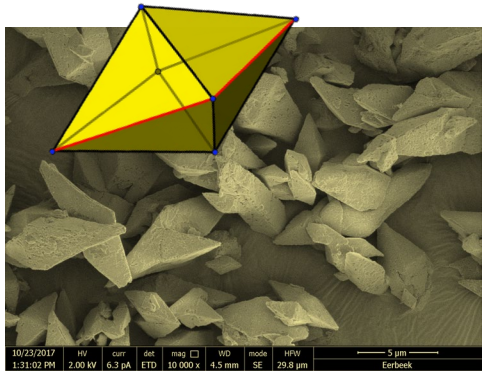




$HS^- + ½\ O_2 \rightarrow 1/8\ \mathbf{S_8} + OH^-$

e.g. *Thiobacillus*
Chemolithoautotrophic





e.g. Fertilizer

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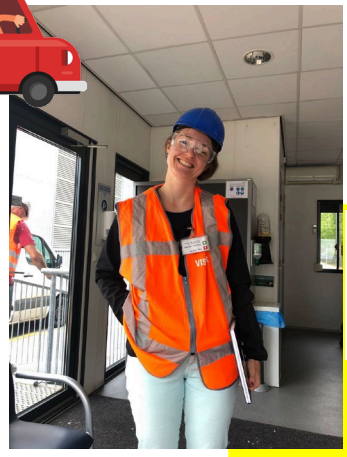
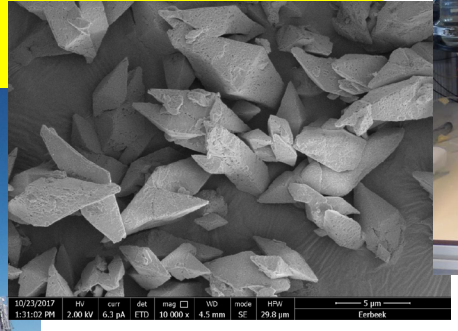
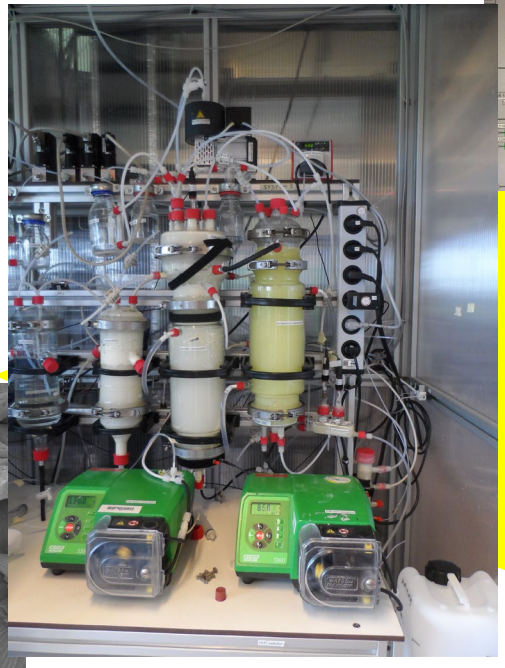
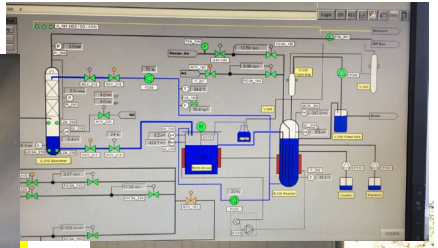
Time-line PhD project: a pyramid approach









Scale

Year 1

Year 2

Year 3

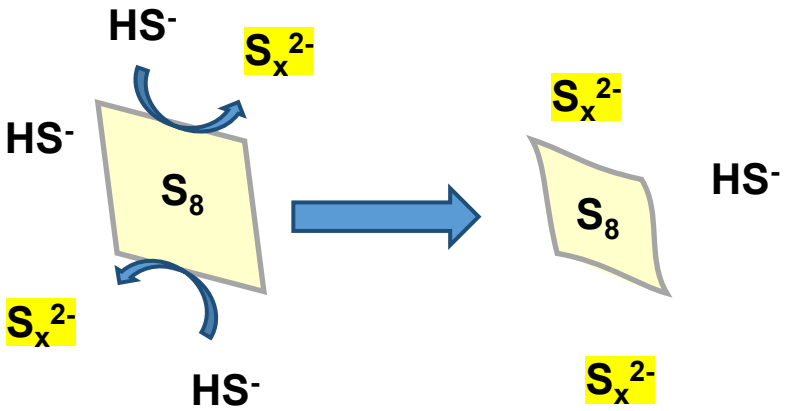
Year 4 (plus a bit...)

Time

Project duration: Aug 2016 - Nov 2021

The key: polysulfide formation

- Partially 'dissolves' sulfur particles

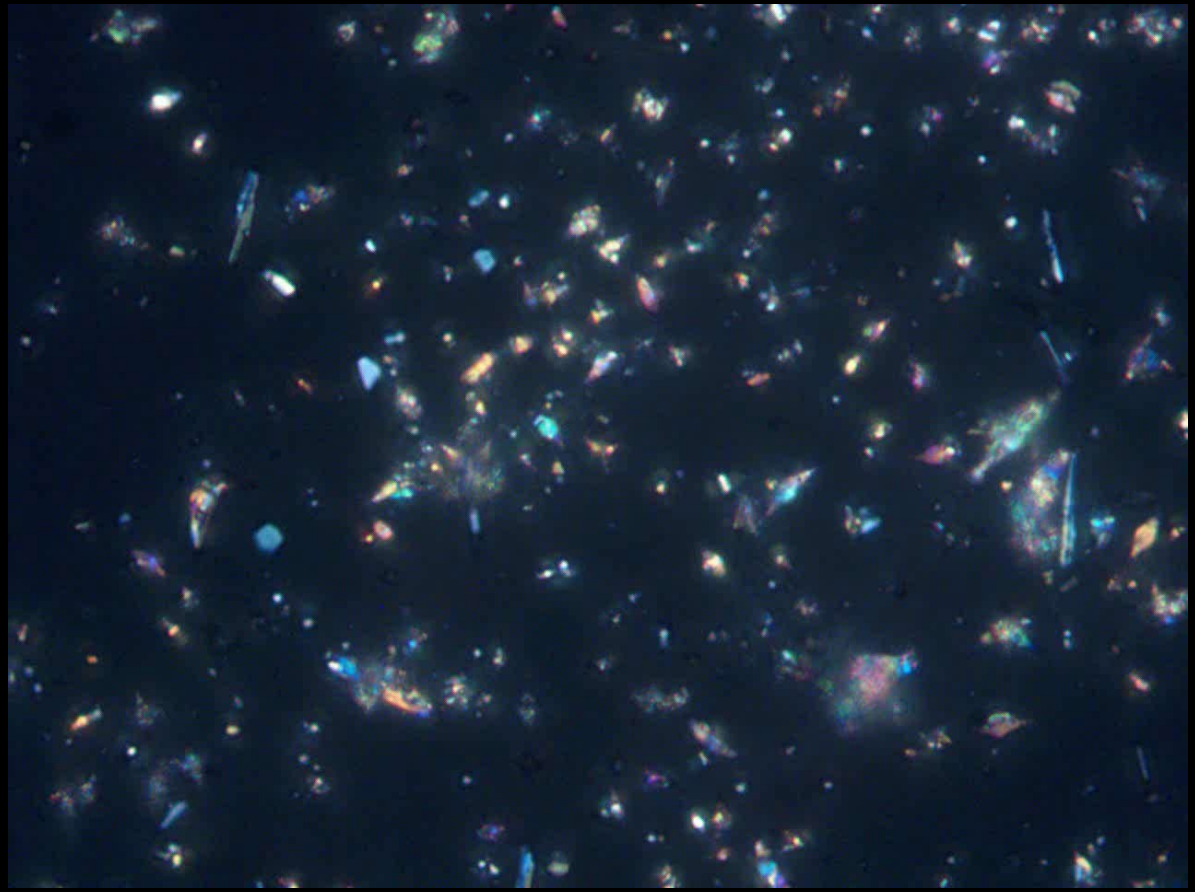


$$HS^- + (x\text{-}1)\ S^0 \leftrightarrows S_x^{2-} + H^+$$

Soluble reactant + solid product in equilibrium with soluble intermediate

Year 2+3

Mol, Annemerel R., et al. *ACS omega* 6.42 (2021): 27913-27923.



Bedankt voor uw aandacht! Zijn er vragen?