

BALKANS JOINT CONFERENCE AND EXHIBITION  
**ACCELERATING**  
*Change* 7-9 NOVEMBER 2023  
GOLEM, ALBANIA

*Towards Safe, Reliable  
and Sustainable Services*



# The development of an electrochemical decentral household treatment unit.

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NOAH Water Solutions

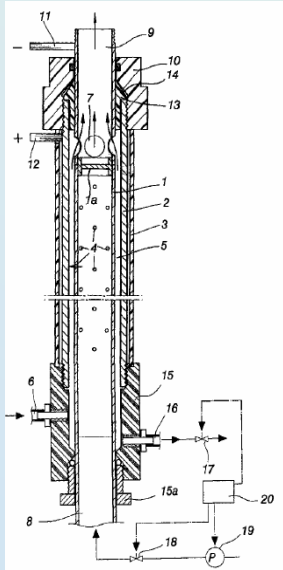
Golem, 9<sup>th</sup> November 2023

# Electrochemical treatment of wastewater

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- Introduction of Noah Water solutions
- Summarize 6 year R&D in 14 minutes
- Results and outlook

# NOAH Water Solutions : a R&D company



## Research:

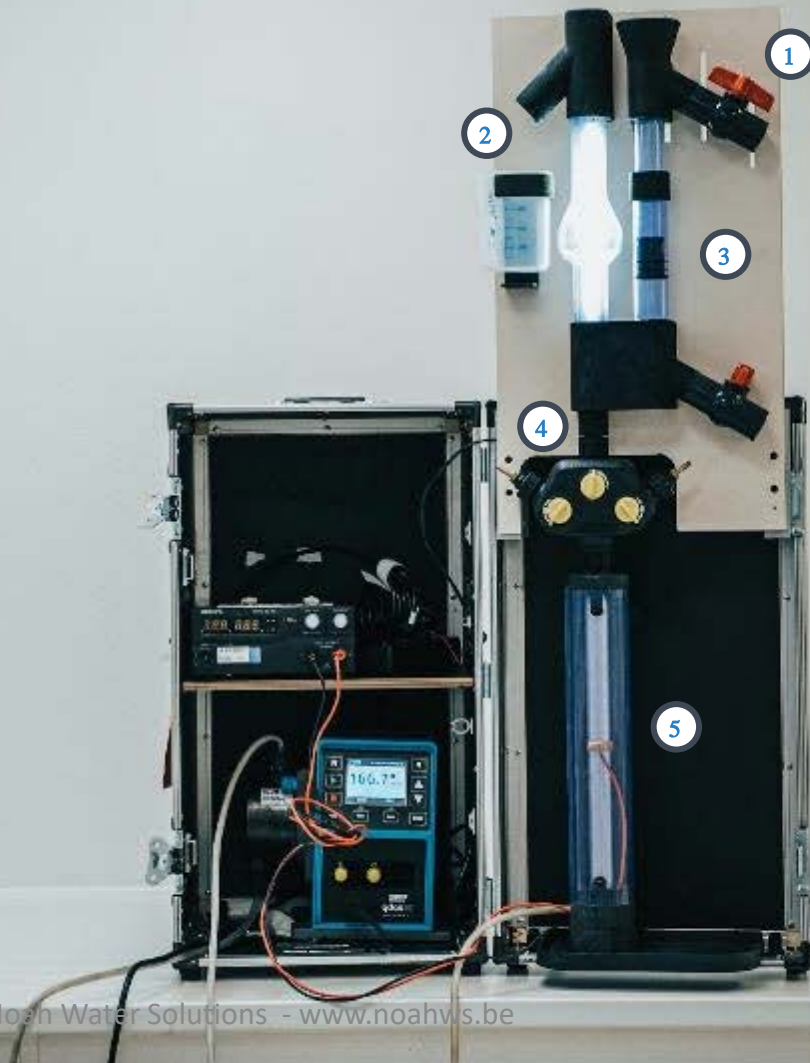
- Own patents WO2022/269487; BE2021/5484
- Connected to the University of Ghent and Antwerp
- PhD research & articles

## Development

- Labreactor to serve international scientific community
- Focus on small industrial installations (0,1-20m<sup>3</sup>/h)
- Focus on sanitation (0,1-3m<sup>3</sup>/h)

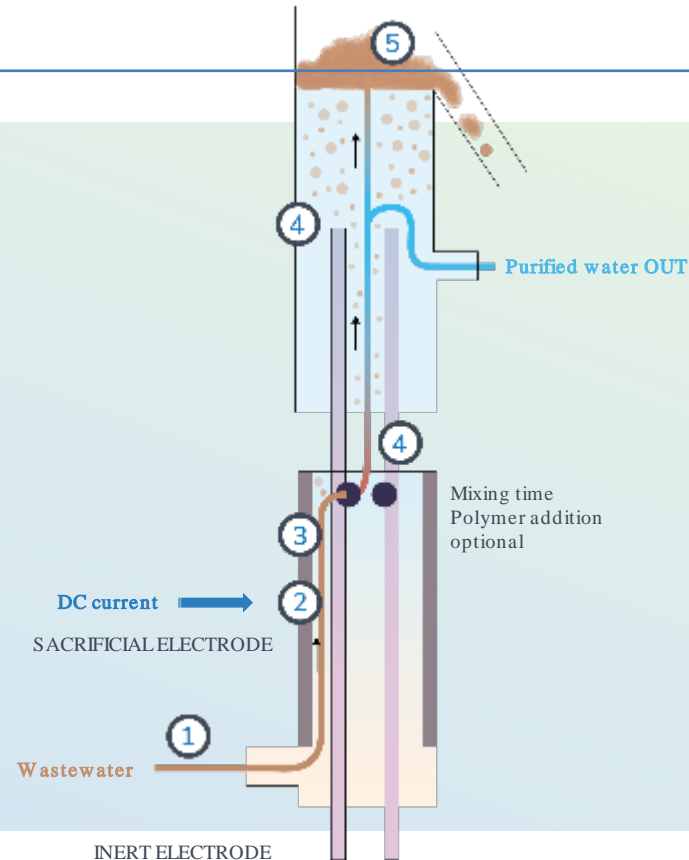
# Lab reactor

- ① Exit effluent  
Height regulation sludge removal
- ② Exit sludge
- ③ Flocculation tower
- ④ Static mixer
- ⑤ Electrochemical cell



# Working principle EC-F

1. Wastewater is pumped through the gap between the two coaxial electrodes.
2. An iron or aluminium sacrificial electrode releases metal ions which speciate depending on pH.
3. The produced metal ions react with water producing metal hydroxides, which encapsulate, adsorb & co-precipitation colloidal particles and pollutants.
4. The inner inert electrode produces very fine hydrogen bubbles which cause a flotation effect.
5. The iron- aluminium hydroxide floc, is floating by produced  $H_2$ . There is no mechanical separation only gravitational.



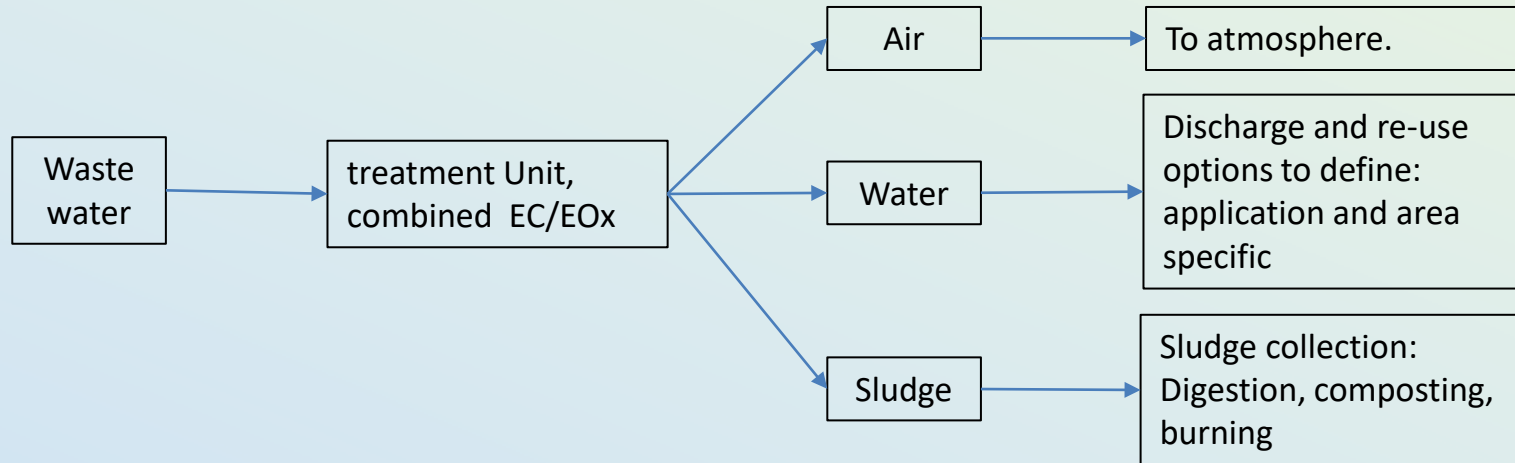
# Motive for the development

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- Drawbacks of biological systems in grid-less applications:
  - Excess sludge production (handling issue)
  - Under-/over-/seasonal load affects the efficiency
  - aeration energy (esp. onboard, warm countries)
  - Size & weight
  - Emissions (CH<sub>4</sub>, N<sub>2</sub>O) septic tanks

*This is NOT a disqualification  
of biological systems!*

# Concept of system



- Focus of development: must comply with land-based and EU Inland Waterways discharge limits

# The challenge:

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- Discharge limits & certifications, differ across EU
- Low capex / opex
- Dry sludge
- Treat-on-demand
- Desinfection
- Re-use of water (closing the loop)
- And lowest GHG emissions.....



# Can EC + Eox be the solution?

- considering different sources, different load – same discharge limits....

Type of wastewater	source	locations:	COD mg/l	1 m3 equals to:
High strength	vacuum toilets, some handwash	trains, some boats, some households	>9000	2000 flushes from vacuum with some handwashing water @ 0,5 l/flush
medium strength	flush toilets, some handwash	boats, construction sites, some households, lodges	<2500 > 1500	125 flushes, total water use 8 liters/flush, handwashing
low strength (domestic wastewater)	toilets + grey water (+kitchen)	households, hotels, some boats	<500 >300	highly diluted domestic wastewater, 110 l person/day

# Can EC + Eox meet the standards?

- and considering different effluent standards.....

		High seas		Inland waterways			Domestic wastewater		SYSTEM TARGETS	
		IMO		EU	NL recreational craft	EU Inland Waterways		EU		
		MEPC.227 (64)	MEPC 227(64) Par. 4.2	2012/49/EU	BSK2019/201145	ES-TRIN ( H 18)		directive 91/271/EEG		
	unit	since 2016		Since 2013	since 2019			in mg/L	reduction %	
BOD <sup>5</sup>	[mg/l]	25 Q <sub>i</sub> /Q <sub>e</sub>	25 Q <sub>i</sub> /Q <sub>e</sub>	20 mg/l <sup>1</sup> – 25mg/l <sup>2</sup>	NO treatment	20 mg/l <sup>1</sup> – 25mg/l <sup>2</sup>	25mg/l <sup>2</sup>	25 mg/L	70-90%	25mg/l <sup>2</sup>
COD	[mg/l]	125 Q <sub>i</sub> /Q <sub>e</sub>	125 Q <sub>i</sub> /Q <sub>e</sub>	100 mg/l <sup>1</sup> – 125 mg/l <sup>2</sup>		100 mg/l <sup>1</sup> – 125 mg/l <sup>2</sup>	125 mg/l <sup>1</sup> – 150 mg/l <sup>2</sup>	125 mg/L	75%	125 mg/l <sup>1</sup> – 150 mg/l <sup>2</sup>
TSS	[mg/l]	35 Q <sub>i</sub> /Q <sub>e</sub>	35 Q <sub>i</sub> /Q <sub>e</sub>					35 mg/L (facultative norm)	70% ( 2000-10000 ie) (facultative norm)	< 50

effluent standards are more or less the same, certification different per group/countrylevel).

# Can EC + Eox add value?

## - Desinfection

coliforms	[cfu/100 ml]	100 $Q_i/Q_e$	100 $Q_i/Q_e$	int. Enterok 330kve/100 ml and e.coli 900kve/ml - (90-percentiel)	Log 6 reduction (99,9999%)
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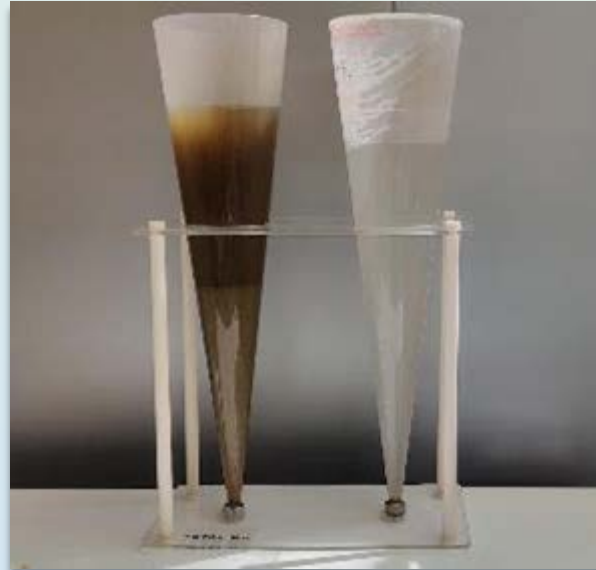
Starting values always > 10<sup>6</sup>CFU/100 ml toilet water.....

## And some nice-to-have-but-not-so-challenging

residual chlorine	[mg/l]	0,5	0,5	-	-	0,01	0	no added chlorine
pH	[-]	6,0 - 8,5	6,0 - 8,5	-	-	6,0 - 9,0		6-9
N <sub>tot</sub>	[mg/l]	20 $Q_i/Q_e$	20 $Q_i/Q_e$	-	-	-		
P <sub>tot</sub>	[mg/l]		1 $Q_i/Q_e$	-				>95% (<1,0 mg/L)

# Start: testing on synthetic faecal sludge

Parameter	influent
	mg/L
COD	4739
sCOD	178
TN	83,5
TP	25,0



Influent: domestic waste water +  
Toilet Paper + cow feces  
>1000 NTU

effluent Process	Removal
mg/L	%
182	96
141	21
25,6	68,7
0,28	99

Energy consumption of 5,1 kWh/m<sup>3</sup>

Effluent step 2: Ti

4,8 NTU

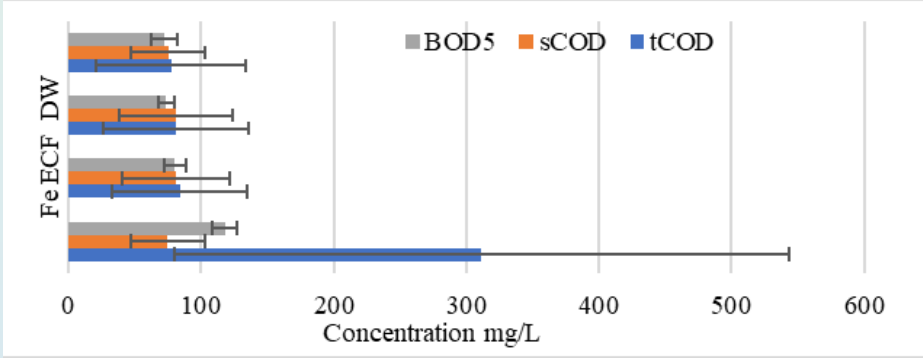
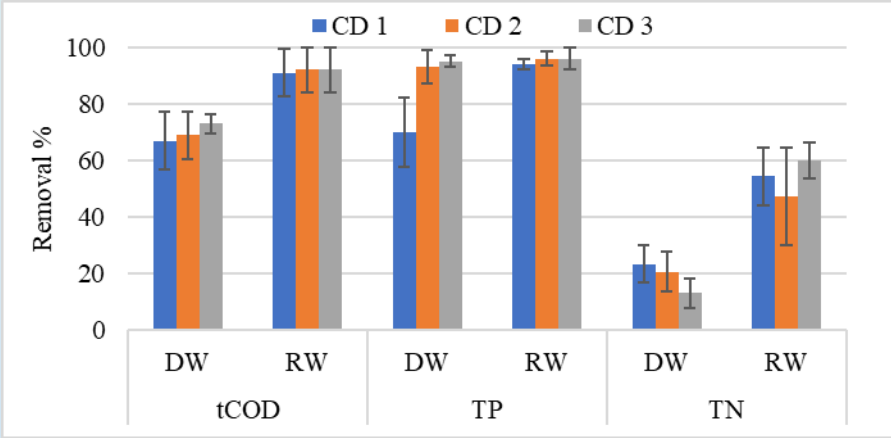
# Next step: testing at festivals 2022



- a. - vacuum toilets 0,5 l/turn
- b. - shredder pump
- c. - electro-coagulation followed by
- d. electro-oxidation

All festivals are different...

# Results on mww



tCOD, TP and TN Removal performances of Al EC-F treatment of DW and RW MWW at applied CD

Concentration of tCOD, sCOD, BOD5 before and After ECF

# Results

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- ✓ Discharge limits EU Directive
- ✓ Discharge limits Inland Waterways
  - on domestic low strength
- ✓ - total disinfection in two steps
- High strength water with 3<sup>rd</sup> step
- N removal needs more attention



# From concept to realization 2023



Floating house, Rotterdam.  
Operational 01-01-2024



# From concept to realization 2023



Construction site  
sanitation unit.  
Step towards sustainable,  
cost-effective permanent  
on-site treatment



# Food for thought:

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- Treatment at source eases process
  - 'Flush and go' concept energy demand.
  - Avoid CH<sub>4</sub>, and NH<sub>3</sub> production by immediate treatment
- Sludge has high biogas potential – valorisation?
- Reach discharge limit – but always necessary? (place dependent? nutrient rich water)
  - Total disinfection paves way for reuse (toilet flush, irrigation, .....)

# Thank you for your attention

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[www.noahws.be](http://www.noahws.be)

# References

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- 1) N. Hassan, et al., Electrocoagulation flotation as a municipal wastewater (pre-)treatment technology: Effect of weather conditions and current density, *J. Environ. Manage.*, 345 (2023) 118906
- Ontwikkeling van een elektrochemische sanitatie unit, (development of an electro-chemical sanitation unit) Sophie van Wambeke, Bachelor thesis, 2021-2022,
- Testreports, analysis, technical development by Noah Water Solutions, Dr. D. Parmentier, R.Goossensen.