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BIOMIMETIC AQUAPORIN FORWARD OSMOS/S MEMBRANE FOR REMOVAL OF FREQUENTLY FOUND PESTICIDES FROM DANISH GROUNDWATER NETWORK

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BORG UNIVERSITET DEPARTMENT OF CHEMISTRY AND BIOSCIENCE ESBJERG SECTION OF CHEMICAL ENGINEERING



Introduction

Map of pesticide contamination



Found in 27% of active DW wells
> 0.1 μg/L in 3.6%
130 wells were closed within 1993-2009



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MEM 2BIO Water teatment

Membrane separation:

- ~ 90% ultra pure water
- ~ 10% residual 'waste' water with high concentration of pollutants, carbon, minerals etc.

Biofilter:

Added specific pesticide degrader organisms to sand filters



Ellegaard-Jensen et al. 2017





Mineralization

Treated concentrate is mixed with permeate

3

Studied pesticides

1. BAM (2-6 Dichlorobenzamide)

MW: 190.028 g/mol

transformation product of Dichlobenil

2. MCPA (2-methyl-4-chlorophenoxyacetic acid)

MW: 200.62 g/mol

3. MCPP (methylchlorophenoxypropionic acid)

MW: 214.65 g/mol





In 2015, Found in 16% of sampled wells of which 9.4% was above 0.1 µg/L.



Forward Osmosis







Use of FO in MEM2BIO project







Aquaporin FO membrane



- Incorporated aquaporin proteins in the membrane
- Higher permeability compared to traditional FO membranes



34 cm²



2.3 m²





FO setups







Membrane characterization

Parameter	Value
NaCl rejection in RO (%)	99.4 ± 0.2
Pure water permeate flux (LMH)	15.2 ± 0.6
Reverse salt flux (g m ⁻² h ⁻¹)	5.6 ± 0.5 (1.7 ± 0.4 by HF)
Water permeability, A (L m ⁻² h ⁻¹ bar)	3.0 ± 0.2
Salt permeability, B (L m ⁻² h ⁻¹)	0.1 ± 0.03
Membrane structural parameter, S (µm)	305 ± 43
Contact angle (°)	28.6 ± 3.4
Zeta potential at pH=5.3 (mV)	- 21 ± 2





Pesticides rejection in pure water





17th Nordic filtration symposium

Pesticides rejection in Varde water







Time (min)

BAM

MCPA — MCPP — Permeate flux

Pesticides rejection by different setups

	BAM (%)	MCPA (%)	MCPP (%)	Pure water permeate Flux (LMH)
Hollow fiber	98.1	98.6	98.9	15.8
Flat sheet	93.3	94.7	94.9	15.2
Small FO compartment	97.2	-	-	9.4

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H. Madsen et. al., Journal of Membrane Science 476 (2015) 469-474



Future work

- Use of the other water samples from Kolding and Hvidovre.
- Use of the other draw solutes: Glucose and Sodium acetate
- Study of effect of recovery on the membrane performance.
- Production of concentrates for biological treatment using different draw solutes
- Comparison of RO and FO in terms of scaling propensity
- Combination of FO and RO as an integrated membrane process.





