

## **Biomimetic aquaporin forward osmosis membrane for removal of frequently found pesticides from danish groundwater network**

Nikbakht Fini, Mahdi; Madsen, Henrik Tækker; Muff, Jens

*Publication date:*  
2018

[Link to publication from Aalborg University](#)

### *Citation for published version (APA):*

Nikbakht Fini, M., Madsen, H. T., & Muff, J. (2018). *Biomimetic aquaporin forward osmosis membrane for removal of frequently found pesticides from danish groundwater network*. Abstract from Nordic Filtration Symposium, Aalborg, Denmark.

### **General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal -

### **Take down policy**

If you believe that this document breaches copyright please contact us at [vbn@aub.aau.dk](mailto:vbn@aub.aau.dk) providing details, and we will remove access to the work immediately and investigate your claim.

# ***BIOMIMETIC AQUAPORIN FORWARD OSMOSIS MEMBRANE FOR REMOVAL OF FREQUENTLY FOUND PESTICIDES FROM DANISH GROUNDWATER NETWORK***

*MAHDI NIKBAKHT FINI, HENRIK TÆKKER MADSEN, JENS MUFF*



**AALBORG UNIVERSITET**  
ESBJERG

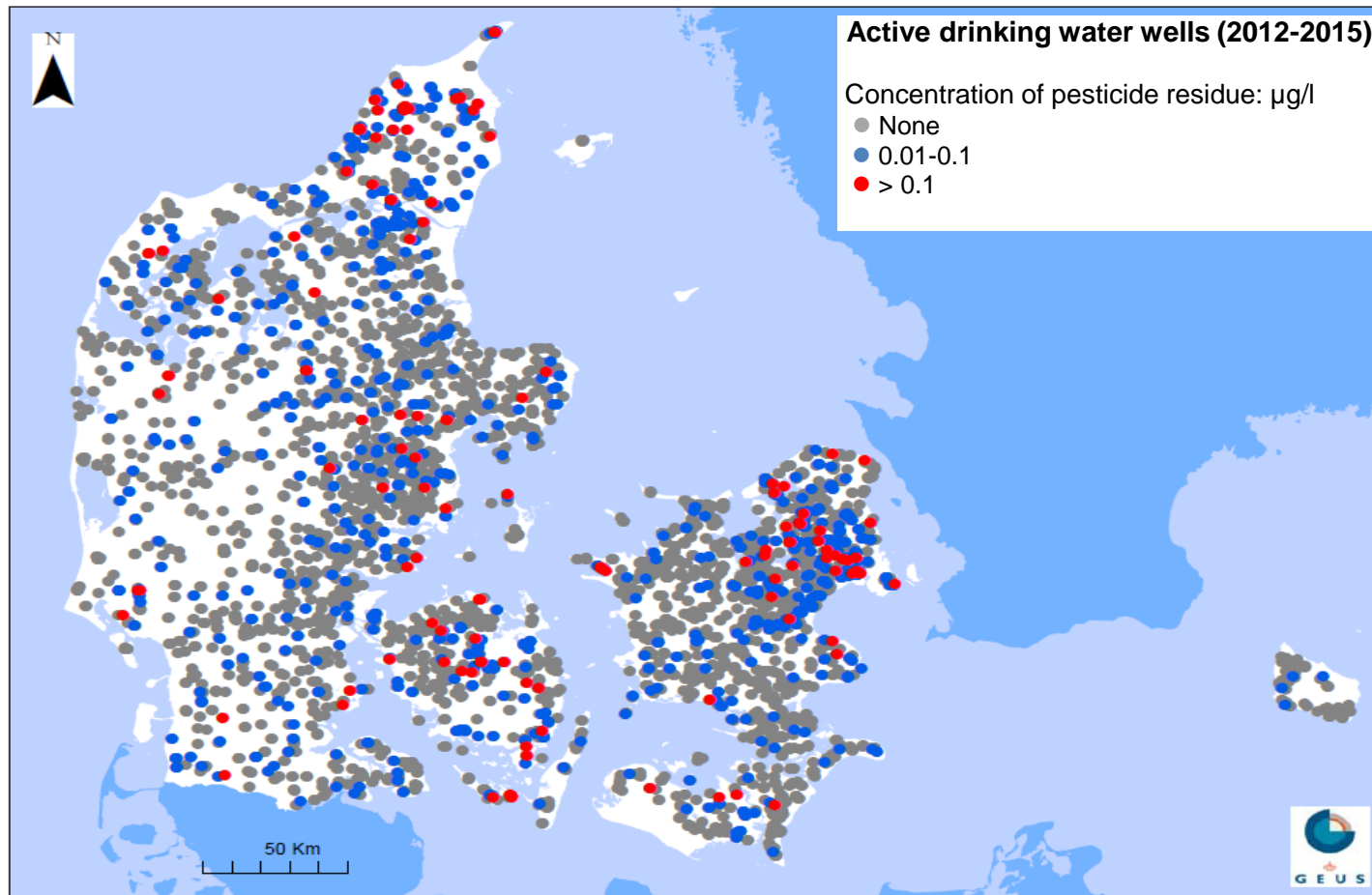
DEPARTMENT OF CHEMISTRY AND BIOSCIENCE  
SECTION OF CHEMICAL ENGINEERING



**NoFS**

# 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



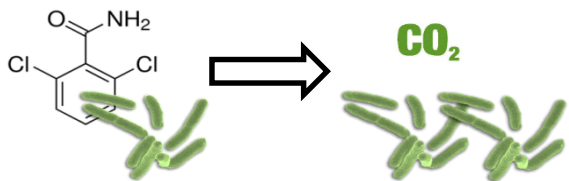
**Membrane separation:**

~ 90% ultra pure water

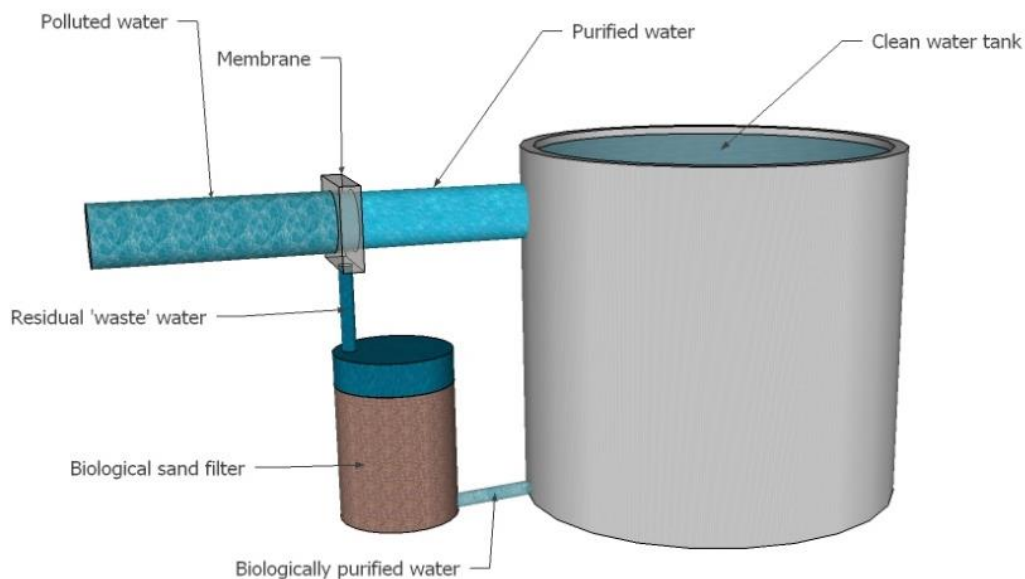
~ 10% residual 'waste' water with high concentration of pollutants, carbon, minerals etc.

**Biofilter:**

Added specific pesticide degrader organisms to sand filters

**Mineralization**

Treated concentrate is mixed with permeate



*Ellegaard-Jensen et al. 2017*

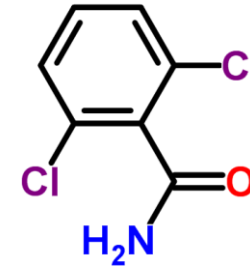


# Studied pesticides

## 1. BAM (2,6-Dichlorobenzamide)

MW: 190.028 g/mol

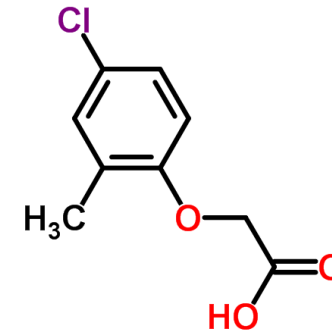
transformation product of Dichlobenil



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

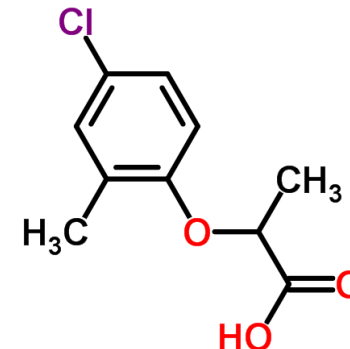
## 2. MCPA (2-methyl-4-chlorophenoxyacetic acid)

MW: 200.62 g/mol



## 3. MCPP (methylchlorophenoxypropionic acid)

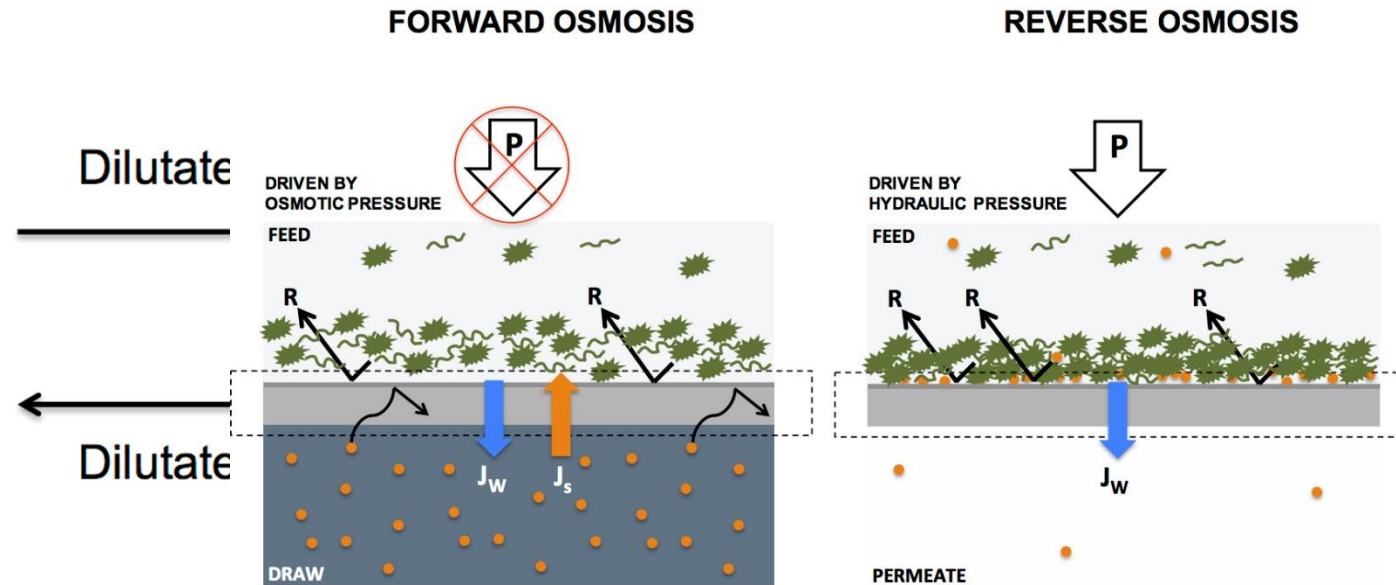
MW: 214.65 g/mol



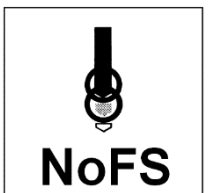
# Forward Osmosis

Advantages of FO process

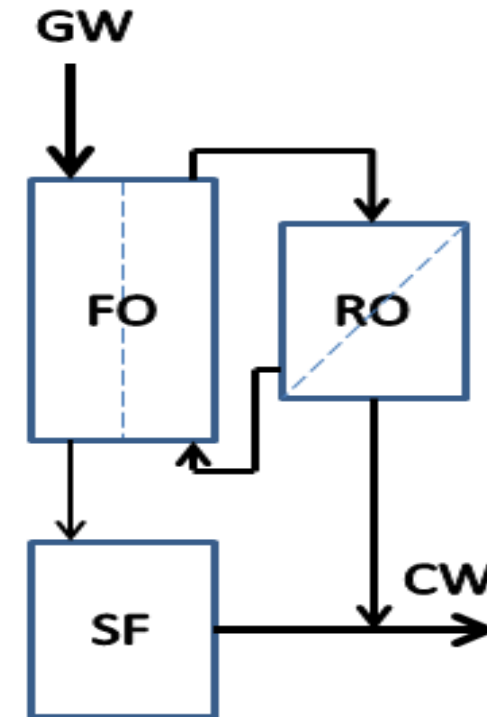
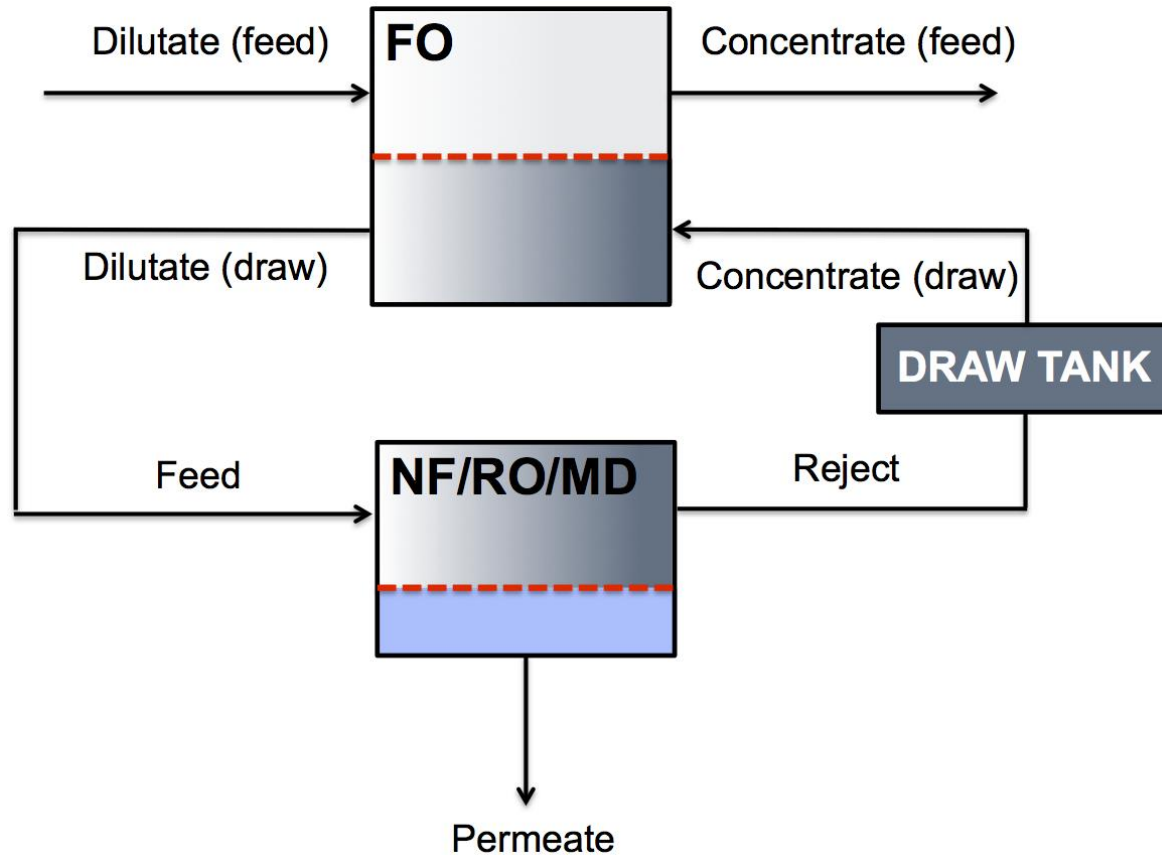
- Less energy requirement
- Less risk of fouling/scaling



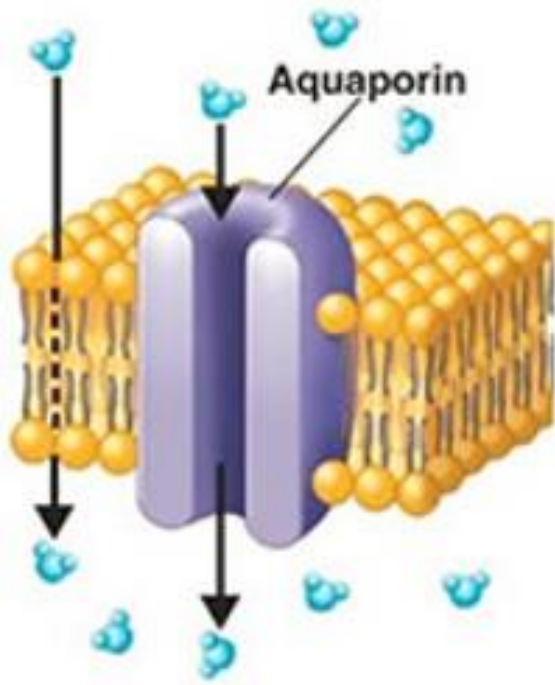
AALBORG UNIVERSITET  
ESBJERG



# Use of FO in MEM2BIO project



# Aquaporin FO membrane



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



34 cm<sup>2</sup>



2.3 m<sup>2</sup>



AALBORG UNIVERSITET  
ESBJERG



# FO setups



Conductivity/pH  
meter

Conductivity/pH  
meter



AALBORG UNIVERSITET  
ESBJERG



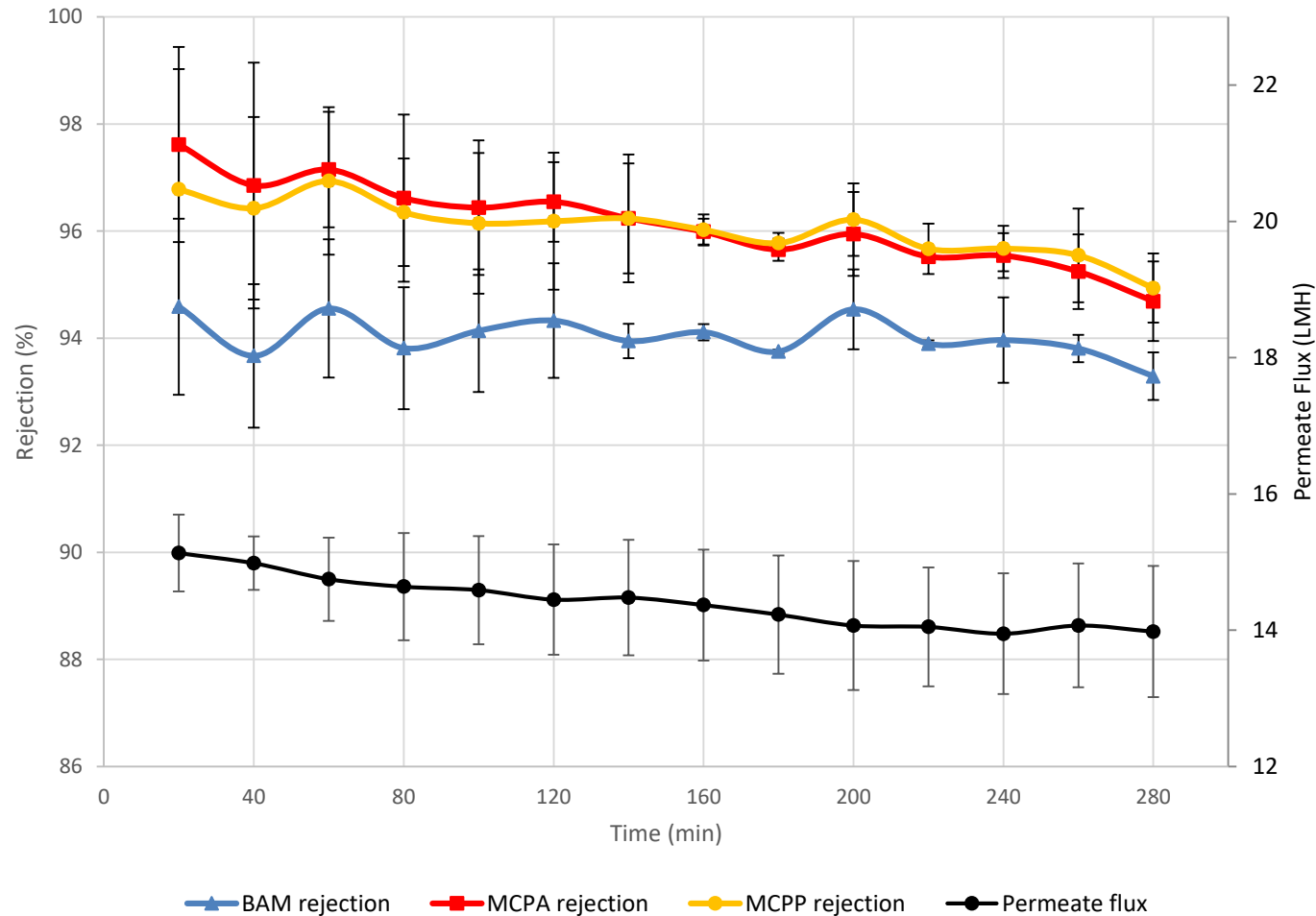
# Membrane characterization

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



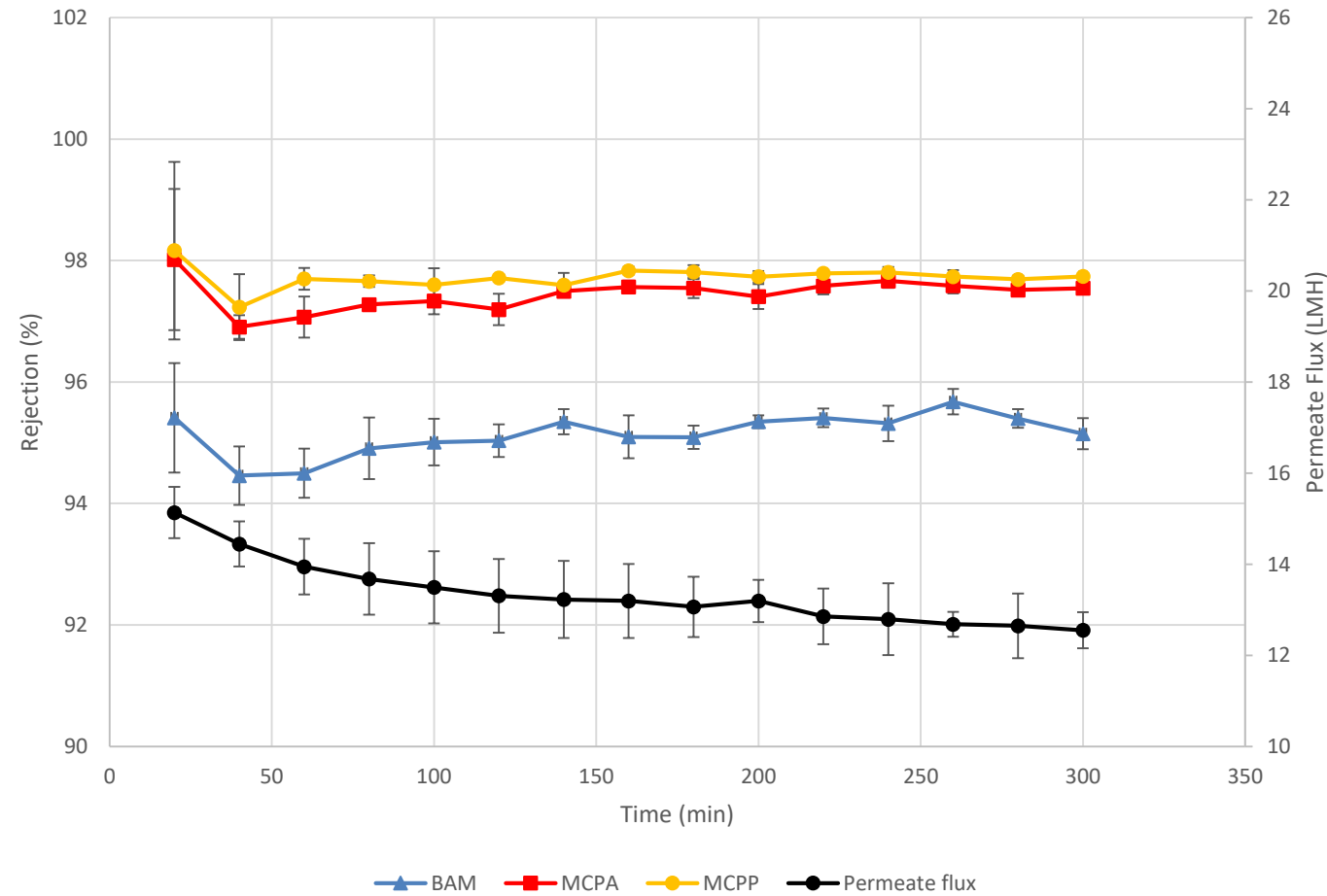
# Pesticides rejection in pure water

- Feed 2 L, 1 mg/L
- Draw 200 mL, 1 M NaCl
- Flat sheet membrane



# Pesticides rejection in Varde water

- Feed 2 L, 1 mg/L
- Draw 200 mL, 1 M NaCl
- Flat sheet membrane



# 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

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.

??  
THANK YOU  
FOR  
ATTENTION!  
ANY QUESTIONS?