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CROSS-FLOW FILTRATION WITH DIFFERENT CERAMIC MEMBRANES FOR POLISHING WASTEWATER TREATMENT PLANT EFFLUENT

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CHRISTENSEN

ICIM 2014, 8TH JULY, BRISBANE, AUSTRALIA



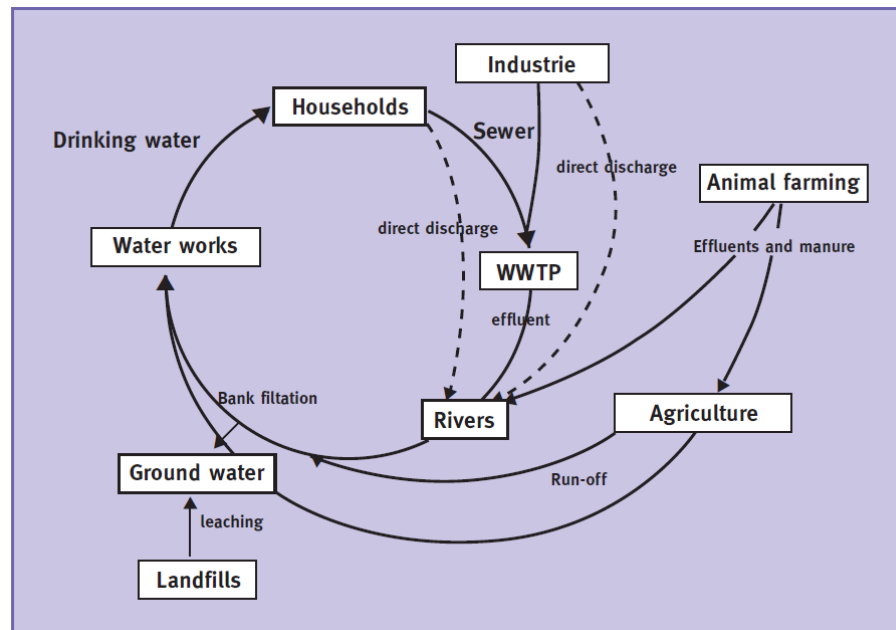
AALBORG UNIVERSITY
DENMARK

Outlook

- ☐ Problem and Hypothesis
- ☐ Materials and Methods
- ☐ Results and Discussion
- ☐ Conclusion

Challenge

- ❑ Micro/nano-pollutants in wastewater are a challenge to wastewater professionals. The presence of contaminants in **waste water treatment plant (WWTP)** effluents may cause a severe risk for the drinking water preparation. The effluent cannot be simply discharged to environment because it contains toxic ions and organic micro-pollutants which are harmful for aquatic organism.



Challenge

Compounds	Examples	Detected in Denmark WWTP*	Detected in EU/US WWTP**
Organic Contaminants from Industrial sources	Sulfonated organic compounds, MTBE	▲	▲
Household and personal care products	Sunscreen Agents	▲	▲
Pharmaceuticals	Acetaminophen, Ketoprofen, Ibuprofen, Diclofenac		▲
Party drugs	Defattening pills, Viagra, XTC	▲	▲
Pesticides	Glyphosate		▲
Metal Ions	Cu, Pb, Zn, Cd, Cr, Hg	▲	▲

*Punktkilder 2012, Miljøministeriet, www.nst.dk (in Danish).

** Pollutants in urban waste water and sewage sludge, European Commission Report 2011, www.europa.eu.int

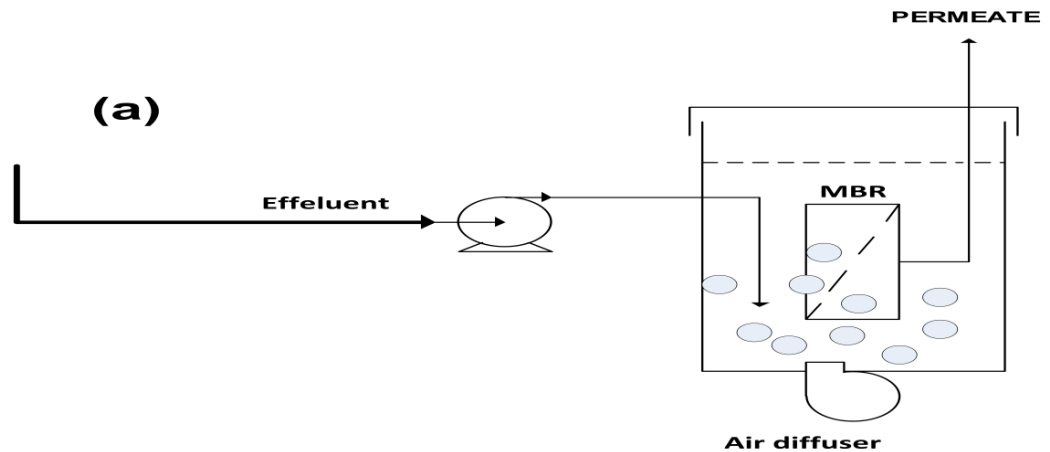
***Municipal WWTP Effluents, RIWA Report 2007, The Netherland.

Hypothesis

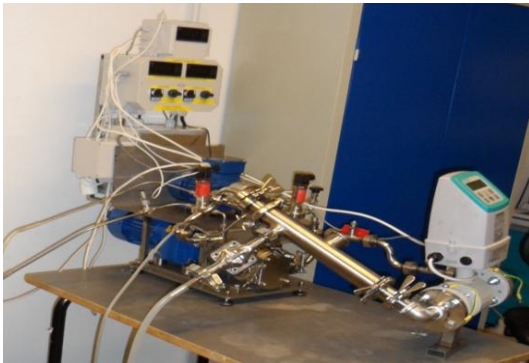
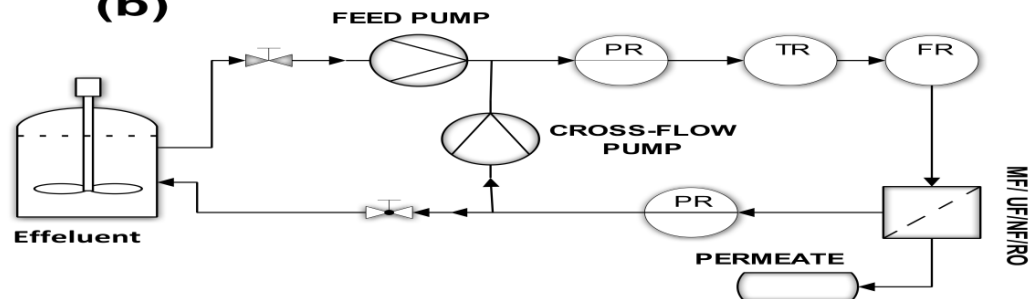
- ❑ A possible strategy to avoid this is to polish the effluent by membrane processes.



(a)



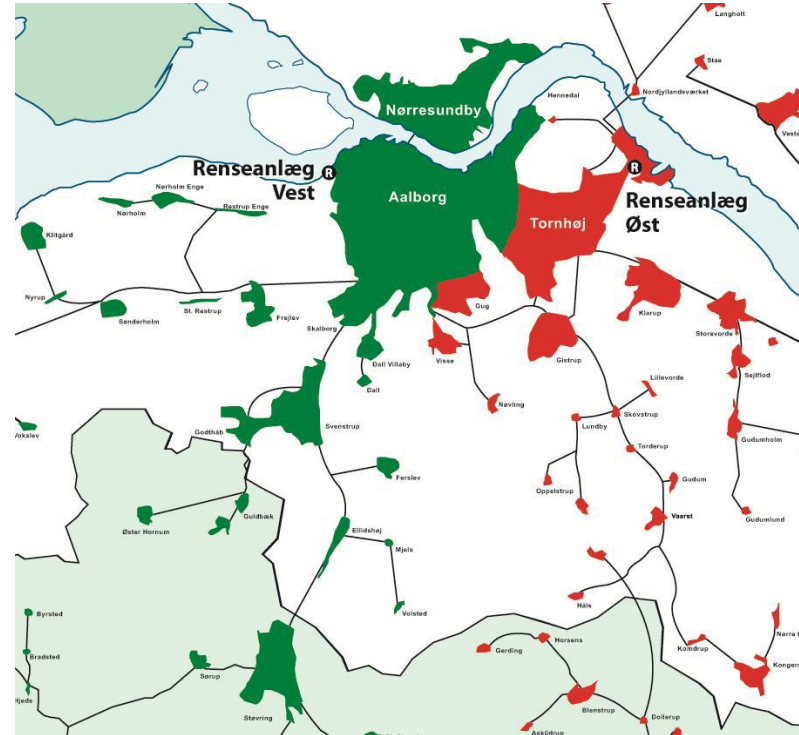
(b)



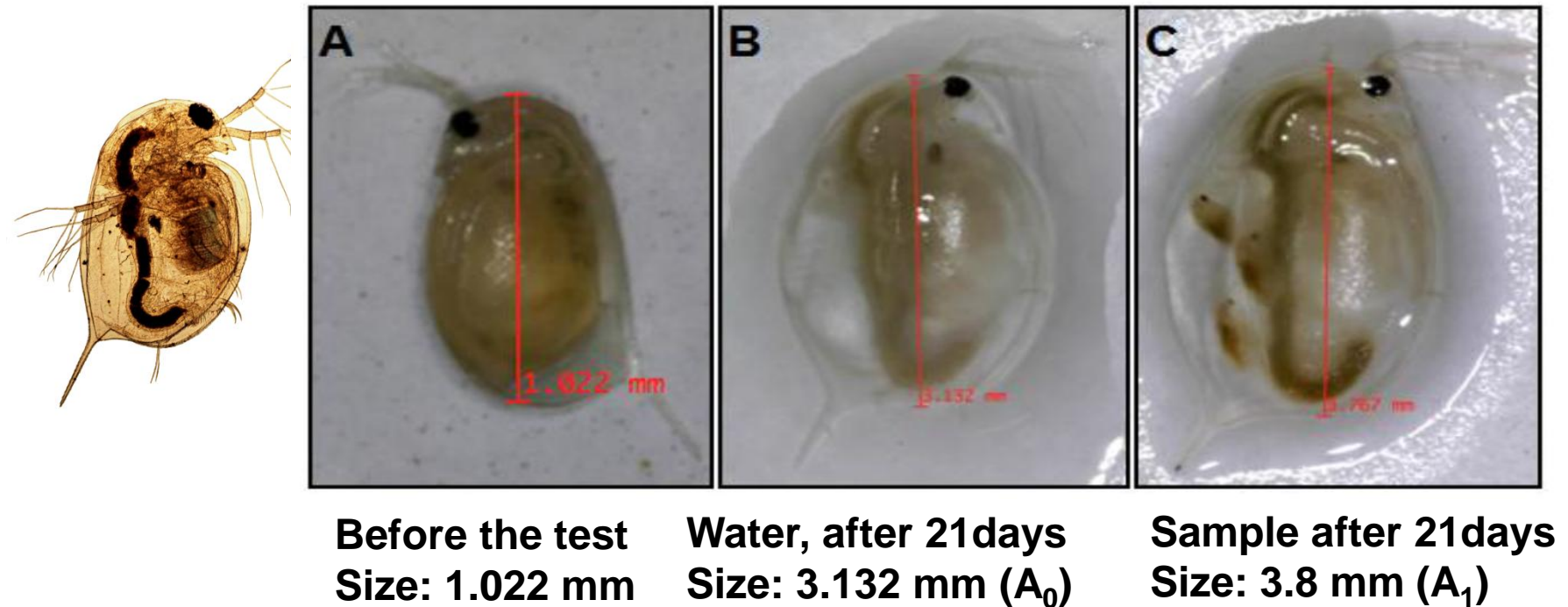
Materials and Methods

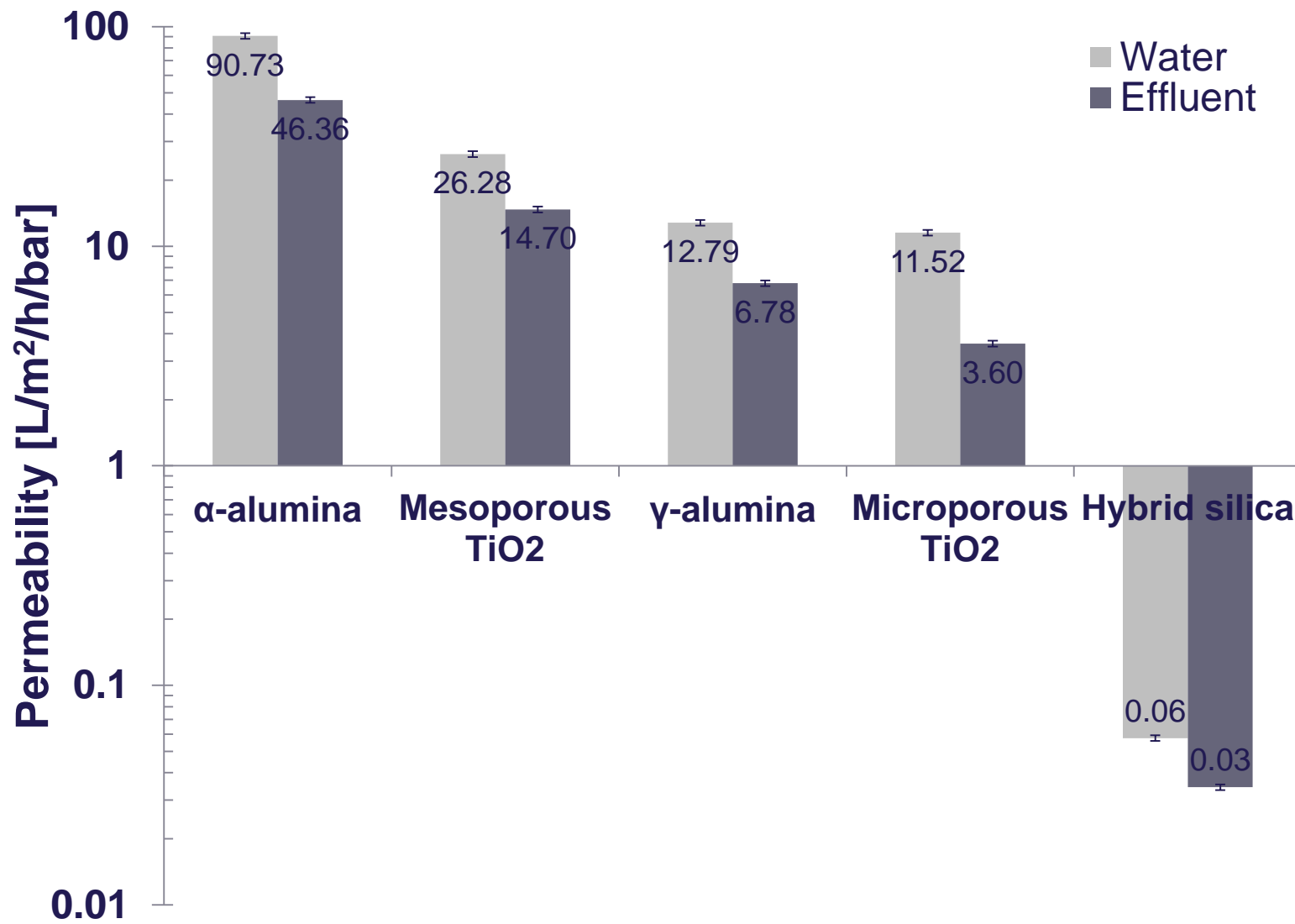


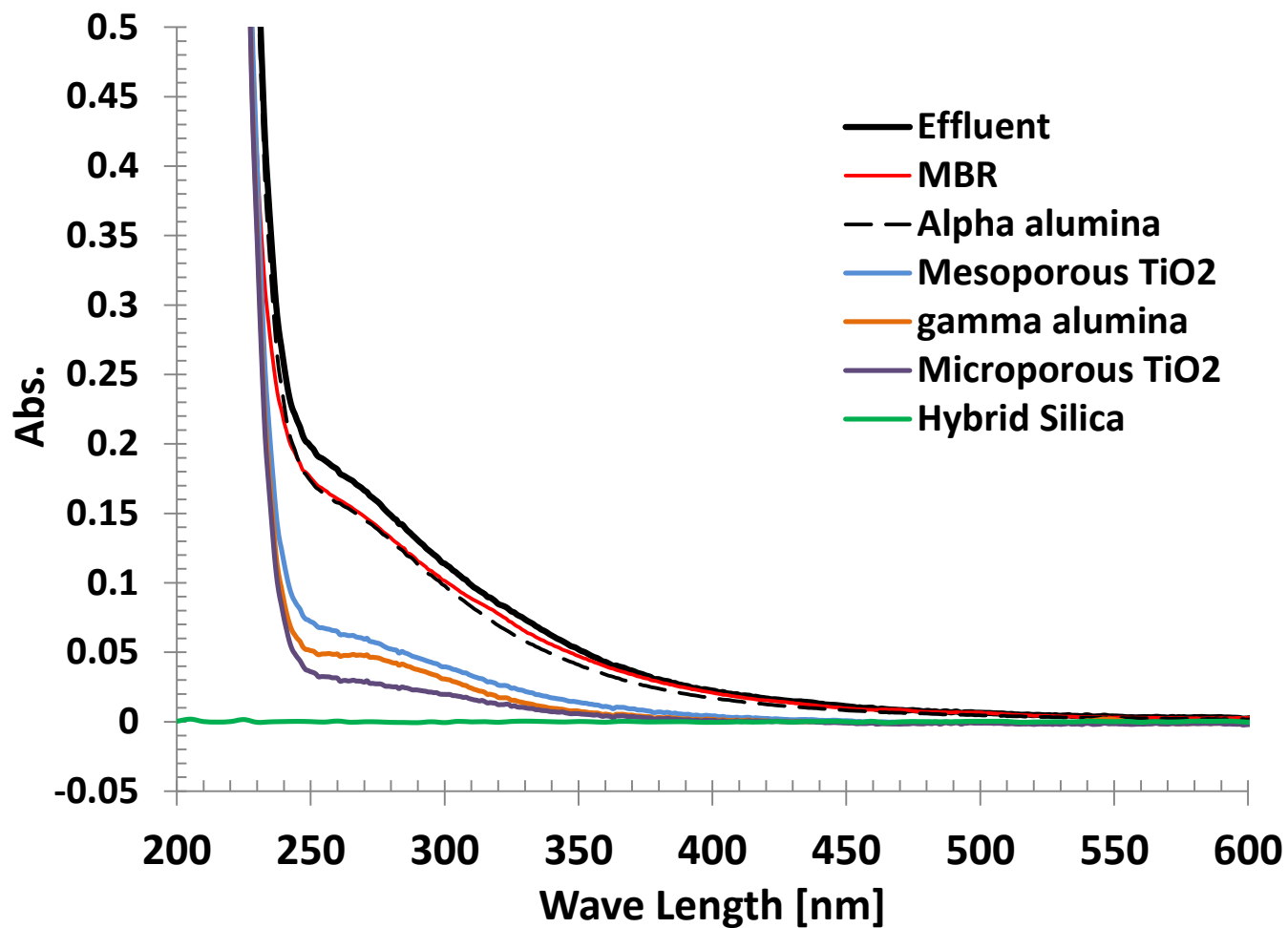
- ❑ **Sample.** The samples were taken from Aalborg WWTP which is located in the west of Aalborg city, Denmark.
- ❑ **Filtration.** The effluent was pumped at 6 bar to a cross-flow filtration.
- ❑ **Membranes.** Various monotube active layers such as on macroporous α -alumina support ($\sim 100\text{nm}$) were used was used.
- ❑ **Analysis.** The total ions and specified toxic ions rejections were measured using **conductivity** measurements respectively. The type and the molecular size of removed organic compounds were determined using **pH**, full spectrum **UV** and size exclusion **HPLC**. Inorganic N-compound rejections were calculated by **N-autoanalyzer**. Bioassays were done with ***Daphnia magna*** method.
- ❑ **MBR.** *The MBR Pilot plant is already working in the WWTP site.*

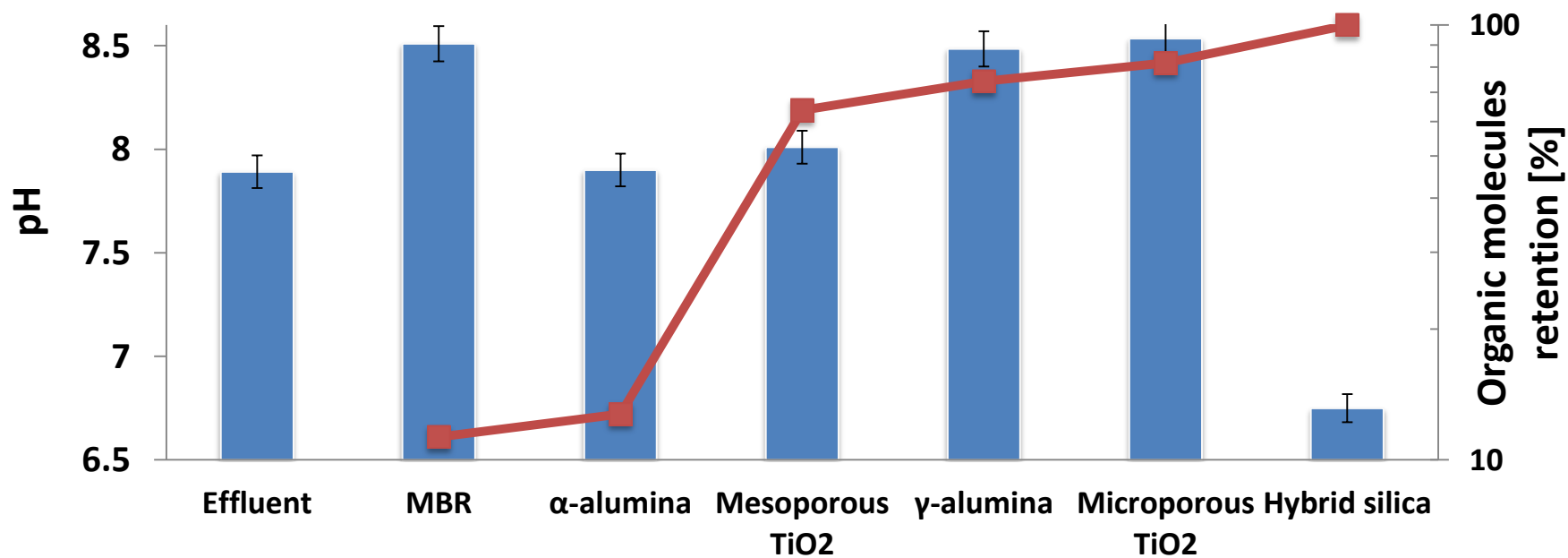
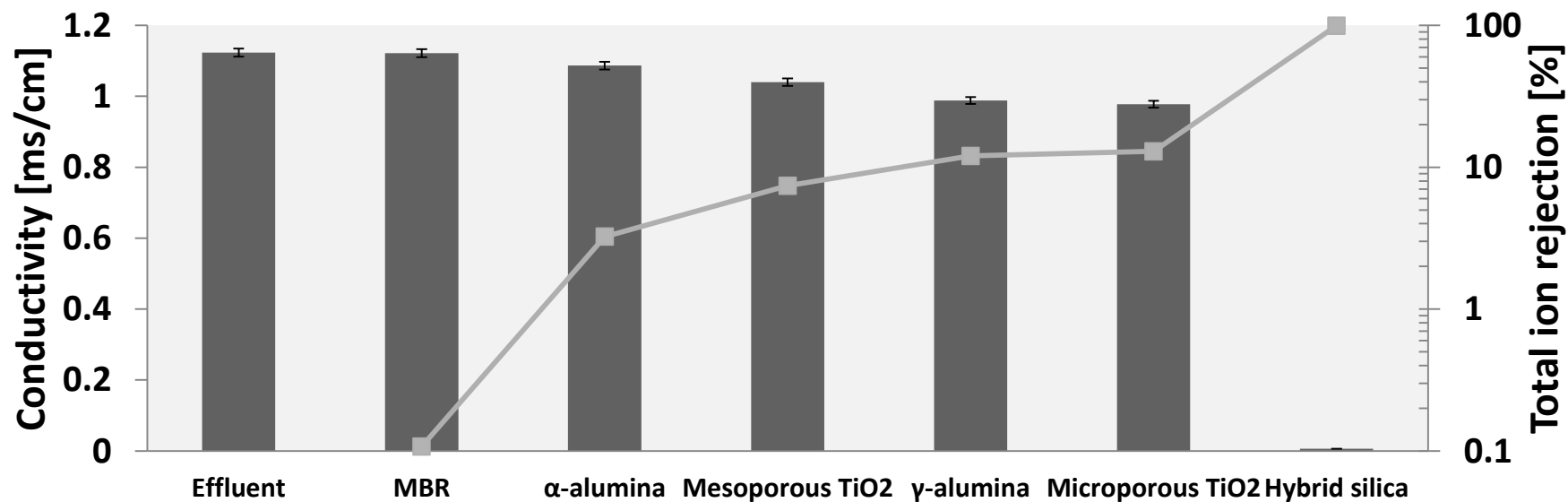


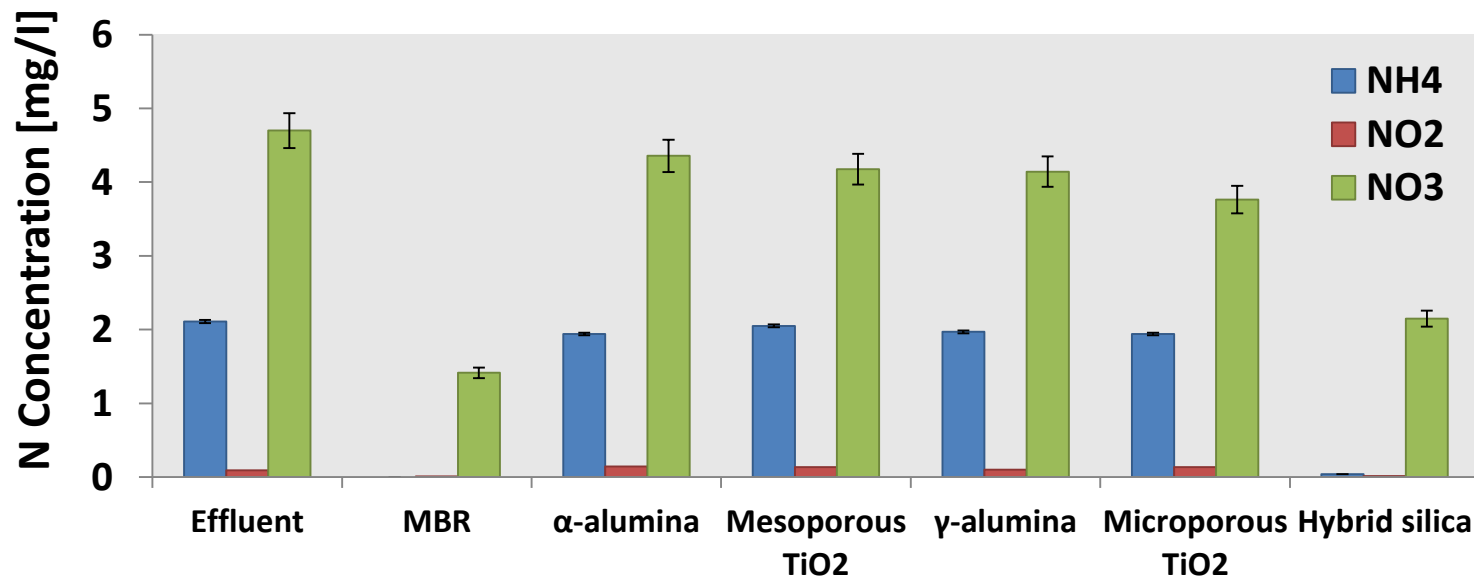
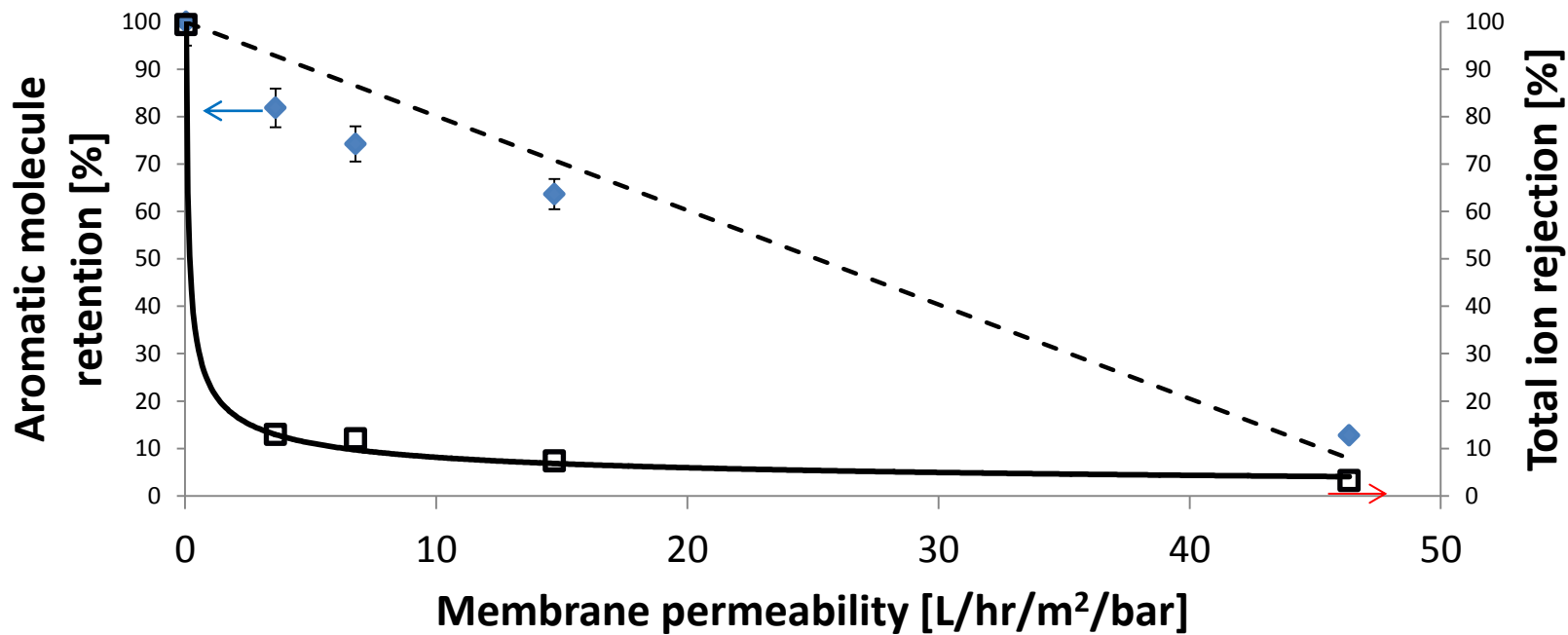
Material	Type	Nominal Main Pore size
α -alumina	MF- Macroporous	~100nm
TiO ₂	UF-Mesoporous	15 nm
γ -alumina	NF- Mesoporous	5 nm
TiO ₂	NF- Microporous	1 nm
Hybrid silica	RO-Microporous	<1nm

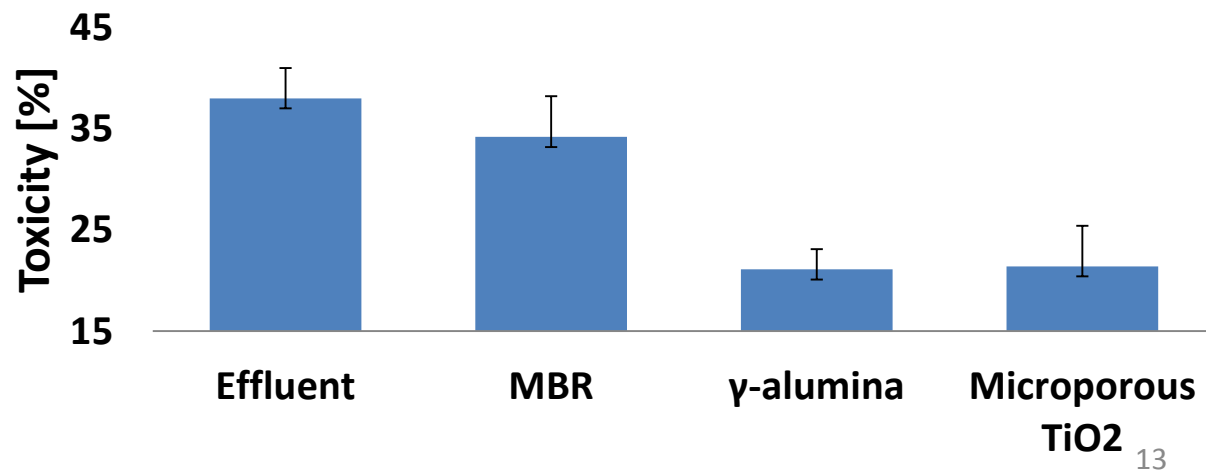
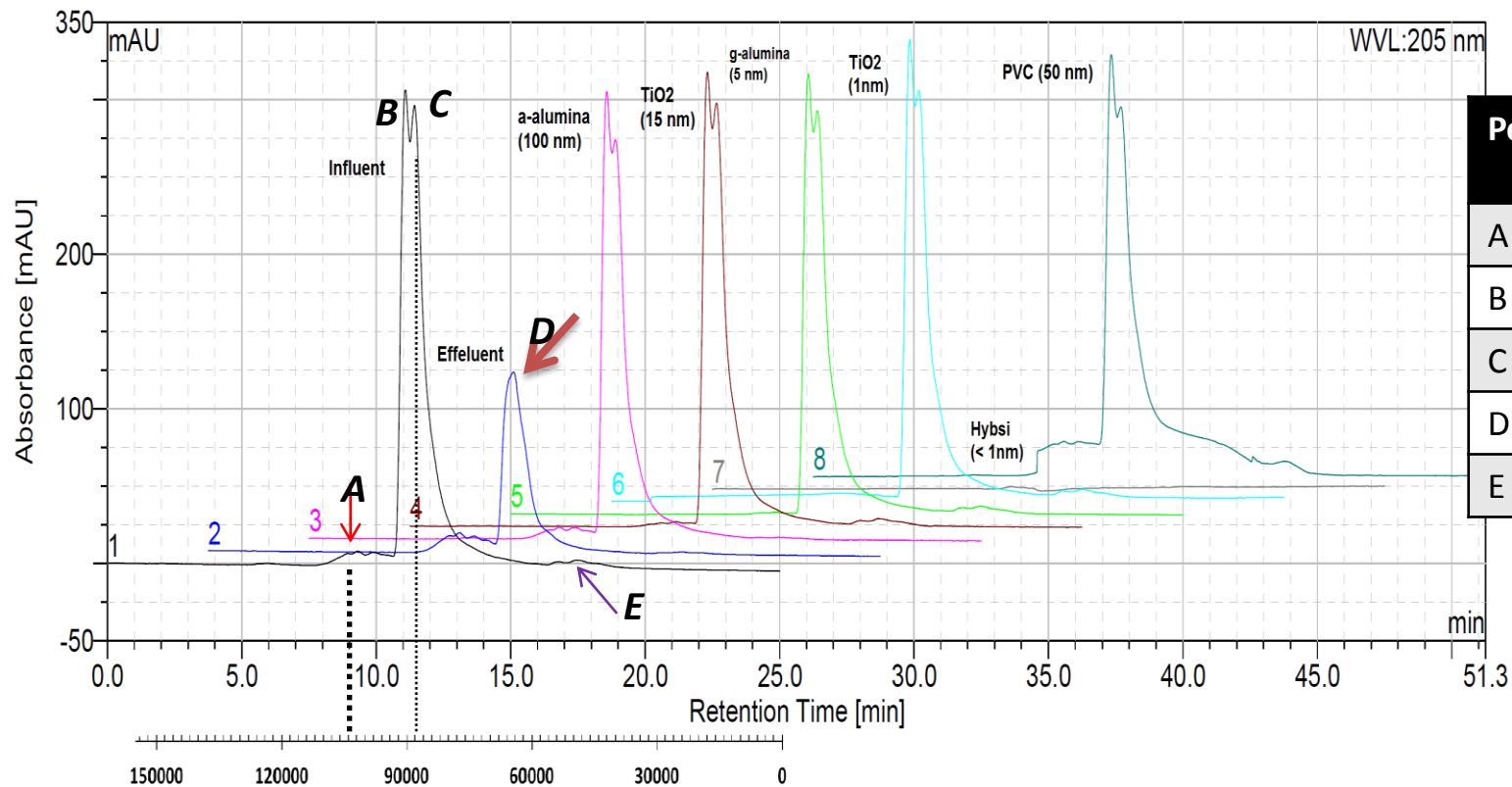














- **Hybsi** active layer (<1nm, RO) could remove most of inorganic ions and organic molecules and increase the water quality up to drinkable water. But its permeability is very low (0.03 LMH/B).
- **α-alumina** (>100 nm, MF) did not shows a better performance for removing organic compounds and ions rejections.
- **Mesoporous TiO₂** (15nm, UF), **γ-alumina** (5 nm, NF) and **microporous TiO₂** (1nm, NF) could remove most of the aromatic organic compounds more than **MBR** but their ion rejections are not obvious (less than 10%).
- Chromatography results showed that MBR could remove a range of organic components (around 90 KDa) **even** better than NF ceramic membrane.
- MBR shows a better performance in competition with all ceramic membrane to remove N-compounds.
- Bioassays with ***Daphnia magna*** suggested that effluent polishing with γ-alumina membrane reduced toxicity of the treated water better than MBR and even TiO₂ micro porous membrane.
- Our study showed that **γ-alumina** is the optimized membrane for this application.

TIPS OF DAY:

**“EXPERIMENTAL DESIGN IS
FUNDAMENTAL FOR THE DEVELOPMENT
OF NEW MEMBRANE APPLICATION”**

THANK YOU FOR YOUR ATTENTION.



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