Novel Photocatalyst-Composite Membrane Filter

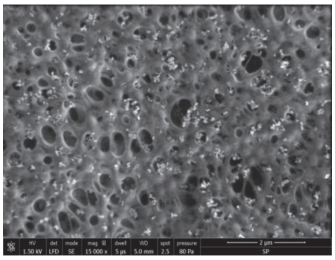
for Treatment of Pharmaceutical Residues and Other Organic Pollutants in Waste Water

Background

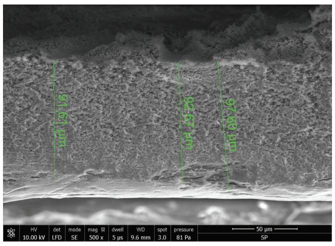
Toxic organics, **pharmaceuticals** and antibiotics are currently only partially or not at all removed from wastewater, as the waste water treatment of today will only degrade those substances to a low extent. Therefore, those substances will be found in the effluent from the waste water treatment plants and this is seen as a possible threat to both human health and aquatic species.
Photocatalytic membranes are known to have a potential application in water and **waste water treatment**, and they show great promise as novel methods to combat the challenge of toxic organics in waste water.

Membrane Production

For this study a photocatalytic membrane has been prepared by integrating photocatalysts into the membrane structure. The membranes were produced aiming for 100 micrometer thickness of the membrane, which was achieved.



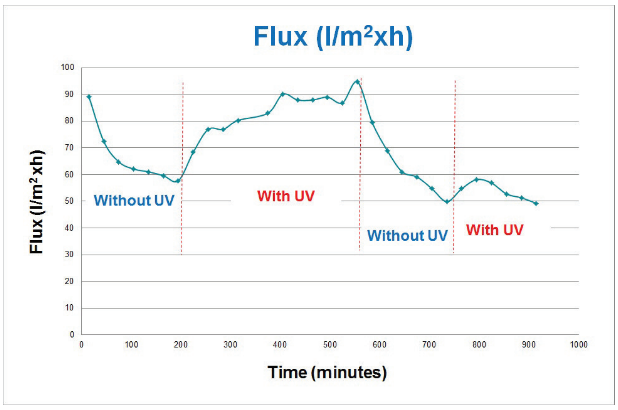
SEM image of the membrane showing the photocatalysts on the PVDF membrane.



Membrane thickness shown in a cross section of the membrane.

Flux

Tests were performed in both dead-end and cross-flow configuration, the photocatalytic membrane shows **improved flux when irradiated with UV light**. The flux could be fully restored after washing with alcaline cleaning solution.



Flux in cross-flow filtration as a function of time and use of UV light.

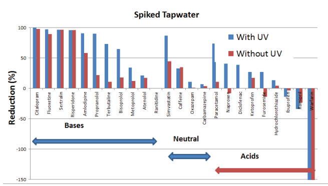
Reduction of Pharmaceutical Residue

Tests were performed using **water spiked with 24 pharmaceuticals**. The membrane filter with photocatalysts could decompose the pharmaceutical residues in both **tap water and effluent from a Membrane BioReactor (MBR)** containing dissolved organic matter.

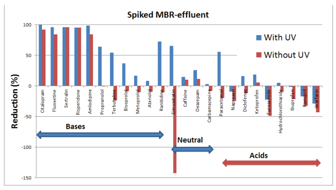
Ion-suppression in LC/MS/MS is probably the explanation to the **observed negative reduction** for some of the pharmaceuticals in our study. In tap water is probably due to that bleeding of polymeric material from the solid-phase extraction (SPE) columns during sample extraction. Thus, the measured reduction are minimum levels.

The **hydrophobicity** as well as **the charge of the pharmaceuticals**, and thus the pH of the aqueous phase, was found to be a **key factor for the efficiency of the photocatalysis**.

Bases with high K_{ow} (high partitioning in octanol compared to water) and high log D (D is the ratio of solubility of the ionized species) **show good reduction even without UV irradiation**. The following bases have Log K_{ow}>2.5 and log $D_{pH7.4}$ >1.27: Citalopram, Fluoxetine, Sertralin, Risperidone, Amlodipine, which contained one or more F or Cl.



Reduction of pharmaceutical residues in spiked tap-water measured with LC/MS/MS



Reduction of pharmaceutical residues in spiked MBR effluent, measured with LC/MS/MS

Conclusions

Membrane filter with photocatalysts, irradiated with UV light, are **promising for keeping high flux and reducing the downtime of operation** by lengthening the cleaning cycle**.**

For **effective photocatalytic degradation the pharmaceutical need to be in close vicinity or adsorbed onto the photocatalyst.**

The **dissolved organic matter** present in the MBR water do thus not interfere with the degradation by absorbing the active UV light.

Recommendation: Optimize technique for groups of pharmaceuticals with similar chemical properties.
Compensate for losses in both recovery and ion-suppression during sample preparation and analysis by addition of isotope-labeled standards for every pharmaceutical investigated before the start of the sample preparation.

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