Institut Européen des Membranes

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Post-doc position in Montpellier University - IEM

Preparation and implementation of catalytic ceramic nanofilters.

Keywords: *Ceramic nanofilters, Soft chemistry routes, Heterogeneous catalytic ozonation, Membrane separation, Nanofiltration, Advanced Oxidation Processes.*

General context

SAWARE is a four year project which objective is to develop a tertiary treatment of municipal wastewater coupling nanofiltration (NF) and ozonation for a safe wastewater reuse. Nowadays, water scarcity and quality are big challenges facing humanity in many places around the world. To solve this problem, municipal wastewater (WW) is thus considered to be an alternative water source for various applications after proper treatment. Nonetheless, urban WWs are increasingly contaminated with organic micropollutants (OMPs). Although their concentration in urban WWs is often very low ($\leq$ 10 µg/L), their effects can be disastrous because of their potential persistence in the environment, their possible endocrine disrupting effect and their accumulation in biological bodies. In addition, human and veterinary antibiotics have been found widespread in different environmental compartments due to their persistence and low degradability. These toxic compounds have become a major issue for the Water Utilities (REACH 2006, WFD 2000 and 2012) and legislations in European Union in the coming years will be tightened with regard to OMPS in municipal WW and to their discharge. These evolutions are driving the WW treatment to come up with advanced technologies.

In this view, membrane processes are widely used but they are only a separation step, they must be coupled with techniques for the efficient destruction of pollutants and then provide new hybrid processes as a post-treatment step. With this aim in mind, Ozonation (O_3) and Peroxone processes (O_3 + H_2O_2) are also investigated, as they generate highly active species, hydroxyl radicals. Coupling of membrane processes and Advanced Oxydation Processes (AOP) could thus be a promising treatment for WW reuse.

SAWARE is a project of applied research which objective is to develop an innovative and advanced integrated “membrane and oxidation” system for the treatment of municipal WW coupling membrane bioreactor (MBR), nanofiltration (NF) using organic and innovative inorganic material and ozonation (O_3) for a safe and affordable WW reuse. The main innovation of the SAWARE project lies in the MBR/ O_3/ NF expected synergistic effect for advanced treatment of secondary effluent containing a cocktail of priority substances targeted by the legislation.

Objectives of the Post-doc

One of the objective of SAWARE project is to show the feasibility of the use of ceramic nanofilters for WW treatment and to develop functionalized ceramic nanofilters in order to make catalytic NF membranes for a direct coupling with ozonation or peroxone. In this way, a post-doc position is proposed which primary mission concern the development of efficient multifunctional ceramic membranes for direct coupling of NF and heterogeneous catalytic ozonation with preservation of low MWCO of the membrane. The objective is to obtain efficient catalytic activity for favoring chemicals oxidation and limiting fouling phenomena at the surface of NF

membrane. The performance of these membranes for micropollutants rejection will be then characterized and synergetic effect during coupling with BRM and O_3 will be evaluated.

Several tasks will thus be performed:

- ***Selection of commercially available ceramic nanofilters***: a market study will be performed in order to identify the different types of commercially-available ceramic nanofilters. It will more particularly take into account the MWCO of the membranes; the chemical composition of the separative top-layer, of the intermediate layers and of the support and associated chemical an thermal stability and the available geometries: flat membranes, capillary tube, multichannel tube etc…From the comparison between the results of this market study and the specifications of the project, a selection of few ceramic nanofilters will be done in order to functionalize them to be active during heterogeneous catalytic ozonation.

- ***Preparation by soft chemistry routes of catalytic nanomaterials***: catalytic nanomaterials will be prepared by soft chemistry routes. The studied compounds will be selected among single (or mixed) oxides already identified as efficient for heterogeneous catalytic ozonation. The selection will be done taking into account compatibility criteria with the previously selected ceramic nanofilters. The prepared nanomaterials will be then characterized in order to evaluate their catalytic performance in batch conditions.

- ***Preparation of catalytic ceramic nanofilters***: the most active catalytic materials identified in the previous task will be deposited and consolidated on the separative top-layer of the selected ceramic nanofilters. These modified nanofilters will be then characterized in terms of separative properties (in comparison with the untreated ones) and of heterogeneous catalytic ozonation (positive effect on the reduction of the fouling phenomenon in comparison with the untreated ones).

- ***Characterization of OMPs rejection and of fate dependence on thephysicochemical properties*** of the ceramic NF membranes (charge, hydrophobicity, molecular weight cut-off) with. Several water matrixes spiked with OMPs will be used for these experiments in order to identify rejection mechanisms: ultrapure water, ionic matrice and real effluent. Membranes will be characterized before and after fouling with real matrix in order to identify membrane surface modifications due to fouling by organic matter (hydrophilicity, Zeta potential, AFM, SEM and EDX…).

- ***Definition of the optimized treatment scheme*** according to the overall SAWARE results. The goal will be to get the best efficiency of the coupled processes, to confirm and to quantify the additional synergetic effect of the coupling (MBR, ceramic NF, O_3) due to catalytic membranes.

Beginning of the position: November 2017.

Duration: 18 months.

The candidate must have completed a PhD in Materials Chemistry and have good knowledge of heterogeneous catalysis and membrane processes and of analytical chemistry. In addition, the candidate must possess good interpersonal and communication skills, both written and oral.

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