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Tetracycline degradation in water by enzymes immobilized on silica monoliths

Tetracycline (TC) is considered as a recalcitrant micro-pollutant because it is not completely degraded by conventional wastewater treatment plants. Immobilizing laccases on different solid supports like membranes have been tested for TC degradation and resulted being more active than free laccases while showing a good stability (de Cazes et al., 2014). However, the degradation rates reported are limited by the small surface area available in membranes for enzymes immobilization. Silica monoliths featuring large surface area (400 - 700 m^2/g), porosity and permeability have been successfully used for process intensification in catalytic reactions under continuous flow (Galarneau et al., 2016). Herein we show that these new kind of monoliths are also promising supports to immobilize enzymes, as laccases, for improving the degradation rate of pollutants like TC.

Silica monoliths with uniform macro-/mesoporous structures (20 µm and 20 nm macro- and mesopores diameters) high porosity (83%) and high surface area (370 m^2/g) were prepared. The monoliths were cladded in steel tubing and Laccase from *Trametes versicolor* was immobilized by covalent grafting. Activity tests were carried out by passing 20 mg/L tetracycline antibiotic aqueous solution through the monoliths in a plug flow reactor with continuous recycling configuration. The tetracycline degradation efficiency was found to be 40-50 % after 10 h of reaction at pH 7.

The preliminary results show that the laccase immobilization in a new kind of silica monoliths results in very promising outcomes for tetracycline degradation. Coupling fast reaction kinetics with high hydrodynamics thanks to these supports can yield to high degradation rates. This type of enzymatic-monolithic reactors should be suitable for the purification of antibiotic contaminated waters in continuous flow.

[1] De Cazes, M., Belleville, M.-P., Petit, E., Llorca, M., Rodríguez-Mozaz, S., de Gunzburg, J., Barceló, D., Sanchez-Marcano, J., 2014. Design and optimization of an enzymatic membrane reactor for tetracycline degradation. Catal. Today 236, 146–152.
[2] Galarneau, A., Sachse, A., Said, B., Pelisson, C.-H., Boscaro, P., Brun, N., Courtheoux, L., Olivi-Tran, N., Coasne, B., Fajula, F., 2016. Hierarchical porous silica monoliths: A novel class of microreactors for process intensification in catalysis and adsorption. Comptes Rendus Chim. 19, 231–247.