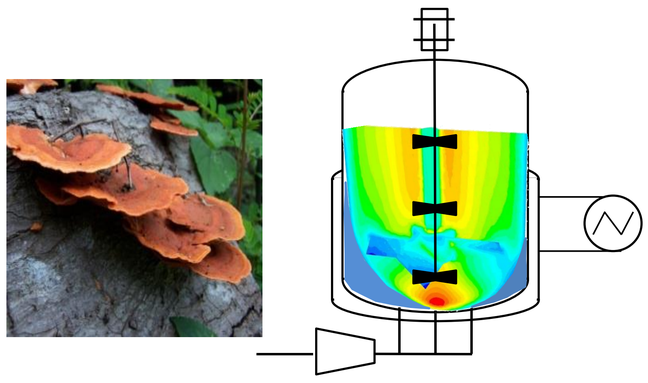
Enzyme Processing Technologies
From Biodiversity to Bioengineered Processes

BIONEXXYS

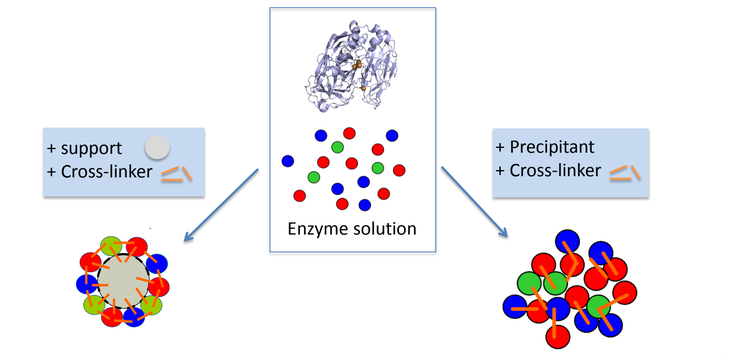
Enzyme production



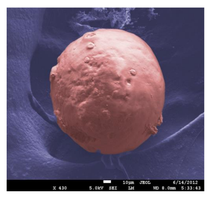
White rot fungi have a strong action on lignin thanks to an unspecific enzyme mechanism producing free radicals.

Computational fluid dynamic was used to evaluate the shear stress generated by mixing/aeration during fungal fermentation.

Enzyme formulation

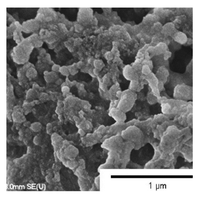


Carrier-bound immobilized enzyme



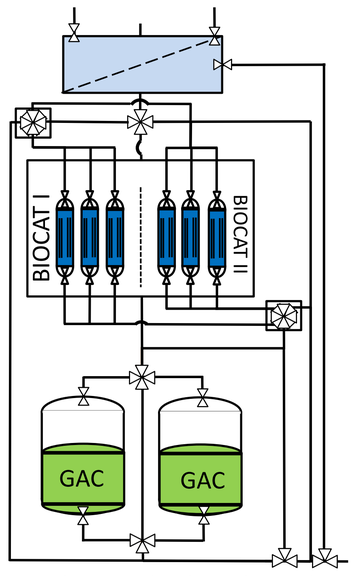
Mesoporous-silica bound enzyme(ø ~ 100 µm).

Cross-linked enzyme aggregates (CLEA®)



Enzyme aggregates (ø ~ 10 - 30 µm).

Enzyme processes

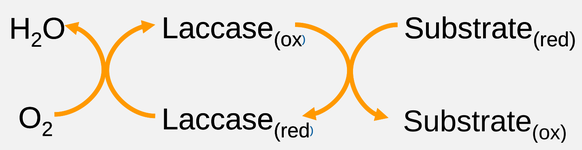


Integrated activated carbon – biocatalytic system for broad-range pollutant removal.

Household biocatalytic Cartridge.

White rot fungal strains were selected based on their exceptional laccase productivity.

Laccases are phenoloxidases (EC 1.10.3.2) having a broad-substrate specificity. They use oxygen as a final electron acceptor which render them very attractive for environmental applications[1].



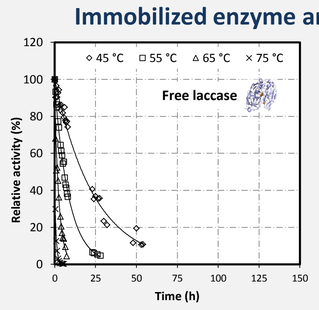
Bioprocesses were designed and optimized to produce and recover high laccase activities.

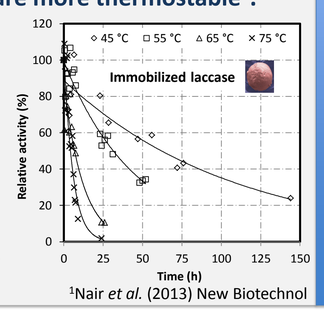
[1]Demarche *et al.* (2012) Biotechnol Adv

Biocatalytic material made of (co-)immobilized enzymes are formulated for heterogeneous biocatalysis applications.

Insolubilization facilitates product recovery, allows biocatalyst recycling and continuous - flow through - processes. Last but not least, it extents biocatalyst life.

Immobilized enzyme are more thermostable[2].

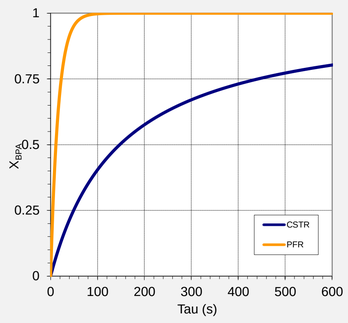




[1]Nair *et al.* (2013) New Biotechnol

BIONEXYS aims to transform enzymatic mechanisms into **scalable and sustainable technological systems.** In-depth knowledge of process kinetics is necessary to achieve this goal.

The conversion rate of bisphenol A is two hundred times higher in the cartridge configuration than in continuous stirred-tank configurations.



Conversion of 10 µM bisphenol A (BPA) in aqueous solutions (pH 5 buffered water) in the cartridge configuration (PFR) versus in a continuous-stirred tank membrane reactor (CSTR).

THE ULTIMATE CARTRIDGE FOR ENVIRONMENTAL CLEAN-UP

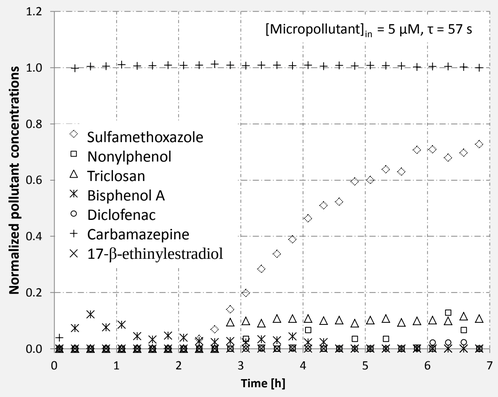
Case study I

Targeting micropollutant in domestic wastewater

The removal of endocrine disruptors in the secondary effluent of a municipal WWTP

The laccase *CG01* cartridge is currently operated in various conditions to gain information on its performance towards the micropollutant removal in wastewater.

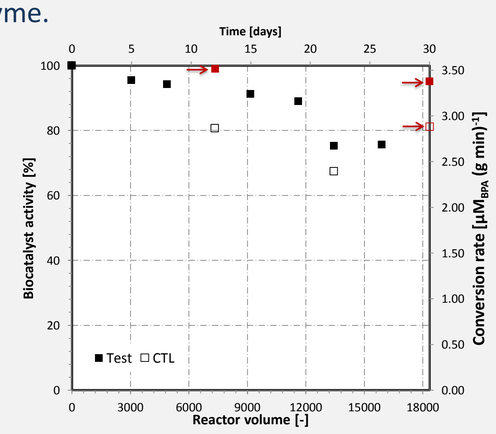
A cartridge run with a cocktail of micropollutants in water showed more than **90 % removal of BPA, NP, DF, TCS and EE2**.



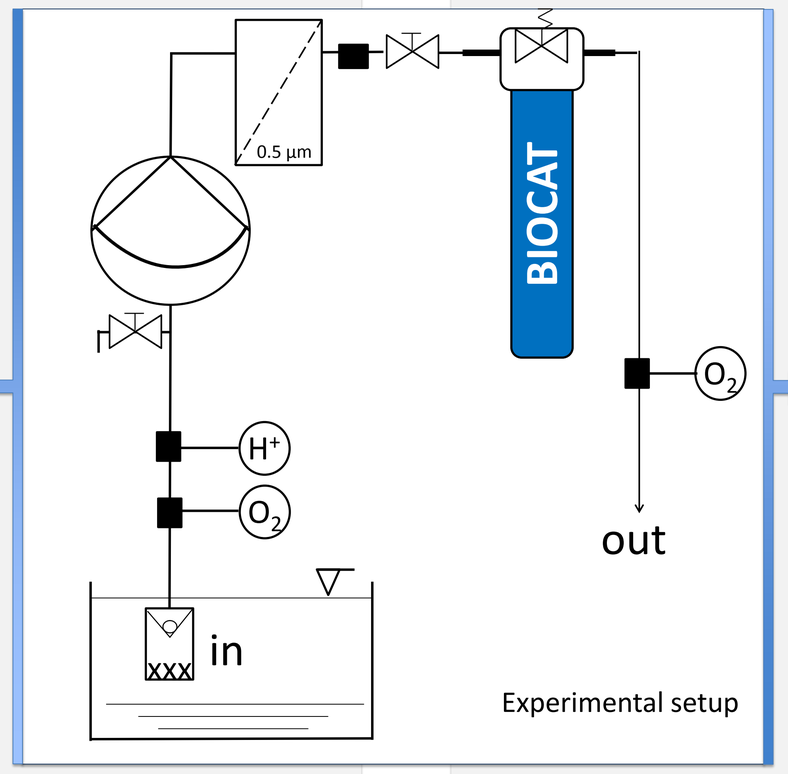
SMX, CBZ were recalcitrant to the biocatalytic treatment in the tested conditions with this particular enzyme.

The cartridge was continuously fed with secondary effluent from the WWTP of Louvain-la-Neuve.

The residual activity of the cartridge after 30 days of operation (~18,000 reactor volumes) was 80 to 95 % which reveals the **high stability of the biocatalytic material in wastewaters**.



Time course of laccase activity in cartridges continuously fed with 1 nM-BPA spiked secondary effluent. Activity was evaluated regularly (■) and occasionally (□) by measuring the specific conversion rate of 5 µM BPA (given in right axis). Substantial activity recovery was observed after backwash (→).



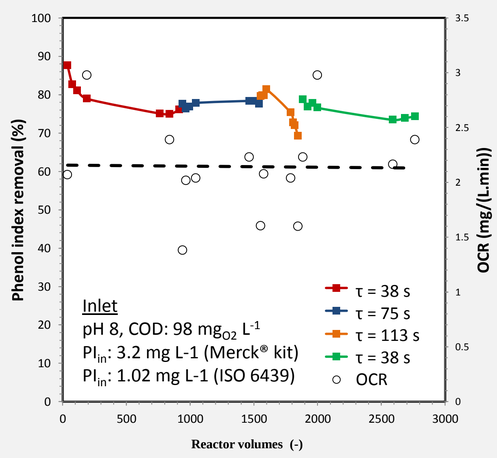
Case study II

Targeting specific pollution in industrial wastewater

The abatement of phenol index in the effluent of a phenol-resin manufacturing plant

Phenol-rich secondary effluent from a manufacturing plant was continuously fed in the *CU01* laccase cartridge and was allowed to react for 38 to 113 s according to the set flow.

The effluent was a complex mixture of substituted phenols (dimers and oligomers) with a phenol index (PI) of 1.02 mg L^{-1} (ISO 6439) and an average chemical oxygen demand of ~100 mg_{O2} L^{-1}.



Time course of the phenol index removal after the biocatalytic treatment. The residual phenol index was measured using a Merck® kit and occasionally confirmed following ISO 6439. The average oxygen consumption rate (OCR) quantified the oxygen consumed by laccase catalysis.

A steady 75 % PI removal (89 % following ISO 6439 method) was measured **without significant enzyme deactivation** throughout the 4-days run.

The PI was always twice below the limit value of 0.2 mg L^{-1}.

This case study demonstrates the tremendous potential of the **modular biocatalytic system for the tertiary treatment of industrial effluents** to meet current and upcoming environmental legislations.

A spin-off project

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Thanks to

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