Biobarriers for the Rehabilitation of Contaminated Systems

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The research activity of the Chemical Engineering Lab is defined within the mission and focus of BRIDGE group and aims to provide knowledge for environmental restoration, rehabilitation and sustainability by integrated recycling. As so, it aims the definition and development of innovative processes able to treat water/soils/sediments contaminated with metals, solvents and/or pharmaceuticals through the sorption concept, associated with co-adjuvant biological/chemical/electrochemical processes as biodegradation or oxidation. At present, different microorganisms as bacteria and fungi are under study, metabolically active or not, associated and/or supported by distinct sorbents that ranges from low-cost agro-forestry wastes (fern, eucalyptus leaves, oak leaves, grapefruit, cane pruning wine grapes, pine bark, cedar bark, rice husk, waste coffee grounds, eggshells, waste cork), natural materials like cork, clays, zeolites to designed sorbent materials, with chemically enhanced sorbing surface.
The general methodological approach used for the purpose includes: biosupports/biosorbents design and manufacture (equilibria, kinetics and mechanistic characterization), molecular and microscopy techniques and materials characterization by XPS, XRD, TGA, FTIR and RAMAN spectroscopy. The entrapment of metal ions with industrial interest has been under scrutiny in Chemical Engineering Lab for a long time and the effort led to catalysts design and manufacture, starting with waste metals that proved to have catalytic applications in liquid and gas phase mild oxidation [1]. On the other hand, several different industries use solvents on their productive processes making the problem of the deposition of these solvents on aquifer systems or on the soil very serious and the policy of the European Union in terms of solvent depositions is very restrictive. The same approach will be applied in this solvents issue (3-pentanone, DEK, MEK, toluene, 1,2-dichlorobenzene) adding a biodegradation step to the role played by the supported biofilm. The biodegradation of complex molecules as the active principles of pharmaceuticals (fluoxetine, ibuprofen) is also under consideration with very promising results [2]. Besides the kinetics, equilibria and mechanistic studies on the retention/degradation processes established at the possible combinations between sorbates/biosorbents, mathematical modeling and simulation is being performed in order to generalize the applicability of this approach to distinct rehabilitation pathways. These models will allow knowledge integration and upscale to reactors development and operation, defining a strategy for wastes valorization and sustainability by recycling or by downstream applications as it is the case of biobarriers made of recycled wastes, working as a support for eco-compatible biofilms that retain and degrade emerging contaminants.

References

[1] Silva, B, Neves, IC, Tavares, T, A sustained approach to environmental catalysis: Reutilization of chromium from wastewater, *Critical Reviews in Environmental Science and Technology*, 46(19-20), 1622-1657, 2016.

[2] Silva, B, Costa, F, Neves, IC, Tavares, T in Psychiatric pharmaceuticals as emerging contaminants in wastewater, *Springer's Brief*, ISBN: 978-3-319-20492-5, 2015.