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Greener fenton processes for removal of persistent organic pollutants from wastewaters

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Many persistent organic pollutants (POPs) are difficult to remove from wastewaters by conventional treatment methods so modern approaches has been developed based on advanced oxidation processes (AOPs). The main advantage of AOPs is actual destruction of pollutants to less hazardous ones, not only their transfer from one medium to another. They are characterized by a common chemical feature: the capability of exploiting the high reactivity of OH· radicals. The common oxidizers listed by decreasing oxidation potential are: FeO42- > O3 > S2O42- > H2O2 > Cl2 > ClO2 thus selection of Fenton oxidation with application of Fe2+ and H2O2 is evident. These processes are capable to quickly convert organic pollutants completely to carbon dioxide, water and inorganic salts. The Fenton reaction causes the dissociation of the oxidant and the formation of highly reactive hydroxyl radicals that attack and destroy organic pollutants. In the homogenous Fenton process, almost all organic compounds, containing hydrogen (RH), could be oxidised, while the process is efficient only in the pH range of 2.0-4.0 with peak efficiency at around 2.5-3.0. Weakness of the homogenous Fenton process is formation of waste sludge, containing various iron salts and hydroxyls which could significantly affect the efficiency and economic aspect of the process. The amount of the sludge is dependent upon the ratio and the volume/mass of added reagents. Some authors addressed the problem of adsorption of pollutants to surface of formed waste sludge which has not been investigated so far, but it could probably results in competition of adsorption and oxidation processes leading to less effective destruction of pollutants.

These drawbacks could be overcome by application of heterogeneous Fenton oxidation where various types of iron compounds are immobilized on different supports in order to facilitate catalyst separation and prevent the generation of waste sludge. The Fenton reaction proceeds on the surface of the catalyst but the reaction rate is often negatively influenced by mass transfer limitations in the stagnant liquid in the pores of the catalyst support. Due to the important role of the catalytic support its selection may therefore have a remarkable effect on catalytic activity. Carbon-nanofibre (CNF) based microstructure materials are promising catalyst support due to the large volume of pores resulting in a high surface area ensuring maximizing number of active sites. At the same time, initial acidification, required in homogenous processes, might be avoided.

In the presentation, problems of persistent pollutants will be discussed and European REACH (Registration, Evaluation and Authorisation of Chemicals) legislation in the framework of POPs presented, following by overview of benefits and problems related to application of various advanced oxidation processes for removal of persistent pollutants, focused mainly on Fenton oxidation. Homogenous and various heterogeneous processes with different catalyst and catalyst supports will be compared. Finally, a case study related to removal of endocrine disruptive chemicals (synthetic and natural estrogens) will be discussed.

Biography

Andreja Zgajnar Gotvajn obtained her PhD in the field of Chemical Engineering in 1998. She is Assistant Professor of Environmental Engineering and head of the Department of Chemical, Biochemical and Environmental engineering. Her research work is focuses on toxicity studies in aquatic compartments, risk assessment and hazard identification of chemicals, waste water treatment: Biological and advanced oxidation processes, etc. She participated in 6 national research projects; she is currently involved in the program Chemical Engineering. She also leads 4 bilateral research projects. In 2011 and 2012 she spent two months as a Visiting Professor and Researcher at Tulane University, School of Public Health & Tropical Medicine New Orleans, USA.

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