Reclamation of water polluted by pesticides (priority and preferential substances) with high potential leaching through solar heterogeneous photocatalysis

J.A. Escudero, G. Pérez-Lucas, S. Navarro

Departamento de Química Agrícola, Geología y Edafología. Facultad de Química. Universidad de Murcia. 30100, Murcia. Spain. (escugarcia@gmail.com)

Modern agriculture depends to a large degree on the use of pesticides. Once a pesticide is introduced into the environment, it can be influenced by three major processes (adsorption, mobility and degradation), those which determine the fate of the pesticide by affecting its persistence and movement [1]. Pesticides can enter in water bodies via diffuse or via point sources. Diffuse pesticide input paths into groundwater are leaching through the soil and unsaturated zone and infiltration through riverbanks and riverbeds. The contamination of water bodies with agricultural pesticides can pose a significant threat to aquatic ecosystems and drinking water resources. Concretely, Europe confronts enormous groundwater pollution problems with agriculture being the biggest polluter. The majority of Europeans (about 60–65 %) rely on groundwater for drinking water purposes, and its use is threatened by the leaching of pesticides and nitrates from agriculture [2].

Conventional biological treatments of water offer some advantages such as their low cost and easy operation although they are not very effective for pesticide removal due to their low biodegradability. Thus, numerous studies have demonstrated that pollutants can be removed from water by advanced oxidation processes (AOPs) such as O3/UV, H2O2/UV, H2O2/O3/UV, homogeneous photo-Fenton, and heterogeneous photocatalysis [3]. AOPs have been broadly defined as near ambient temperature treatment processes based on highly reactive radicals, especially the hydroxyl radical (•OH), as the primary oxidant while the other radical and active oxygen species are superoxide radical anions (O2•−), hydroperoxyl radicals (HO2•), triplet oxygen (3O2), and organic peroxyl radicals (ROO•). Clearly, the •OH radical (E° = 2.8 V) is among the strongest oxidizing species used in water and wastewater treatment and offers the potential to greatly accelerate the rates of pollutant oxidation. Among AOPs, heterogeneous photocatalysis is a process of great potential for pesticide residues abatement in water. The basic principles of this process have been extensively reviewed in the recent literature [4].

In this view, the aim of this research was to assess the photoactivity of TiO2 and ZnO on the degradation of different pesticides, included as Priority Hazardous Pollutants by the EU, under sunlight irradiation at pilot plant scale. For this purpose, we have previously studied their leaching potential through the soil and the role of the most important operating parameters (proportion of anatase/rutile in TiO2 samples, catalyst loading, effect of the addition of an electron acceptor, pH, light intensity, initial concentration of pollutants, and interfering substances) on the photooxidation of the studied pesticides.

References