MESOPOROUS MATERIALS FOR GLYPHOSATE DEGRADATION IN WATER THROUGH CATALYTIC WET AIR OXIDATION

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ABSTRACT

In recent decades, pollution of water resources has grown mainly due to inadequate treatment of industrial waste and excessive use of agrochemicals [1]. Currently the world consumption of agrochemicals is 4.6 million tons per year. In Argentina, herbicides account for 64% of the total agrochemicals market. Within them, glyphosate is a broad-spectrum herbicide and it is the main active ingredient in commercial formulations. The great solubility of this substance in water causes that, when they are applied on the ground, they can diffuse towards groundwater generating a severe contamination. In this context, the advanced oxidation processes, among them "catalytic wet air oxidation", are proposed as an alternative of degradation of glyphosate in aqueous media [2]. They are based on the formation of reactive chemical species, such as hydroxyl radicals, which are oxidizing agents capable of degrading the most resistant molecules.
Although there are reports that employing this type of oxidation process, the use of high pressures and high temperatures are reported in most works [3]. In this context, mesoporous materials such as SBA-15 and MCM-41 substituted with transition metals appear as very promising catalytic supports because of their structure, high specific area and pore volume, which make it suitable for use in degradation of pollutants. Thus, in this work the use of nano-structured mesoporous solids modified with iron and aluminum is proposed to degrade glyphosate in aqueous solutions by catalytic wet air oxidation process. Fe-SBA-15 and Al-MCM-41 [4] materials with a Si/Fe or Al molar ratio = 20 and the pure siliceous matrix were catalytically evaluated in a fixed-bed reactor at room temperature and pressure. An aqueous solution of glyphosate of 15 ppm at a contact time of W/F = 40 gh/mol (g of catalyst on glyphosate feed rate) was fed with a TOS (time on stream) of 15 min. The reaction samples were analyzed by ion chromatography (Thermo Scientific ICS-1100 Dionex). The obtained results showed an 80% of glyphosate degradation, obtaining phosphate, nitrate and nitrite ions when the Fe-SBA-15 material was used. When Al-MCM-41 and pure siliceous matrix were evaluated, there was no degradation of glyphosate. Thus, these materials could be considered as not catalytically active for the tested reaction. Meanwhile, by replacing the Si by Fe in the material (Fe-SBA-15) the degradation of the pollutant molecule could be achieved. Thus, adding an iron source in the synthesis gel, an active material was developed. So, employing a solid catalyst such as Fe-SBA-15 for the catalytic wet air oxidation the degradation of glyphosate was achieved at soft reaction conditions resulting in lower environmental impact and operating costs and increasing the sustainability of the process.

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