HETEROGENEOUS PHOTO-FENTON PROCESS WITH IRON MODIFIED MCM-41 MATERIALS FOR THE DEGRADATION OF ATRAZINE

T. B. Benzaquén [a], N.I. Cuello[a], Y.V. Di Benedetto[a], O.M. Alfano[b] , G.A. Eimer[a].

[a] CITeQ (UTN-CONICET), Maestro López y Cruz Roja Argentina, Ciudad Universitaria (5016), Córdoba, Argentina. (geimer@frc.utn.edu.ar)

[b] INTEC (UNL-CONICET), Ruta Nacional N°168 (3000), Santa Fe, Argentina.

Although wastewater treatment with conventional biological processes are often the most cost-effective alternative of all treatment options, different industrial wastewaters containing toxic or biorecalcitrant organic pollutants cannot be treated with these processes [1]. In recent years, to overcome this drawback, the applications of Advanced Oxidation Processes (AOP's) have emerged as an important alternative for the efficient removal of organic pollutants [2]. In this work, MCM-41 materials have been synthesized and modified with different metal loadings of iron by the wet impregnation method. The different meso-structures obtained were characterized by XDR, UVVIS-RD, ICP and TEM and their behaviors as heterogeneous catalysts in the photo-Fenton reaction were studied. Thus, iron-containing mesostructured materials have been successfully tested for the heterogeneous photo-Fenton degradation of atrazine (ATZ) aqueous solutions using UV-visible irradiation at room temperature and close to neutral pH. Photo-Fenton tests were carried out in an isothermal, batch reactor (V_R=85 cm^3) made of borosilicate glass tube, with four tubular UV-Vis lamps (ACTINIC BL 20, Philips). The system included a sintered glass piece placed at the bottom through which an air flow was introduced to provide good mixing conditions. Also, the experimental setup had an all-glass heat exchanger connected to a thermostatic bath. As a result, it was shown that when the Fe content was 2.5 wt.% the pollutant degradation reached a maximum value. Then, in order to compare the effects of the most significant operating variables (initial catalyst concentrations ($C^0_{Fe/MCM-41(2.5)}$), H_2O_2 to ATZ initial molar ratios (R) and radiation levels (RAD)) on atrazine degradation, a study of the photonic efficiency is presented. The photonic efficiency of atrazine degradation was evaluated considering different experimental conditions employed two factorial designs (one for RAD=100% and the other for RAD=50%). Optimal values of R and $C^0_{Fe/MCM-41(2.5)}$ were detected for the two radiation levels studied. Thus, it was demonstrated that the photonic efficiencies were negatively affected by an increase of initial H_2O_2 concentration above R=175 and of initial catalyst concentration above 1 g L^{-1}. In addition, the efficiency of the system is not significantly improved by an increase of the levels of UV-radiation for R=350. Finally, the evolution in the iron speciation on solids for different metal loadings was also investigated. Several iron species were detected and, nature, dispersion and size of such species, was correlated with the different catalytic behaviors of the nanocomposites. It was found that iron oxide nanoparticles increased in amount and size when the Fe loading was increased (5, 10 and 15 wt.%) indicating a possible blocking of isolated Fe^{+3} species responsible for the activity of the solid (active sites). Consequently, the Fe/MCM-41(2.5) appears as a very promising catalyst for a heterogeneous photo-Fenton process of pre-treatment, capable of enhancing the biodegradability of water contaminated with biorecalcitrant chemicals, as the herbicide atrazine.

References

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