Fe containing silica gel catalysts for catalytic wet peroxide oxidation processes

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Background

The degradation of pollutants by catalytic wet peroxide oxidation (CWPO) using the Fenton's reagent is a well known process, the major drawback being the need to recover the iron catalyst at the end of treatment. To overcome this, new heterogeneous catalysts have been developed and studied since some years ago, which involve the incorporation of iron species into a solid matrix [1-2]. In this work we aimed to develop Fe containing silica gel catalysts (5wt. % Fe) using sol-gel techniques and to test their suitability for the CWPO of azo dye Chromotrop 2R aqueous solutions.

Results

The catalysts were prepared by hydrolysis and polycondensation of tetraethylorthosilicate, incorporating the Fe element in the solid matrix of the material during the sol-gel procedure, and were characterized by thermogravimetric analysis, N_2 adsorption, Fourier Transform Infrared Spectroscopy (FTIR) and optical microscopy. The oxidation reactions were performed in a glass reactor equipped with pH meter, temperature controller and magnetic stirrer. Dye concentration was monitored during the reaction by UV-Vis spectrophotometry. The developed materials show high activity in the removal of the azo dye, complete conversions being obtained after one hour of reaction in a large range of process operating conditions ($[dye]_0$ = 40 mg/L, 50ºC, pH between 3 and 7, catalyst concentration between 0.1 g/L and 0.5 g/L and hydrogen peroxide concentration between 7.1 mM and 35.3 mM). The effect of a thermal post-treatment over the catalyst was studied and the activity was found to decrease with post-treatment temperature. This is explained in terms of a structural modification of the silica-gel matrix during heat treatment, as supported by FTIR analysis. Catalyst stability under the studied reaction conditions was assessed by measuring (atomic absorption) the amount of iron present in the treated solutions, which can only result from catalyst leaching. Catalyst attrition and pH were found to be the main factors influencing catalyst stability. This study indicates that Fe containing silica gel materials are promising catalysts for CWPO processes.

Justification for acceptance

To the best of our knowledge, this work reports for the first time the preparation and characterization of iron containing silica gel catalysts and their application to the degradation of an azo dye in aqueous solution by CWPO, being thus an important contribution to the field of catalysis for clean water.

References

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