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Catalytic wet air oxidation of a non-azo dye with Ni/MgAlO catalyst

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HIGHLIGHTS

- ▶ Ni supported over hydrotalcite calcined precursors as catalyst.
- ▶ Catalytic wet air oxidation in batch reactor for Basic Yellow 11 removal.
- ▶ Effects of reaction conditions and catalyst stability were tested.
- ▶ The catalyst proved to be stable and efficient for the dye degradation.

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ABSTRACT

The catalytic activity of Ni supported over hydrotalcite by impregnation (Ni/MgAlO) as catalyst for Basic Yellow 11 (BY11) degradation under moderate conditions was investigated. BET, XRD and XRF were employed to characterize the catalyst. To evaluate the catalytic system, wet air oxidation of dye was carried out at temperatures between 100 and 200 °C, and oxygen pressures ranging from 30 to 60 bar. The effect of initial concentration from 100 to 400 ppm on the degradation of Basic Yellow 11 was also investigated. The degradation process was monitored by UV–VIS spectroscopy, TOC and toxicity analyses. At 150 °C, 50 bar oxygen pressure and 200 ppm initial concentration, 64.5% selectivity towards CO_2 was obtained after 3 h of treatment, while only 20.2% selectivity was achieved without catalyst at the same experimental conditions. The structure and morphology of the catalyst under different cycling runs show that the catalyst is stable under such operating conditions and the leaching tests show low leaching effect.

1. Introduction

Effluents from the dying and textile industry are considered one of the most problematic wastewaters and its disposal has become a major environmental problem. Those wastewaters are characterized by the presence of color, high total organic carbon (TOC) levels as well as an important chemical oxygen demand; mainly due to the presence of dyes and other organic by-products. Dye containing wastewaters are usually recalcitrant to degradation by the conventional biological treatments due to its high toxicity, as these compounds are often hardly biodegradable or even biocides. As a consequence, those effluents should be remediated by means of physicochemical technologies before its discharge or a biological treatment.

Nowadays, some physical operations [1] are available for the removal of organic pollutants from contaminated water, especially adsorption methods [2,3]. However, these techniques only allow the removal of pollutants, not its destruction, and additionally, generate large amounts of sludge [4,5].

Advanced Oxidation Processes (AOPs) are a promising alternative for wastewater treatment as they can provide complete mineralization of organic pollutants [6]. Among AOPs, wet air oxidation (WAO) is an attractive technique for industrial wastewater treatment. WAO involves the combustion of pressurized organic matter at relatively high temperatures. The main drawback of this technique is its high energetic requirements [6]. In order to be able to employ milder operating conditions and reduce the operating costs, catalytic wet air oxidation processes (CWAO) have been developed [7,8]. The presence of a catalyst may improve the overall reaction rate and enhances the removal of reaction intermediates compounds, which are refractory to the WAO process [9], improving the formation of hydroxyl radicals, well-known promoters of the oxidation [10].

Hydrotalcites (HTs) are anionic clays with a layered structure with high similarity to the Brucite, where cations Mg^{2+} have been

Abbreviations: WAO, wet air oxidation; CWAO, catalytic wet air oxidation; BY11, Basic Yellow 11; TOC, total organic carbon; TN, total nitrogen; TU, Toxicity Units; S_{NOC}, selectivity towards nonorganic compounds; X_{TOC}, TOC conversion; X_{dye}, dye conversion.

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