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# Pillared montmorillonite supported ferric oxalate as heterogeneous photo-Fenton catalyst for degradation of amoxicillin

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ABSTRACT

Degradation of amoxicillin (AMX) was achieved using pillared montmorillonite ferric oxalate (PMFeOx) catalyst in photo-Fenton process. The catalyst was prepared by aluminum pillaring of mild acid treated montmorillonite (MATM) clay followed by incorporation of ferric oxalate. The PMFeOx catalyst produced was characterized. XRD results revealed the intercalation of aluminum with an increase in basal spacing from 1.24 to ~1.69 nm, the specific surface area also increased from 164.94 to 211.61 $m^2\,g^{-1}$. SEM images of PMFeOx showed the formation of irregular flaky morphology with random orientation. The FTIR profile at relevant wavenumbers detected intercalation of aluminum and incorporation of iron. The optimum condition that achieved 99.65% and 84.26% initial concentration reduction and COD removal respectively, for 40 ppm AMX solution was 15% excess $H_2O_2$ and 2.0 g PMFeOx catalyst loading at 40 °C in 10 min. The catalyst displayed good efficiency in degrading amoxicillin.



## 1. Introduction

Antibiotics are hazardous contaminants in aquatic environment and they are considered “emerging pollutants” even at ng $L^{-1}$ levels because of their adverse effects on aquatic and human lives [1,2]. Amoxicillin (AMX) is a broad-spectrum β-lactam antibiotic that belongs to the penicillin class and is used in veterinary and human medicine, representing one of the most prescribed antibiotics in Europe and in the United States [3]. About 10–20% of this antibiotic is absorbed into human body when ingested while the remaining is eliminated by excretion and ended up contaminating the ecosystem [4]. The slurry and manure applied to the fields are a direct entry route of antibiotics into the soil and consequently, to the food chain. Depending on the properties of these compounds, they can reach the ground and surface waters [5]. Other sources of AMX in the aquatic environment include effluent discharge from municipal/industrial wastewater, hospital wastewater, treatment plants and accidental discharge [6].

Antibiotics such as AMX act as persistent and bioaccumulative contaminants and by their nature, they are biologically active compounds, developed to have an effect on organisms. Therefore, they have the potential to negatively affect either aquatic or terrestrial ecosystems, even at very low concentrations. Problem that may be created by the presence of antibiotics at low concentration in the environment is the development of antibiotic resistant bacteria and be responsible for several allergenic responses [3,4,6]. Pan et al. [7] recently reported the toxic effects of amoxicillin toward algae and aquatic microorganisms. Despite these problems caused by antibiotics, so far legal limits have not been regulated [4]. Typical processes used to decontaminate wastewaters are biological, physical and chemical. These treatments can be used separately or combined with other processes to enhance the overall treatment efficiency. The choice of the correct system must be carried out considering several factors, both technical (treatment efficiency, plant simplicity, etc.) and economical (investment and operating costs) [8].

Fenton’s process had proved to be highly effective in the degradation and mineralization of most of the pollutants in wastewaters [9–11]. Fenton’s process has not only transformed chemically polluting agents, but present very attractive advantages, such as the complete mineralization of some compounds, their oxidation at very low concentrations, the generation of environmentally friendly byproducts and the low consumption of energy, in comparison with other wastewater treatment methods [8,12–15]. Although photo-Fenton has received much attention in the past few years, the homogeneous photo-Fenton process requires complementary steps, such as precipitation and flocculation to recover the iron catalyst, prevent contamination and enable catalyst re-use [16–23]. The cost of the homogeneous processes depends largely on the supply of chemicals, power and labor requirements and this

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