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Combination of advanced oxidation and biological processes for the landfill leachate treatment

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ABSTRACT

This study's main purpose is to contribute to the Oued Smar landfill leachate decontamination. To achieve this aim, the advanced oxidation process (AOP) via heterogeneous photocatalysis (TiO_2/UV) was coupled with seeded bioreactors with different inoculums types (raw leachate, soil extract and activated sludge). The results obtained after heterogeneous photocatalysis show that the reduction is comprised between 50 and 84% of the initial COD maintained at pH 5. However, this treated leachate cannot be reused or discharged without another treatment into the environment. The new BOD_5/COD ratio ranging between 0.045 and 0.18 are favorable for biological treatment. The AOP–bioreactor coupling allowed an abatement of 90% of the initial BOD_5 and 87% of the initial COD leachate surface reduction with a final value of 1000 mg O_2/L. However, this value is not yet conformed to the norm. The biological treatment has shown the landfill indigenous microorganism's ability to degrade the irradiated leachate since, the mineralization dissolved organic carbon (DOC) rate is almost identical to the value obtained by activated sludge. These results encourage the supposition to recycle the irradiated leachate in the landfill which now possess a biopile behavior (loop AOP + landfill).

1. Introduction

The main problem encountered in the Oued Smar landfill rehabilitation is the generated leachate accumulation. Indeed, from 1978 to 2010, the discharge Oued Smar has received a large urban and industrial waste amount accumulating to 40 million tons. The leachate as a consequence of its heterogeneous composition (highly rich in organic and mineral matter) can contaminate the surrounding environment, in particular groundwater, affecting the water quality and compromising the human health. In addition to groundwater contamination, a soil quality alteration and an ecosystem imbalance was observed. The removal of the persistent leachate pollutants is a significant challenge (Deng and Ezyske, 2011; Cortés-Lorenzo et al., 2014; Zhang et al., 2013).

The conventional landfill leachate treatments can be classified in three major groups: (a) leachate transfer, (b) biodegradation and (c) chemical oxidation. These conventional leachate treatment methods are often expensive because of the initial outlay plant equipment, the energy requirements and the additional chemicals frequent use (Renou et al., 2008a; Oller et al., 2011). The leachate complexity, principally old leachate, implies more efficient and inexpensive treatment search, in order to reduce the landfill leachate negative impact on the environment (Vilar et al., 2011a; Fang et al., 2014).

During the last few decades, AOPs have been an intensive research theme for the mature or biologically stabilized leachate treatment, with the following purposes: (a) to increase the organics biodegradability for subsequent biological treatment; (b) to remove organic constituents; (c) to degrade organics as a post-treatment unit for other technologies (Deng, 2009; Poblete et al., 2011); and (d) reduce the toxicity. The AOP use is then justified if the resulting products in the reaction are assimilated by microorganisms in biological treatment (Lapertot et al., 2008; Yahiat, 2010).

The AOPs are characterized by the highly reactive $HO^{\bullet}$ radicals presence, which are suitable for a rapid and indiscriminate reaction with an organic compounds inducing its almost total mineralization (Bauer, 1994; Rodriguez et al., 2002; Tiburtius et al.,

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