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Synergy between Photocatalysis and Ultrafiltration: An Innovative Approach for Water Depollution

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ABSTRACT

Iron pillaring of mineral clay particles was carried out for catalyst preparation used in the removal of humic substances from aqueous solution. The present study explores firstly the efficiency of photocatalytic oxidation of humic acids (HA), which are typical refractory components of Natural Organic Matter (NOM). Ultrafiltration (UF) has become one of the best alternatives replacing conventional drinking water treatment technologies because of severe regulations for drinking water quality. However, membrane fouling is an important factor which limits its widespread application. The successful operation of a hybrid photocatalysis–membrane separation process is proved at the laboratory scale for degradation of Humic Acids (HA). The global process removal efficiency (comprising both HA oxidation and UF membrane rejection) is higher than conventional UF, as a result of the synergistic effects of both photocatalytic oxidation and membrane filtration.

Keywords: Humic acid, Pillared clays, Photocatalysis, Ultrafiltration.

1 Introduction

Humic substances are complex heterogeneous acidic biopolymers that represent a significant fraction of Natural Organic Matter (NOM) present in freshwater sources [1-2]. The photocatalysis technology can destroy the organic contaminants totally to CO2 and H2O, and it has other several advantages, such as no waste disposal problem, no expensive oxidants needed, low costs, and only mild temperature and pressure [3]. Bentonite is one of the most widely used low-cost clays due to its abundant availability. It's composed mainly of montmorillonite [4]. Low-pressure membrane filtration has been considered as a promising technology for water treatment in the 21st century. The membrane fouling is still the most limiting factor for wider application of ultrafiltration [5]. An interesting solution in water treatment technology is to use a so called hybrid system that combines photocatalysis with membrane filtration. In such systems, the contaminants could be decomposed into simple compounds by photooxidation, while the photocatalyst could be separated by the used membrane. The objective of this study is to investigate the influence of modified Algerian montmorillonite on the hybrid photocatalysis-membrane filtration process and its use for the removal of HA.

2 Experimental

A laboratory scale photoreactor (cylindrical batch reactor) with a volume of 2500 mL useful capacity (see Figure 1) was used for the photocatalytic investigation. In this study an Amicon-Millipore 8200 filtration cell with a capacity of 200 mL was operated in dead-end mode, without stirring. The system used for filtration is depicted in Figure 2.

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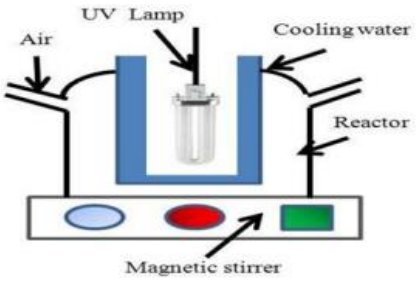

Figure1: Description of the photocatalysis experimental set up.

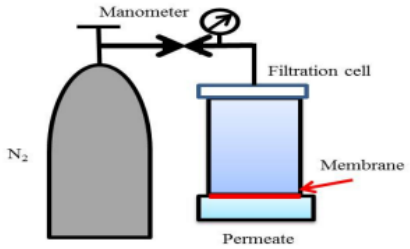

Figure2: Schematic diagram of flat-sheet UF system

3 Results and Discussion

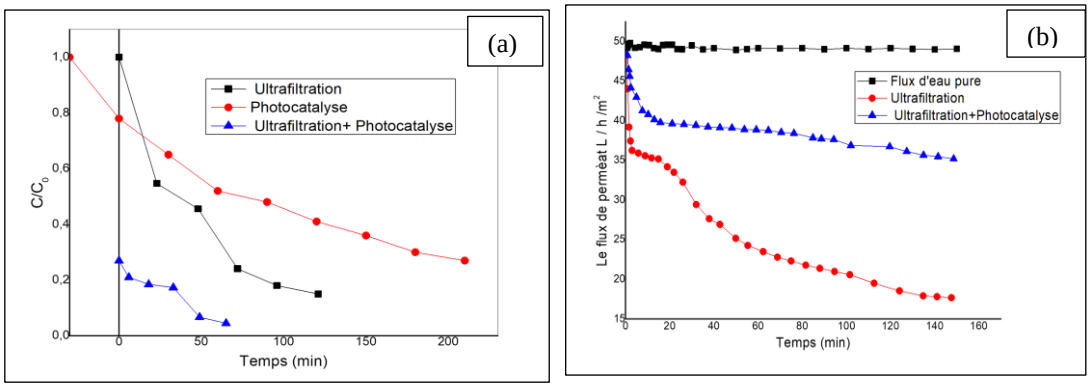

Figure 3 : Amélioration des performances de la dégradation photocatalytique couplée avec l'ultrafiltration

4 Conclusions

The investigation carried out on photodegradation of humic acids revealed that: The new data demonstrates that a hybrid system, combining heterogeneous photocatalysis with suspended Mt-Fe particles and UF membrane filtration, can successfully operate in a 63.5 mm dead-end cell (Model 8200, Amicon Corp.), for the removal of HA. Typical concentrations of HA (10 mg/L) usually encountered in effluents and freshwater sources were degraded. The overall removal efficiency of HA was higher (95.5%) due to the synergistic effects of photocatalysis and membrane filtration processes

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