OPERATIONAL ALTERNATIVES IN THE APPLICATION OF ADVANCED OXIDATION PROCESSES TO HEAVY POLLUTED WASTERWATER EFFLUENTS

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Abstract

Primary wastewater treatment technologies, as the Advanced Oxidation Processes (AOP), are key to minimize the pollutant charge as a pre-treatment step before a conventional biological treatment as sometimes the efficiency of the biological processes is hampered by the presence of some biorefractory pollutants. Also these technologies for wastewater treatment are cost-effective and therefore suitable for developing countries. In this case some AOPs (Fenton Reagen and thermally enhanced UV/H_2O_2) have been successfully applied to two different types of model pollutants, phenol and LAS (alkylbenzenesulfonic acid, a widely used surfactant), both in low and high concentrations.

Introduction

This study is concerned with the advanced oxidation processes for the treatment of polluted effluents, involving the generation of highly oxidising hydroxyl radicals The application of AOPs in wastewater treatment leads to the destruction of the pollutant rather than transferring it to another phase, becoming effective technologies for the removal of organic pollutants is solution. The technologies are key to minimize the pollutant charge as a pre-treatment step before a conventional biological treatment as sometimes the efficiency of the biological processes is hampered by the presence of some biorefractory pollutants. In this case, a classic AOPs (Fenton Reagent) and the recently developed thermally enhanced UV/H_2O_2 were studied in their application to a heterogeneous variety of effluents: On the one hand to a synthetic solutions of phenol and on the other hand to alkylbenzenesulfonic acid (LAS) solutions. Phenol represents high toxicity contaminants, and LAS are one of the major ingredients of synthetic detergents and surfactants used world-wide.

Methods

Both contaminants –phenol and LAS- were studied in two different ranges of concentration, in low concentration (50 to 100 mg/L) and in high concentration (from 1000 to 2500 mg/L), the last ones representing industrial wastewater effluents.

Usually photochemical processes are operated at mild conditions, room temperature in most cases, but there have been some interesting studies in the operation at higher temperatures. To deepen into these studies, an innovative ultraviolet reactor has been designed for this purpose. This reactor allows the heating of a recirculating solution maintaining an accurate control of the temperature (from 25ºC to 80ºC) in the reaction system. A power output of 100W is developed by an annular ultraviolet lamp at 254 nm. Additionally, the final biodegradability of the treated effluent was measured, as these AOPs are determined to become a feasible primary treatment in the combination with biological process.

Results and discussion

Within AOPs, oxidation by **Fenton's Reagent** in one the most studied because it is one of the simplest techniques, effective and widespread for water treatment. In this work, it has been proved that Fenton's reagent, H_2O_2/Fe(II), is applied successfully in the oxidation of phenol as well as in the removal of a surfactant effluent. Among all the parameters studied the main limitation of this system is the pH, as the solubility of iron in its ferric form decreases dramatically as pH decreases. The oxidation rate of phenol at pH=3 increases when the initial concentration of peroxide increases up to R=4 (R is the molar ratio of peroxide to phenol). Above this value the addition of oxidant has no effect on phenol oxidation.

In LAS oxidation by the **thermally enhanced UV/H_2O_2** system the performed experiments temperature have shown a significant effect in the oxidation extent of LAS. In Figure 1 can be seen that the oxidation rate is enhanced with temperature up to 60ºC. On the contrary, in the experiments carried out at 80ºC the decomposition stops at early reaction times of around 20 minutes, as the peroxide depletes completely. At higher reaction temperatures, perhaps, the thermal decomposition of the hydrogen peroxide resulted in the reduction of its effective concentration towards making hydroxyl radicals.

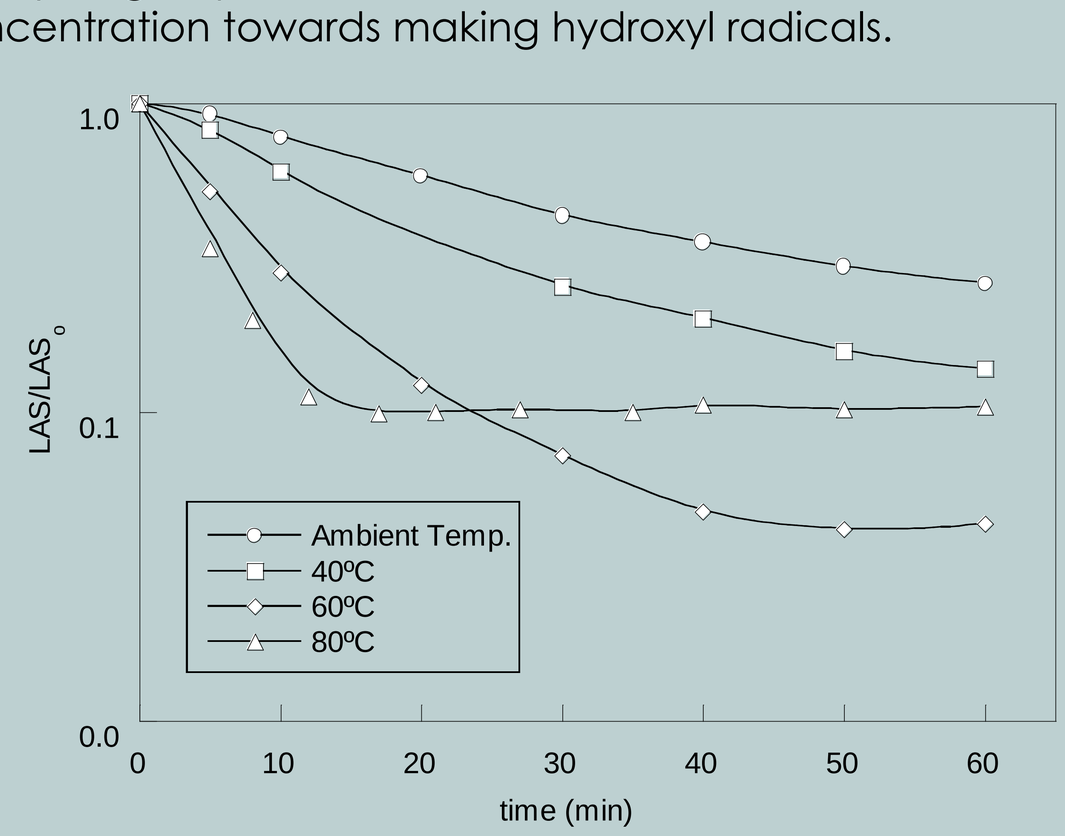

Figure 1.- Degradation of LAS in the thermally enhanced UV/ H2O2 system using a molar relation peroxide to LAS of R=5 for different reaction temperatures.

Significant TOC depletions can be achieved at reaction temperatures of 60 and 80ºC using intermediate to high peroxide amounts, R=10 to 30. Only in the cases of TOC removal where the treated samples readily biodegradable (DBO_5/TOC values). In these severe conditions aromathic LAS oxidation intermediates (mostly sulfopehilcarboxilyc acids) where mostly oxidized.

Conclusions

The analysis of the application of both Advanced Oxidation Processes (Fenton's reagent and UV/ H_2O_2 at thermally enhanced conditions) underline that any of them could have suitable application in wastewater treatment. This study has been performed in LAS and phenolic solutions but these results are interesting for a possible future application of advanced oxidation, especially of the thermally enhanced UV/ H_2O_2 system, in wastewater treatment in a more complex matrix. Further analysis regarding to heat application and combination with biological processes are recommended.