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Temperature-assisted UV/H_2O_2 oxidation of concentrated linear alkylbenzene sulphonate (LAS) solutions

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HIGHLIGHTS

▶ We work with high reaction temperatures in the UV/H_2O_2 system.
▶ The oxidations have been carried out on 1 g L^{-1} solutions of LAS.
▶ This work has focused in the determination of the optimal operating conditions.
▶ The intermediates, the biodegradability and mineralisation are studied.
▶ The effect of temperature on same kinetic parameters is studied.

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ABSTRACT

This study demonstrates the importance of reaction temperature on the UV/H_2O_2 process. Oxidation reactions have been carried out on 1 g L^{-1} solutions of linear alkylbenzene sulphonates (LASs) in the range from ambient to 80 °C. Use of these conditions could be justified as they often represent the thermal conditions in which some polluted effluents are discharged.

At an intermediate temperature of 60 °C and using small amounts of hydrogen peroxide LAS removal is significantly improved due to a more efficient use of the oxidant. This is mainly due to the enhancement of the radical reaction rate constant, as it does the quantum yield of the LAS.

The use of more severe operating conditions, temperatures of 80 °C and high amounts of peroxide is necessary if the aim is to improve biodegradability. Only in that case intensified oxidation makes possible the removal of aromatic intermediates.

1. Introduction

In recent decades, advanced oxidation technologies have emerged among the most efficient alternatives for the destruction of toxic substances, especially in the treatment of effluents characterised by high chemical stability and/or low biodegradability.

Among the advantages of advanced oxidation is the potential for eliminating high loadings of organic carbon along with the ability to act on complex matrices of different pollutants, due to its non-selective behaviour. In many cases, the performance of advanced oxidation relies on the combined use with other technologies, such as the biological treatment. In this latter case, advanced oxidation becomes a promising pre-treatment technology [1]. Unfortunately, one of the main disadvantages of these technologies is their energy intensity and corresponding high cost [2].

Therefore, and in addition to the ongoing development of novel oxidation technologies, there is also a wide range of optimisation in current ones. In this regard, some authors have demonstrated a positive effect of reaction temperature on the efficiency of these processes in a wide variety of pollutants. That is the case of the Fenton reagent in the oxidation of anilines [3], anionic LAS surfactant [4], thiazine-based azo type inks [5,6], 2,4-dichlorophenoxyacetic [7] or a real industrial effluent [8]. The same favourable effect of temperature on oxidation yield and reaction kinetics has been found in the photo–Fenton system [9,10].

Application of temperature to ozone-based AOP [11] or photocatalysis [12] have been scarcely studied, since activation energies are usually low, and as known, these processes are more dependant of physical parameters.

Most of these works, either in the case of UV-based technologies or the Fenton reagent, consisted in the application of temperatures only slightly higher than ambient conditions, up to a maximum of 50 °C.

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