HOMOGENEOUS CATECHOL OXIDATION IN AQUEOUS SOLUTION

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Introduction and Background

Catechol is a priority phenolic pollutant frequently detected in industrial and natural waters, exhibiting high toxicity and resistance to conventional treatment methods. Homogeneous catalytic oxidation processes represent an efficient alternative for the abatement of such recalcitrant organic contaminants. The objective of this study is to evaluate the efficiency and kinetics of the homogeneous oxidation of catechol in aqueous solution under controlled experimental conditions.

Methodology

The oxidation experiments were performed in a batch reactor using a homogeneous catalytic system based on ferrous ions and hydrogen peroxide. The effects of operational parameters, including initial catechol concentration (50 mg/L), oxidant dosage, catalyst concentration, and pH, were systematically evaluated. Catechol removal was monitored spectrophotometrically, while mineralization was assessed through chemical oxygen demand (COD) measurements. Reaction kinetics were analyzed using a pseudo-first-order models.

Results

The results demonstrated a rapid degradation of catechol, with removal efficiencies exceeding 60% within the first 200 minutes under optimal conditions. The highest oxidation rate was observed at acidic pH, confirming the strong dependence of the process on the reaction medium. Increasing the hydrogen peroxide concentration enhanced catechol conversion up to an optimum value, beyond which a scavenging effect was observed. The apparent rate constant increased from 1.2×10^{-3} s^{-1} to 6.8×10^{-3} s^{-1} with increasing catalyst concentration. COD removal reached up to 55%, indicating partial mineralization and the formation of intermediate oxidation products. Kinetic analysis confirmed that the oxidation process followed pseudo-first-order behavior with respect to catechol concentration.

Conclusions and Implications

The homogeneous oxidation process proved to be highly effective for catechol degradation in aqueous solution, offering fast reaction rates and high removal efficiencies. These findings highlight the potential of homogeneous catalytic oxidation as a viable treatment option for phenolic wastewater and provide a scientific basis for further optimization and scale-up of advanced oxidation processes for industrial applications.

Keywords: *advanced oxidation processes, aqueous solution, catalytic systems, degradation kinetics, phenolic pollutants*

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References

1. Sheng Guo, Ran Huang, Jia Yuan, Rong Chen, Fengxi Chen. Efficient removal of aromatic pollutants via catalytic wet peroxide oxidation over synthetic anisotropic ilmenite/carbon nanocomposites. In: npj Clean Water, Volume 6, 2023, no. 74. https://doi.org/10.1038/s41545-023-00287-1
2. Javier Moreno-Andrés, Iván Vallés, Paula García-Negueroles, Lucas Santos-Juanes, Antonio Arques. Enhancement of iron-based photo-driven processes by catechol: Implications for photo-Fenton systems. In: Catalysts, Volume 11, Issue 3, 2021, no. 372. https://doi.org/10.3390/catal11030372