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Effect of H_2O_2 and Metals on the Sonochemical Decomposition of Humic Substances in Wastewater Effluent

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1. Introduction

The aim of this study is to investigate the effects of sonochemical treatment on the decomposition of humic substances, and reaction kinetics and mechanism have also been discussed. Factors such as the dose of hydrogen peroxide, turbidity, and concentration of metals were examined.

2. Matrials and Methods

2.1. Materials: Hydrogen peroxide, Perchlorate salts of metals, potable reverse osmosis(RO) system was used to collect and concentrate humic substances(HS) from Gwang-ju Wastewater Plant effluent.

2.2. Wastewater Characterization: Samples were taken(pre-chlorination) from the Gwangju wastewater treatment plant(GWTP) on two occasions. The Ca(II), Mn(II), Fe(II), and Mg(II) contents were evaluated by ICP emission spectrophotometer.

2.3. Methods: In order to get carbonate-free sample, bicarbonate was removed by acidifying the sample to pH 4 with perchlorate acid and bubbling with pure nitrogen gas. Sonochemical treatments were conducted with an ultrasonic generator (Cole-Parmer 600-Watt, 20kHz, ultrasonic homogenizer 4710) equipped with a titanium probe transducer(Cole-Parmer, Model CV 17).

2.4. Analytical Methods: THMs in 0.5 mL sample from the reactor were extracted using the liquid-liquid extraction method and analyzed with GC(HP-5890) equipped with a Supelco-608 column, a autosampler injector(HP-7376), and a electron capture detector(ECD). TOC: Tekmar-Dhormann DC-190 TOC analyzer.

3. Results and discussion

The extend of TOC removal increases with increasing dose of hydrogen peroxide. While little extent of removal is observed with the ultrasound alone, over 30% of TOC removal is achieved with 10^{-2} M of hydrogen peroxide concentration after 120

min of reaction time. The decomposition rate decreases as the turbidity increases in the range of 1 to 10 mg/L of kaolinite, then slightly decreases upon further increase in the turbidity above 10 mg/L. The sonochemical irradiation combined with hydrogen peroxide reduces the THMFP, while the irradiation without hydrogen peroxide slightly increases the THMFP of humic substances. The decomposition rates increase significantly with increasing dose of Fe(II) and Mn(II), while the rates decrease with increasing dose of Al(III), Ca(II), and Mg(II). Fe(II) and Mn(II) show an important catalytic effect prooting the decomposition of humic substances in wastewater effluent.

4. Conclusion

The sonochemical process has been applied as a treatment method to investigate its effect on the decomposition of humic substances(HS). The reaction kinetics and mechanisms in the process of sonochemical treatment for humic substances in wastewater have also been discussed. It was observed that the metal ions such as Fe(II) and Mn(II) showed catalytic effects, while Al(III), Ca(II), and Mg(II) had inhibitory effects on the decomposition of humic substances in sonochemical reaction with hydrogen peroxide. Experimental results also showed factors such as hydrogen peroxide dose affected the formation of disinfection by-products. Two trihalomethanes, chloroform and dichlorobromomethane were formed as major disinfection by-products during chlorination. The mechanism of radical reaction is controlled by an oxidation process. The radicals are so reactive that most of them are consumed by HS radicals and hydroxyl radicals can be acted on organic solutes by hydroxyl addition, hydrogen abstraction, and electron transfer. The depolymerization and the radical reaction of HS radicals appear to occur simultaneously. The final steps of the reaction are the conversion of organic acids to carbon dioxide.

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