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Sonochemical Decomposition of Humic Substances in Wastewater Effluent

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1. Introduction

The objectives of this study are to investigate effects of sonochemical treatment on the decomposition of humic substances. Reaction kinetics and mechanism in the process of the sonochemical treatment of the humic substances have been discussed. Factors such as total carbonate concentration, ultrasonic energy intensity, dose of hydrogen peroxide, solution pH, and solution temperature were also examined.

2. Matrials and Methods

2.1 Materials: Hydrogen peroxide, Perchlorate salts of metals. A potable reverse osmosis(RO) system was used to collect and concentrate humic substances(HS) from Gwang-ju wastewater Plant effluent. A cation exchanger, high-pressure pump, RO membrane.

2.2 Experiments: 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 a ultrasonic generator(Cole-Parmer 600 Watt, 20kHz, ultrasonic homogenizer 4710) equipped with a titanium probe transducer(Cole Parmer, Model CV 17). Experiments were conducted in an open glass reactor(Sonics & Materials, 20mL).

2.3 Analytical Methods: GC(HP-5890) equipped with a Supelco-608 column, a HP-7376 autosampler injector, and an ECD. TOC analyzer(Tekmar-Dohrmann DC-190).

3. Results and discussion

The extent of TOC removal decreases as the temperature increases. The extent of TOC removal was largest at 25℃ in the temperature range of 25 to 45℃.

The decomposition rate decreases as the initial TOC concentration increases. The decomposition rate was found to be dependent on the initial TOC concentration of humic substances.

The constants k_1 and k_2 are obtained as follows;

The rate of occupying sites on interfacial surface dN_A/dt is proportional to the fraction of unoccupied sites and the TOC concentration of humic substances in solution,

$$\left(-\frac{dN_A}{dt}\right)_{association} = k_1(1-\theta_A)C_A$$

Results of the kinetic studies for TOC removal of humic substanes were fitted with the kinetic model described above, and fitted values along with correlation coefficients are show in Table 1.

Table 1. Fitted Parameters K, *k*, and Coefficient of the Langmuir-Hinshelwood Model for Decomposition of Humic Substances. Conditions for Experimental Data: ultrasonic energy intensity=283watts/cm^2, total volume=10mL, H_2O_2 10mM, pH^0 7, C_0 = TOC 10mg/L, temperature=25℃, ionic strength=0.05M $NaClO_4$.

Run	TOC_0 (mg/L)	K(mg^{-1}L)	k (mg L^{-1}min^{-1})	R
1	2.5	10	0.004	0.9487
2	10	10	0.0032	0.9698
3	20	10	0.0011	0.9589
4	30	10	0.00035	0.9778
5	50	10	0.00015	0.9682

4. Conclusion

The sonochemical process is applied as a treatment method to investigate its effect on the TOC removal of humic substances. The extent of TOC removal was proportional to factors such as ultrasonic energy intensity and hydrogen peroxide concentration while increasing of total carbonate, pH, and temperature decreased the extent of TOC removal of humic substances. The Langmuir-Hinshelwood model provided a good fit of the experimental data. Experimental results also showed the factor such as dose of hydrogen peroxide affected the formation of disinfection by-products. Chloroform and dichlorobromomethane were formed as major THMs during chlorination.

References

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