



## Degradation of high concentration phenol by ozonation in combination with ultrasonic irradiation

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### ABSTRACT

The combination of 50 kHz ultrasound and ozone for the degradation of phenol was studied. The effect of temperature, ozone gas flow rate, initial pH, hydroxyl radical scavenger, and initial phenol concentration on the degradation was investigated. Of the pseudo-first-order degradation rate constants of COD reduction,  $4.8 \times 10^{-3}$  and  $5.4 \times 10^{-3} \text{ min}^{-1}$  were observed with  $\text{O}_3$  and a combination of US and  $\text{O}_3$ , respectively. The COD reduction by single US was negligible. The degradation rate increased with the increase of temperature and gas flow rate, but decreased with the increasing initial phenol concentration. The optimal pH was 11.0 but it had no much effect on the COD removal efficiency, indicating that the low frequency ultrasound enhanced ozonation process for the degradation of phenol is mainly a direct reaction rather than radical reaction. The synergistic effect of phenol degradation by ultrasound enhanced ozonation was not significant in this system. The variation of the concentrations of related ions (oxalate, formate, acetate) during the reaction process was monitored by ion chromatography. Other organic intermediates detected by GC/MS were hydroquinone and catechol. Based on these findings, a tentative degradation pathway was proposed.

*Keywords:* Ozone; Ultrasound; Advanced oxidation; Phenol; Synergistic effect

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