Medium-High Frequency Ultrasound and Ozone based Advanced Oxidation for Amoxicillin Removal in Water

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Medium-High Frequency Ultrasound and Ozone based Advanced Oxidation for Amoxicillin Removal in Water

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Abstract

In this study, treatment of an antibiotic compound amoxicillin by medium-high frequency ultrasonic irradiation and/or ozonation has been studied. Ultrasonic irradiation process was carried out in a batch reactor for aqueous amoxicillin solutions at three different frequencies (575, 861 and 1141 kHz). The applied ultrasonic power was 75 W and the diffused power was calculated as 14.6 W/L. The highest removal was achieved at 575 kHz ultrasonic frequency (>99 %) with the highest pseudo first order reaction rate constant 0.04 min^{-1} at pH 10 but the mineralization achieved was around 10 %. Presence of alkalinity and humic acid species had negative effect on the removal efficiency (50 % decrease). To improve the poor outcomes, ozonation had been applied with or without ultrasound. Ozone removed the amoxicillin at a rate 50 times faster than ultrasound. Moreover, due to the synergistic effect, coupling of ozone and ultrasound gave rise to rate constant of 2.5 min^{-1} (625 times higher than ultrasound). In the processes where ozone was used, humic acid did not show any significant effect because the rate constant was so high that ozone has easily overcome the scavenging effects of natural water constituents. Furthermore, the intermediate compounds, after the incomplete oxidation mechanisms, has been analyzed to reveal the possible degradation pathways of amoxicillin through ultrasonic irradiation and ozonation applications. The outcomes of the intermediate compounds experiments and the toxicity was investigated to give a clear explanation about the safety of the resulting solution. The relevance of all the results concluded that hybrid advanced oxidation system was the best option for amoxicillin removal.