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Degradation of Tetracycline Degradation by a Mercury UV Lamp Coupled with an Ultrafine-Bubbles Ozone Gas Producer

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Extended Abstract

There are currently more than 4,000 medicines are used worldwide, with an estimated total global antibiotic consumption of 100,000-200,000 tons per year. These compounds may be released in large quantities into the environment due to overconsumption and disposal of unused or expired antibiotics [1]. The worldwide misuse of antibiotics has significantly increased bacterial resistance to existing antibiotics and has resulted in more than 25,000 deaths from drug-resistant bacteria in Europe each year [2]. Tetracyclines, discovered in 1940, are one of a family of antibiotics that inhibit protein synthesis by preventing the attachment of aminoacyl-tRNAs to the ribosomal receptor (A) site [3]. Due to the toxicity of tetracycline on the ecology, how to reduce the effect of tetracycline toxicity is a key point; hence, our research teams tried to use several advanced oxidation processes (AOPs) such as ultrasound, Fenton, ultra-violet (UV) light, ozonation, and their combinations for the degradation of antibiotic tetracycline and get satisfactory results [4]. However, the degradation cost by those AOPs is very high so how to reduce the cost of tetracycline degradation was investigated in this study. And, with the combination of a UV and ozone by a mercury UV lamp (wavelength of 254 nm, 16 watts) and an ultrafine-bubble ozone gas producer (diameter of ozone gas bubbles are approximately 0.5-3 μm), the degradation of tetracycline was carried out at different pH levels and anion additions.

Commercial analytical-grade tetracycline was used as the target species for experiments. The ultrafine-bubbles ozone gas production rates were 0.06 and 0.08 g O_3/h, with gas flow rates of 30 to 40 mL/min. Several instruments such as a pH meter, an oxidation reduction potential meter, a dissolved oxygen meter, and a dissolved ozone concentration meter were equipped with the reactor to measure the profiles. A UV-visible spectrophotometer was used to measure the concentration of tetracycline at the wavelength of 357 nm.

As the reaction was carried out at optimal condition by sono-Fenton, tetracycline degradation reached 99% but reduced to 31%-85% as different anions additions. When the ultrafine-bubble ozonation was used, 20 minutes reaction was enough to degrade 99% of tetracycline. The addition of anions reduced the tetracycline degradation rate to 86%-92% and reached 99% at 30-40 minute reaction. Even at very high (5 mM) anion concentrations, the degradation of tetracycline was satisfied by ultrafine-bubble ozonation. When the UV lamp was used to degrade the tetracycline, it was found that less than 20% of tetracycline can be degraded with 60 min reaction. However, when the UV was combined with ultrafine-bubble ozonation, 10 min reaction is enough to degrade 100 mg/L tetracycline, which indicates that the combination of UV and ozone can save the treatment time and costs. Also, the inhibition effect of anion on the tetracycline degradation is also reduced.

References

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