Removal of Antibiotic Residues from Water and Wastewater Effluents

by UV and UV/H₂O₂ process

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Introduction

Antibiotics in the environment
- Antibiotics are among recently emerging micro-contaminants in water, due to their extensive use in treatment of human and veterinary medicine.
- Some of the major concerns of antibiotics residues in the environment is the development of multiple drug resistant bacteria that will make its way into the food chain.

UV & UV/H₂O₂ treatments
- Treatment of water contaminated with organic pollutants, applying ultraviolet (UV) light, has significantly increased in recent years.
- Addition of H₂O₂ to the UV photolysis process leads to the production of hydroxyl free radicals which react very quickly with many contaminants leading to their possible destruction:
  1) \( H₂O₂ \rightarrow OH^- + 2H\)
  2) \( OH^- + SMX \rightarrow \) product

Objectives

1. Study the degradation kinetics of SMX under polychromatic UV light and UV/H₂O₂.
2. Study the influence of various parameters (pH, H₂O₂ concentration, water quality) on the degradation kinetic.
3. Calculate the Electrical Energy per Order (EEO), which is the amount of electrical energy required to reduce the concentration of a pollutant by 1 order of magnitude (90%).

Experimental procedure

- Degradation kinetic experiments were carried out in a collimated beam reactor, using 0.45 kW polychromatic (200–400 nm) medium-pressure (MP) lamps.
- 150 ml Sample was spiked with SMX (1 μg/ml) and irradiated with and without different concentration of H₂O₂.
- Samples of 0.5 ml were withdrawn at appropriate intervals for analysis.
- The photodegradation of SMX was also carried out in a UV flow-through lab reactor, imitating a full scale reactor. The reactor contains a 0.5 MP UV lamp.
- The pomp flow rate is 1.2 m³/hr.
- The reactor operates in a close circuit.

Conclusions

- SMX degradation rate in water (pH ~6) as function of H₂O₂ concentration showed that small amounts of H₂O₂ accelerate the photodegradation of SMX, while higher amounts of H₂O₂ decreases degradation rate.
- Photolysis rate of SMX in water at different pH is highest at pH 4.7 (k = 0.0124 1/sec) and lowest at pH 6.7 (k = 0.033 1/sec).
- Water quality is found to be highly significant in SMX photolysis, where the effluent high absorbance slow the SMX degradation rate.
- UV Photolysis and H₂O₂ assisted photolysis can be satisfactory for degradation of SMX (at the correct conditions) as a fluence of less than 600 mJ/cm² is needed to break down 99% of SMX at pH 4.7.
- EEO value for SMX is 6 kWh/m³/order.