



Contribution ID: 378

Type: Oral

## Removal of Wastewater Pharmaceutical Chemical Contaminants Using AOPs

Thursday, 27 April 2017 11:35 (20 minutes)

Quantitatively removing all remaining traces of pharmaceuticals such as antibiotics and estrogenic steroids from effluent wastewater is essential before its further use or release into the environment. In particular, the presence of antibiotics and even their metabolites in wastewaters can enhance the proliferation of antibiotic-resistant bacteria such as MRSA and ND-1. Unfortunately, conventional primary and secondary water treatments that rely mainly upon adsorptive and chemical-physical processes have been demonstrated to be insufficient for quantitative large-scale treatment. These removal treatments are considerably complicated by the presence of much higher levels of other water constituents such as dissolved organic matter (DOM) and carbonate.

Therefore, to prevent increasing levels of antibiotics entering environmental waters, additional treatment using radical-based, advanced oxidation processes (AOPs), are being considered to augment our traditional water treatments. In real-world waters most AOPs utilize the hydroxyl radical ( $\text{HO}\cdot$ ), which can be created using a variety of techniques including combinations of ozone, hydrogen peroxide and UV-light.  $\text{O}_3/\text{H}_2\text{O}_2$ ,  $\text{O}_3/\text{UV-C}$ , and  $\text{H}_2\text{O}_2/\text{UV-C}$ . Other AOPs that produce a mixture of reducing and oxidizing radicals include the light irradiation of titanium dioxide, sonolysis, or the irradiation of water via electron beams or  $\gamma$  rays. Once these radicals are generated the dissolved oxygen present will predominately react with the reducing hydrated electron or hydrogen atoms produced. However, the deliberate addition of a compound such as persulfate to these waters can augment  $\text{HO}\cdot$  reactions through the concomitant production of the sulfate radical ( $\text{SO}_4^{\cdot-}$ ) by the reaction of both these two reducing radicals. While this is a promising enhancement in the AOP treatment methodology the effectiveness of the sulfate radical augmentation approach must be fully established before its use at large scale. In particular, the cost-effectiveness of this approach will depend upon the reactivity of the sulfate radical with other water constituents.

Therefore, we have performed electron pulse radiolysis measurements to determine reaction rate constants for hydroxyl and sulfate radicals with a large number of DOM fractions from various sources. The sulfate radical rate constants were found to be effectively independent of the DOM aromatic/ aliphatic constituent fractions, and in general about an order of magnitude slower than determined for the analogous  $\text{HO}\cdot$  radical reactions. The slow reactivity of the sulfate radical with DOM is encouraging, as it would allow a greater fraction of these radicals to react with the contaminants present at much lower concentrations. To further investigate this, we have also now performed preliminary measurements on the use of sulfate radicals to remove low-levels of beta-lactam antibiotics in the presence of different DOM species. Kinetic and efficiency data for penicillin-G in the presence of varying ratios of Suwannee River fulvic acid and Elliot Lake humic acid have been determined and will be reported.

### Country/Organization invited to participate

United States of America

**Primary author:** Mr MEZYK, Stephen (California State University at Long Beach, United States of Amer-

ica)

**Presenter:** Mr MEZYK, Stephen (California State University at Long Beach, United States of America)

**Session Classification:** A12

**Track Classification:** MITIGATING THE IMPACT OF CLIMATE CHANGE