ENV-405 | Water and Wastewater Treatment

Lecture 6. Ozonation and advanced oxidation processes

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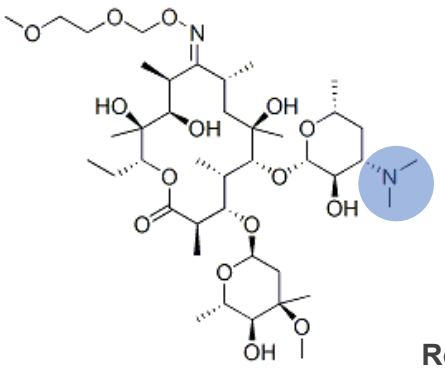
Exercice #1 | pH-dependence of ozone reactions

Roxithromycin (RX) is a macrolide antibiotic, which can be oxidized at the tertiary amine moiety by ozone (see below). It has a pKa of 9.2 and second order rate constants for the reaction with ozone of 1 $M^{-1}s^{-1}$ (protonated) and 107 $M^{-1}s^{-1}$ (deprotonated).



Roxithromycin (RX)

Q1. Plot the pH-dependence of the apparent second order rate constant for every unit of pH between pH 0 and 12 (as for phenol in lecture #6).

Q2. Determine the reactivity pK of RX.

Q3. Use the apparent second order rate constant calculated at pH 7 to calculate the half-life for RX. We will consider that ozone concentration is constant and equal to 1 mg/L.

Exercice #2 | Oxidation of phenylurea herbicides

Some phenylurea herbicides have been oxidized in a drinking water treatment plant using ozone. The second-order rate constants for their reaction with ozone and OH radicals are given in the table below.

Pesticides	**$k_{O3,P}$, $M^{-1}s^{-1}$**	**$t_{1/2}$ for only O3**	**$k_{\bullet OH}$, P, $M^{-1}s^{-1}$**
Isoproturon	141	250 s	$5 \cdot 10^9$
Chlortoluron	51	11 min	$4 \cdot 10^9$
Diuron	15	40 min	$4.5 \cdot 10^9$

Q1. Formulate the rate equation for the oxidation with ozone and OH radicals.

Q2. Assuming a reaction with ozone only, how can the half-lives given in the table be estimated? From this equation, determine the ozone concentration applied in this case?

Q3. In lake Zurich water, a typical ratio R_{CT} is 10^{-8}. What is the fraction of each pesticide reacting with ozone and with OH radicals, respectively?

Q4. What is the degree of transformation for an ozone exposure of 0.015 M.s?