

MASTER'S THESIS

A mechanistic study of the oxidation of $\text{Na}[\text{VO}(\text{O}_2)_2(\text{bpy})]$ by HOCl and its DNA-cleavage activity

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**A Mechanistic Study of the Oxidation of Na[VO(O₂)₂(bpy)]
by HOCl and its DNA-Cleavage Activity**

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**A thesis submitted in partial fulfillment of the requirements
for the degree of
Master of Philosophy**

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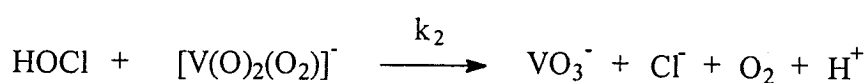
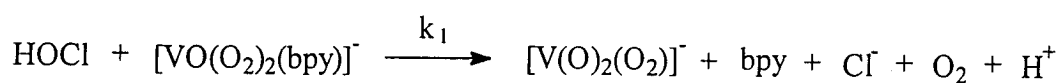
Abstract

DNA-cleavage activity has recently been demonstrated in a variety of vanadium(V)-peroxo complexes when photo-irradiated at neutral pH. Singlet oxygen, which is capable of DNA-scission, was shown to be produced during the photolyses of these complexes. In this work, we investigated the DNA-cleavage activity resulting from the oxidation of selected vanadium(V)-peroxo complexes by hypochlorous acid and *N*-bromosuccinimide at neutral pH. Significant DNA-cleavage activities were found in the $\text{Na}[\text{VO}(\text{O}_2)_2(\text{bpy})]$ and the $\text{K}[\text{VO}(\text{O}_2)(\text{dipic})(\text{H}_2\text{O})]$ complex. These activities were seen to be complex concentration- and incubation (reaction) time-dependent. Further investigation of the oxidation of these two complexes by hypochlorous acid and *N*-bromosuccinimide at neutral pH was therefore undertaken.

Spectrophotometric titrations revealed a complex-to-oxidant stoichiometric ratio of 1 : 2 for the diperoxo complex, $\text{Na}[\text{VO}(\text{O}_2)_2(\text{bpy})]$, with both oxidants studied. But a complex-to-oxidant stoichiometric ratio of 1 : 1 was found for its monoperoxo counterpart, $\text{K}[\text{VO}(\text{O}_2)(\text{dipic})(\text{H}_2\text{O})]$. Detailed quantitative analysis of the product mixtures showed that metavanadate(V) anion, VO_3^- , and chloride anion were the principal products of the oxidation with hypochlorous acid. Singlet oxygen was also detected using *trans*-

methoxyvinylpyrene, a highly-selective singlet oxygen probe, by HPLC-fluorescence detection technique.

Detailed kinetic study of the oxidation of the $[\text{VO}(\text{O}_2)_2(\text{bpy})]^-$ complex by hypochlorous acid in 0.5 M phosphate buffer at neutral pH was carried out. Global kinetic analysis suggested a model consisting of two consecutive irreversible elementary reactions with a non-steady-state intermediate for this reaction. A proposed mechanism based on this kinetic model as well as the results from our stoichiometric study and product analysis is given as follows:



where k_1 and k_2 were found to be $18.5 \pm 1.68 \text{ M}^{-1}\text{s}^{-1}$ and $1.05 \pm 0.118 \text{ M}^{-1}\text{s}^{-1}$, respectively. The observed invariance of k_1 and k_2 with respect to a 5-fold variation of the total ionic strength of the reaction medium suggests that HOCl, and not OCl^- , is the kinetically relevant oxidant species at neutral pH.

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