

Removal of selected antibiotics and antiretroviral drugs during post-treatment of municipal wastewater with UV, UV/chlorine and UV/hydrogen peroxide

Ngumba, E.^{*1}, Gachanja, A.¹ and Tuhkanen, T.²

¹Jomo Kenyatta University of Agriculture and Technology, Department of Chemistry, P.O. Box 62000-00200 Nairobi, Kenya

²University of Jyvaskyla, Department of Biological and Environmental Sciences, P.O. Box 35, FI- 40014 University of Jyvaskyla, Finland

*Email: *engumba@jkuat.ac.ke*

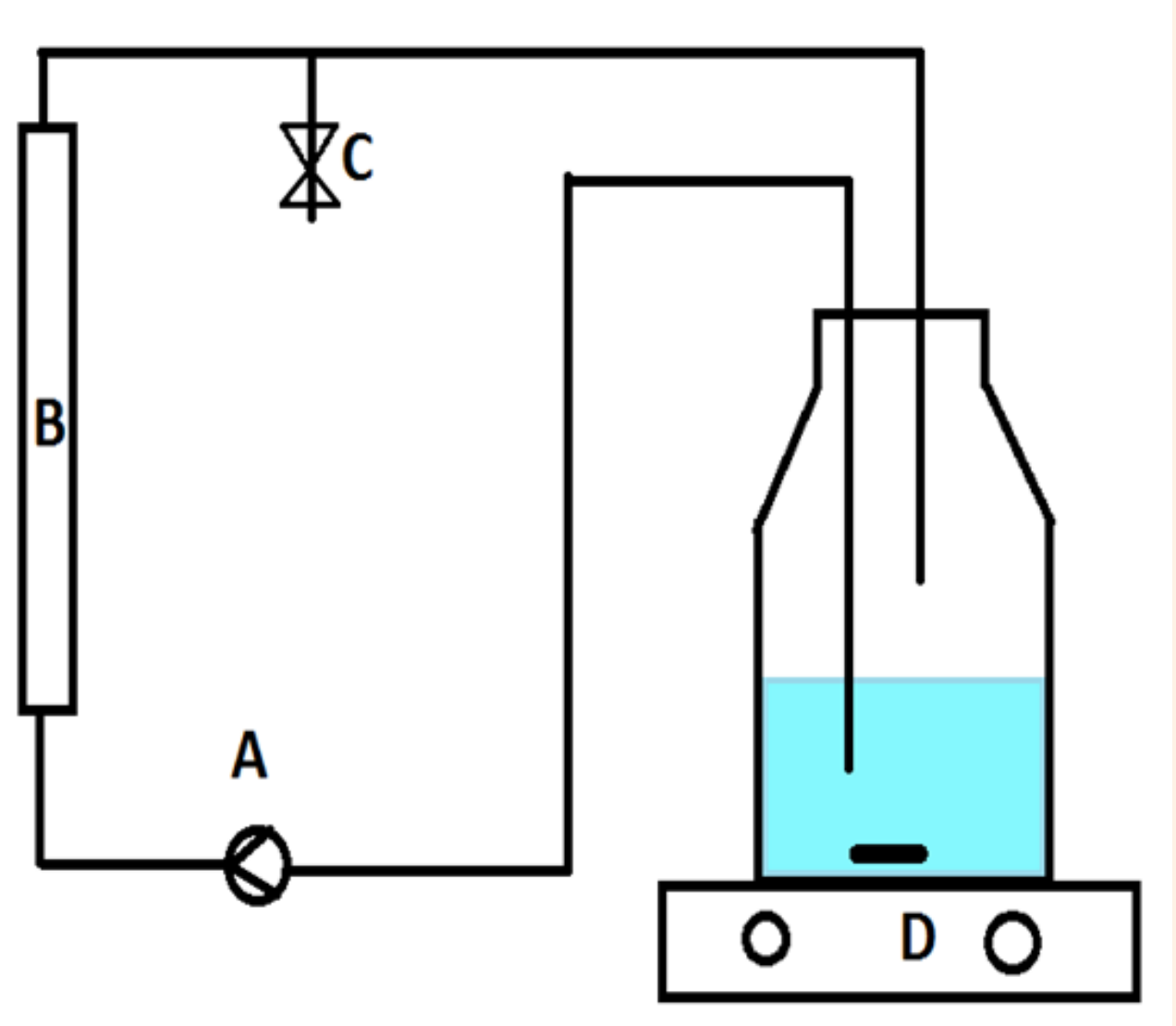
Introduction

Active pharmaceutical ingredients (APIs) are only partially removed by convectional wastewater treatment plants. This study aimed at assessing the post-treatment degradation of selected antibiotics and antiretroviral drugs by direct UV photolysis and advanced oxidation processes (UV/H₂O₂ and UV/Cl₂) using low pressure mercury lamp.

The target compounds included: Sulfamethoxazole (SMX), trimethoprim (TMP), ciprofloxacin (CIP), lamivudine (3TC), nevirapine (NVP) and zidovudine (ZDV)

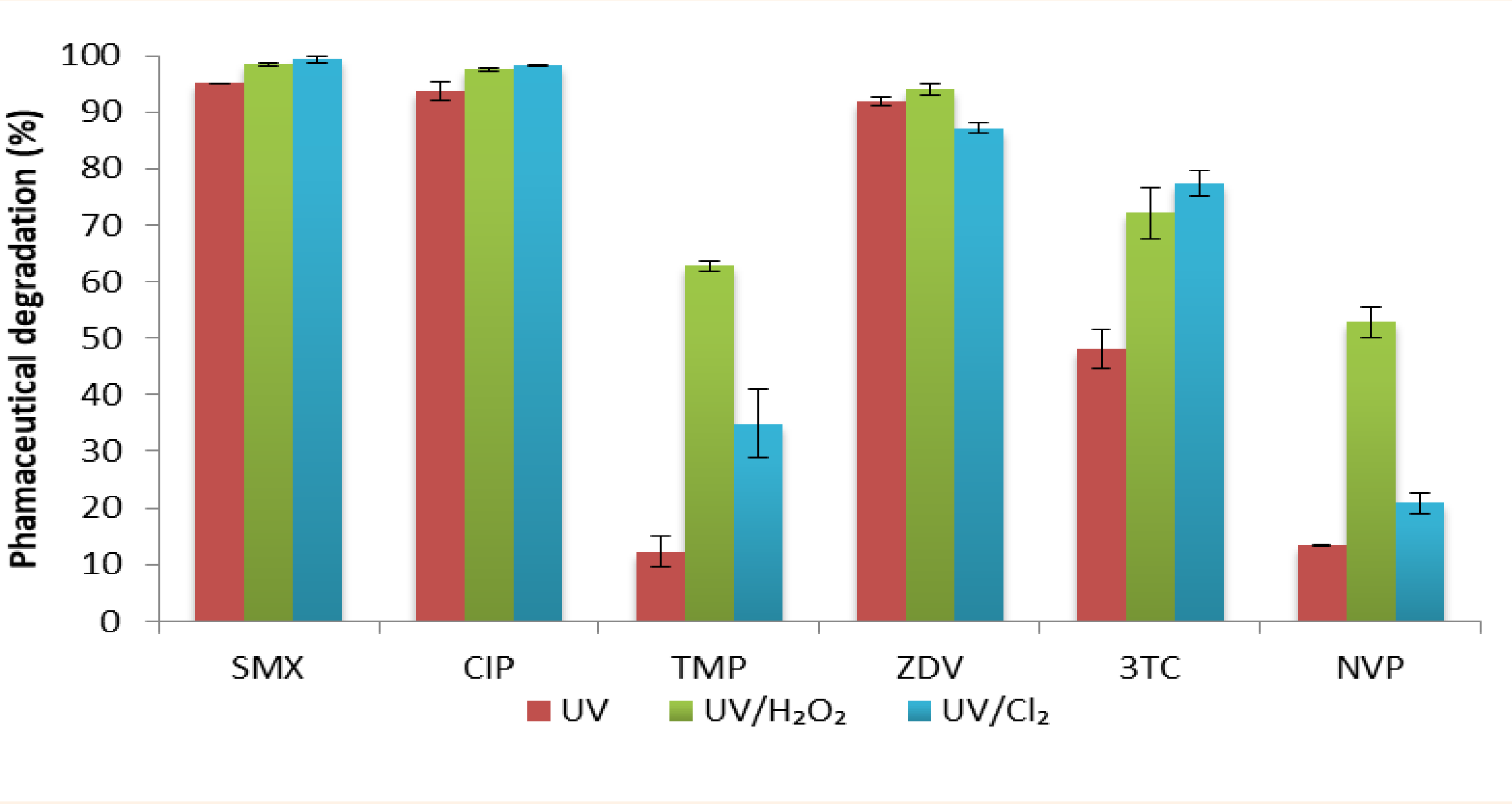
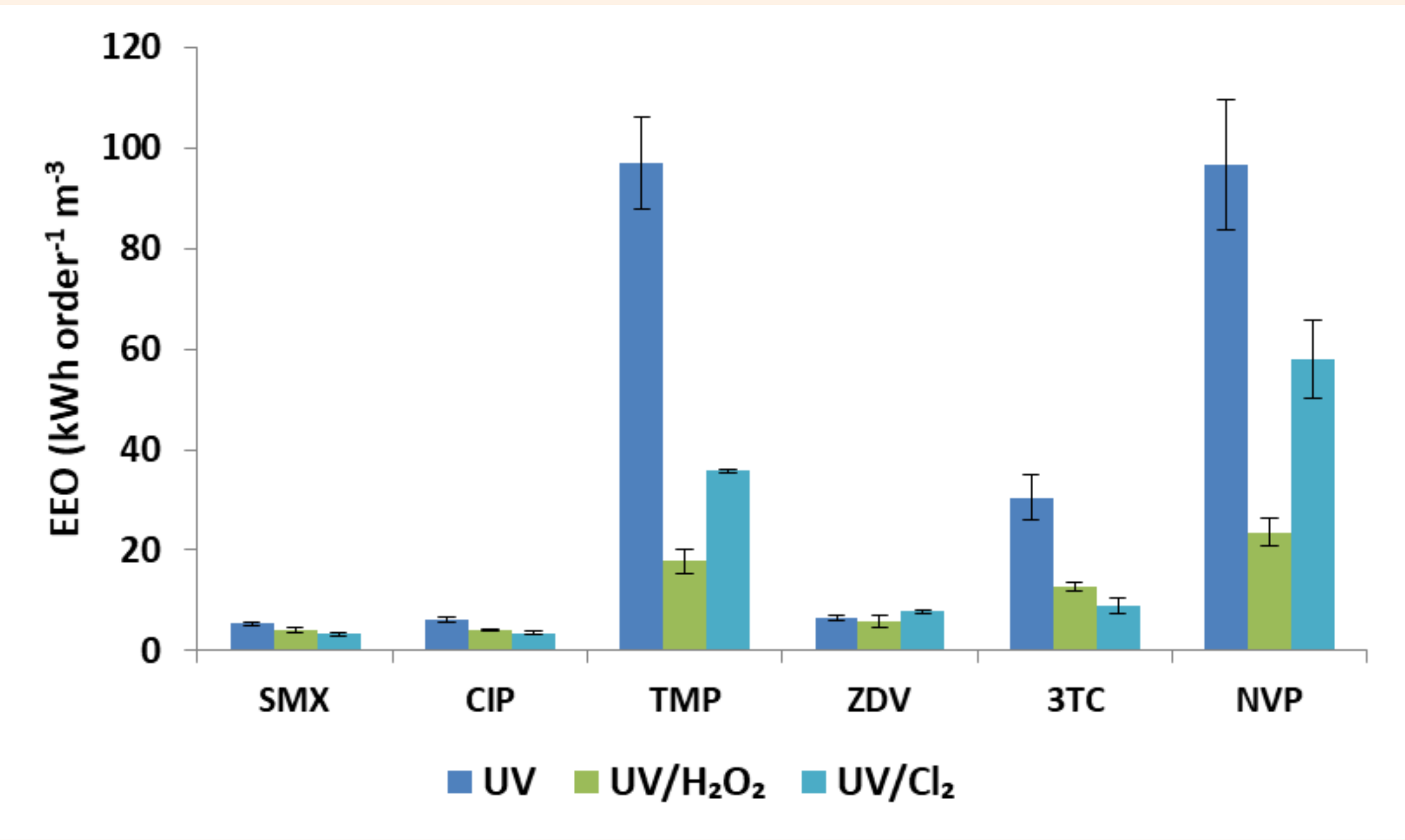
Methodology

- ♦ UV irradiation experiments were performed using a 670 mm 40 W low pressure mercury lamp (Aquada 2 UV system, Wedeco, Germany) emitting at λ_{max}=254 nm.
- ♦ To evaluate the degradation of individual APIs, the experiments were conducted based on the following experimental design:
 - a.Determination of target APIs degradation by direct UV photolysis, UV/H₂O₂ and UV/Cl₂ processes in spiked buffered ultrapure water and varying the sample pH, irradiation time and the initial oxidant concentrations;
 - b.Determination of the target APIs degradation in biologically treated municipal wastewater effluent varying the initial oxidant concentrations and irradiation time.
 - c.Determination of the target APIs degradation by Cl₂ and H₂O₂ in ultrapure water at pH 7.5 without UV irradiation (dark experiments).
- ♦ The target analytes were analyzed by SPE-LC-MS/MS



Scheme of AOP experimental set-up. Legend: A) Recirculation Pump, B) UV reactor, C) Sample Valve, D) Magnetic stirrer

RESULTS



The removal of 20 μM target antibiotics and antiretroviral drugs in wastewater by direct UV photolysis, UV/H₂O₂ and UV/Cl₂ at electrical energy dose of 6.67 kWh/10³L and 20.4 mg/L H₂O₂ and 42.6 mg/L Cl₂

The electrical energy per order of compound removal (E_{EO}, kWh order⁻¹ m⁻³) for direct UV photolysis, UV/H₂O₂ (20.4 mg l⁻¹) and UV/Cl₂ (42.6 mg l⁻¹) in treated wastewater effluent.

- ♦ The rate of degradation of the six compounds by direct UV photolysis, UV/H₂O₂ and UV/Cl₂ processes followed pseudo first-order reaction kinetics.
- ♦ SMX, CIP and ZDV were readily removed by direct UV photolysis
- ♦ The pseudo-first-order rate constants for the UV/H₂O₂ process in wastewater were significantly higher than UV/Cl₂ process especially for NVP and TMP. This implies that the treatment efficiency UV/Cl₂ process is inferior to that of UV/H₂O₂ and much more electrical energy would be required to achieve similar removal efficiencies. However, due to the relatively low chemical costs UV/Cl₂ AOP process can be an alternative to UV/H₂O₂ in water with low DOC and after thorough suitability evaluation of each target water stream.

References

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Acknowledgements

This work was financially supported by the University of Jyvaskyla . The authors appreciate the technical and material support provided by Universal Corporation-Kenya and Jomo Kenyatta University of Agriculture and Technology-Kenya

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