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Advanced reduction processes (ARPs) induced by ultraviolet (UV) radiation in degradation of water pollutants.

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INTRODUCTION

Advanced reduction processes (ARPs) can complement advanced oxidation processes (AOPs) and other wastewater treatment methods to increase their overall degradation efficiency. The use of ARPs in the removing pollutants from industrial effluents containing a high load of toxic and difficult to biodegrade chemical compounds revealed to be effective [1,2]. Reduction of pollutants by means of hydrated electrons generated during UV-radiation through a series of contaminants transformations into non-toxic compounds has a very high potential for application in industrial wastewater treatment processes [3-4].

Generating of hydrated electrons

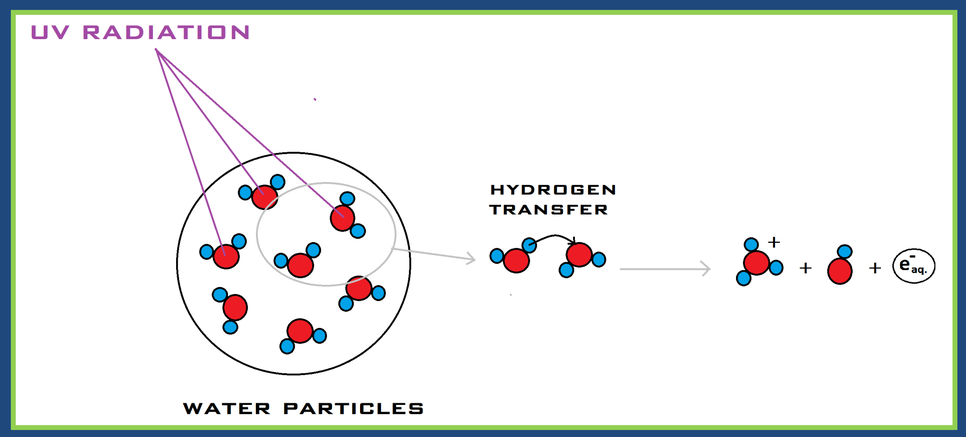
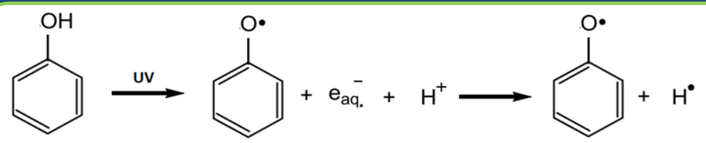


Figure 1. Water UV-radiolysis process.

The high energy of the UV radiation breaks up the bond between hydrogen with the rest of a water molecule. The free hydrogen atom attaches to the water molecule to form the oxonium ion. The rest of the water molecule creates an OH- ion, which quickly converts into the OH radical and a free electron, which is solvated by the water molecules to form a solvated electron (hydrated electron). Hydrated electrons have the highest possible reduction potential of -2.9 V [5], which allows for the effective removal of various types of halide derivatives from the wastewater, which are resistant to AOPs. All ARPs require optimization that's why the influence of environmental conditions, such as temperature and pH of the solution, on the degradation efficiency is also discussed. The control of conditions during the ARPs using hydrated electrons is crucial because the presence of oxygen, incorrect pH, and temperature can significantly reduce the efficiency of the reaction or stop it altogether. It is also possible to form hydrated electrons from other kinds of compounds or even impurities: for example phenol (reaction 1), iodite (reaction 2), or sulfite (reaction 3) [6-7]. The possibility of such reactions allows the reduction of pollutants with the help of other compounds present in the wastewater, which increases the potential of this method of pollutant degradation.

Generating of hydrated electrons from other contaminants



(1)

$$I^- + h\nu \longrightarrow I^{-*} \longrightarrow I^{\bullet} + e^-_{aq.} \qquad (2)$$

$$SO_3^{2-} + h\nu \longrightarrow SO_3^{\bullet -} + e^-_{aq.} \qquad (3)$$

$$CH_2ClCOO^- + e^-_{aq.} \longrightarrow {\bullet}CH_2COO^- + Cl^- \qquad (4)$$

Conclusions:

The possibility of using hydrated electrons to reduce a halide derivative to an organic radical and chloride ion (reaction 4) [7] makes ARPs (guided by hydrated electrons) effective in wastewater purification processes from persistent organic pollutants resistant to oxidation.

References:

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