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ABSTRACTS

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Comparison of the low-pressure mercury-vapor lamp and Xe•-excimer lamp for the transformation of sulfonamides - inhomogeneity, mineralization, toxicity, and the effect of inorganic ions

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Vacuum ultraviolet (VUV) photolysis is one of the straightforward alternative methods among Advanced Oxidation Processes (AOPs) to eliminate pollutants in low concentrations from water. The light source determines the photolysis efficiency, especially for VUV photolysis. There are two commercially available VUV light sources: low-pressure mercury-vapor lamp (LPM lamp) and Xe•-excimer lamp. LPM lamps with quartz sleeves are widely used for disinfection, while the same lamp with a high-purity quartz sleeve emits 185 nm VUV light besides 254 nm UV light and is widely used for ultrapure water production. The Xe•-excimer lamp emits 172±7 nm "quasi-monochromatic" VUV light. The molar absorbance of water varies extremely in the VUV wavelength range; its value at 185 nm is 1.8 cm^{-1}, while at 172 nm is 575 cm^{-1}. Consequently, the penetration depth (the thickness of the water layer in which 99% of the radiation is absorbed) is about 11 mm for 185 nm, while less than 0.04 mm for 172 nm. Considering the difference between the photon fluxes (4.90×10^{-7} mol_{photon} s^{-1} for 185 nm and 1.02×10^{-5} mol_{photon} s^{-1} for 172 nm light) and penetration depths, the HO• concentration is extremely high in the thin photoreactive zone of Xe•-excimer lamp, which has significant consequences.

It is generally accepted that VUV photons are absorbed exclusively by water. However, some inorganic ions have a high molar absorbance at 185 nm ($\varepsilon_{NO_3^-}$=5568 M^{-1} cm^{-1}, ε_{Cl^-}=3063 M^{-1} cm^{-1}), so they can compete for VUV photons. Our knowledge about the further role and significance of the species formed via VUV photolysis of these ions is limited, and there is no information about their molar absorbance at 172 nm. This study compares the UV, UV/VUV_{185nm}, and VUV_{172nm} photolysis of four sulfonamides (sulfamethazine, sulfamethoxypyridazine, sulfachloropyridazine, sulfadimethoxine) using LPM and Xe•-excimer lamp from several points of view. The transformation and mineralization rate, energy requirement, toxicity change, and the effect of matrices and their main inorganic components, such as HCO_3^- Cl^- and NO_3^- were determined and compared. Our results proved that the presence of inorganic ions has to be considered in the case of VUV photolysis. Their role is quite complex because they can compete for VUV photons, act as radical scavengers, and radicals or radical ions formed via their direct VUV photolysis can react with the organic substances and significantly change the radical set.

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