Application of Various Advanced Oxidation Processes for Elimination of Sulfonamides from Aqueous Solution: Reaction Mechanism, Efficiency, Toxicity and Economic Considerations

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Antibiotics are essential resource for the treatment of multiple types of infectious diseases, both in the case of humans and animals. In latter case antibiotics are used not only for diseases treatment but also for promote growth. However, in recent years their widespread use generated serious concerns, mainly due to the increase in the diversity and dispersion of organisms resistant to these compounds. The amount of antibiotics sold for animals destined to food is approximately four times greater than for human use, whereas the world consumption of antibiotics is estimated an increase of 67% for the year 2030. Among antibiotics, sulfonamides are one of the most widely used in veterinary medicine.

This work aims the detailed investigation of various Advanced Oxidation Processes, such aa ozonation, UV(254 nm) photolysis, UV(254nm)/VUV(185 nm) and ozone/UV(254 nm) combination for transformation and mineralization of various sulfonamides: sulfamethazine and sulfamethoxipiridazine.

Experiments were carried out by varying the parameters like pH, dissolved oxygen concentration, ozone concentration and initial concentration of target substances. The relative contribution of the hydroxyl radical based reaction, direct UV photolysis and reaction with molecular ozone to the transformation of the target substances were investigated in the case of the various methods applied. The quantum yield for the transformation resulted by direct UV and VUV photolysis were determined and compared.

The mineralization was followed by measuring COD and TOC values. Both decreased very fast using ozonation in the first period, but no more than 40-60 % of the COD can be eliminated by this way. At the same time, the combination of ozonation and UV photolysis was found to be much more effective in the mineralization, while the transformation rate was not enhanced significantly. Transformation mechanisms are also suggested and based on the determination of aromatic intermediates. The change of ecotoxicity and antibacterial activity of the solutions treated by the various processes were also determined.

For the practical application, the effect of matrix and the electric energy consumption are very important factors. Transformation rates determined in Milli-Q water was compared to that determined in purified wastewater and tap water. The electric energy consumption was calculated.

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