Comparison of the efficiency of mercury vapor lamp and LED light sources in the case of heterogeneous photocatalysis of sulfonamides

Máté Náfrádi[1] , **Tamás Hlogyik**[1] , **Benjámin Vas**[1] , **Gellért Farkas**[1] , **Tünde Alapi**[1]

[1]*University of Szeged, Faculty of Science and Informatics, Department of Inorganic and Analytical Chemistry, Szeged*

Corresponding author: nafradim@chem.u-szeged.hu

Introduction:Due to the intensive development of optoelectronics in recent years, the use of light emitting diodes (LEDs) radiating in the UV region has become increasingly popular. This makes it possible to improve the efficiency of additive water treatment methods based on photochemical processes. UV LEDs radiating in the 300-400 nm range can be used for heterogeneous photocatalysis, an efficient and widely studied process for the removal and mineralization of hazardous organic matter from water.

Aim:The main goal of our work was the comparison of two light sources (mercury vapor lamp (MVL) emitting 300-400 nm light, and LED light source, which emits 398 nm light) in the conversion of sulfonamides as hazardous pollutants using heterogeneous photocatalysis. TiO_2 and ZnO semiconductors, the most commonly used and commercially available photocatalysts were applied. The comparison of the efficiencies of the light sources and photocatalysts was based on the rate of conversion and mineralization of sulfonamides, the apparent quantum yield of their conversion, and the electrical energy required to reduce the concentration by an order of magnitude (E_{EO}).

Results: The photon flux of the light sources were determined by ferrioxalate actinometry and found to be 4.83×10^{-6} molphoton s^{-1} for the MVL (15 W), and 5.12×10^{-6} molphoton s^{-1} for the 398 nm UV-LED (4.6 W).
Both TiO_2 and ZnO photocatalysts were effective in transforming sulfamethoxypyridazine (SMP) and sulfamethazine (SMT) for both light sources, but the apparent quantum yield of the conversion was significantly higher for the Hg vapor lamp compared to the LED light source.
Another point of view of the comparison was the electrical energy required to reduce the concentration of SMT and SMP by one magnitude (E_{EO}). For SMT, there was no significant difference between values determined in TiO_2 and ZnO containing suspensions, radiated with Hg vapor lamp. The EEO value determined in LED irradiated suspension was two times higher using TiO_2 instead of ZnO, due to the better absorption properties of the latter photocatalyst at 398 nm. In the case of SMP the combination of TiO_2 with LEDs was the most efficient. When electrical energy requirement for mineralization was compared, the TiO_2 photocatalyst and Hg vapor lamp was found to be the best combination in the case of both sulfonamides.

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