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Intensification of the photocatalytic water disinfection process using a rotating magnetic field

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ABSTRACT

This dissertation focuses on the intensification of the photocatalytic water disinfection process with commercially available titanium dioxide and titania modified with metals (copper, platinum, silver, and gold) activated under LED/Vis light and rotating magnetic field (RMF). The primary objective of the research was to investigate the impact of the rotating magnetic field (RMF) on the process of photocatalytic water disinfection. The model strains of Gram- negative bacteria *Escherichia coli* K12 (ATCC 25922) and Gram-positive *Staphylococcus epidermidis* (ATCC 49461) were used.

The literature review section presents the current state of knowledge on the use of photocatalysis and magnetic fields for water disinfection, the mechanisms of photocatalytic water disinfection, the effects of magnetic fields on microorganisms, and the reactor design solutions for water treatment.

The characterization of commercial and metal- modified photocatalysts, was presented in experimental section. The detailed description own designed hybrid photoreactor with the generator of RMF was depicted. Statistical analysis, including ANOVA and response surface methodology (RSM), was employed to determine the influence of process parameters and to identify the optimal conditions for photocatalytic water disinfection enhanced by the rotating magnetic field, depending on the applied photocatalyst.

Additionally, the mechanism for RMF-assisted photocatalytic water disinfection, was proposed. For this purpose additionally study for selected photocatalyst were conducted. The amount of hydroxyl radicals (•OH) generated on the surface of the activated photocatalyst, the activity of catalase, and the assessment of bacterial cell structure damage was examined

It was found that efficiency of photocatalytic disinfection process in hybrid reactor depends on type of photocatalyst and process parameters e.g. photocatalyst concentration, frequency of RMF and duration of the process. Commercially available photocatalyst activated under LED/Vis light and RMF had demonstrated low-level disinfection against *Escherichia coli* and *Staphylococcus epidermidis* bacteria in water. The highest disinfection efficiency was achieved using 5.0CuHomoP25 activated under LED/Vis and RMF of frequency 50 Hz.

The proposed mechanism of bacterial cell death during the RMF-assisted photocatalytic process begins with loss of cell wall integrity trigger by reactive oxygen species (mainly •OH).The flowing of cytosol occurs and that cause a disruption of homeostasis. The rotating magnetic field increases the speed of this process and the movement of ions.

The new patented hybrid photocatalytic reactor, equipped with an rotating magnetic field generator and LED/Vis light sources, represents an innovative solution for water disinfection.

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