THE EFFECT OF PEROXYMONO- AND PEROXYDISULFATE IONS ON THE PHOTOCATALYTIC EFFICIENCY OF ZNO

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One of the urgent problems in water treatment is the effective removal of non-biodegradable and biologically active trace pollutants. The application of advanced oxidation processes (AOP) as an additive method is suitable for the effective removal of most organic pollutants from biologically treated wastewater. One of the promising AOPs is heterogeneous photocatalysis, based on the excitation of a semiconductor photocatalyst. The photogenerated charges (hole (h^+_{vb}) and electron (e^-_{cb})) can initiate oxidation and reduction of various materials on the surface. The oxidation of organic pollutants requires an effective e^-_{cb} capture to hinder the fast recombination of photogenerated charges. During complex, multi-step processes, radicals are formed, which contribute to the transformation and mineralization of organic materials. The combination of heterogeneous photocatalysis with an oxidizing agent, such as H_2O_2, and persulfate ions (peroxymonosulfate (HSO_5^-, PMS) and peroxydisulfate ($S_2O_4^{2-}$, PDS)) can result in enhanced efficiency due to the formation $^{\bullet}OH$ and $SO_4^{\bullet-}$.

In this work, we studied the ZnO/PMS, and ZnO/PDS systems and compared them to the ZnO/H_2O_2 process. Suspensions were irradiated with LEDs having an emission maximum of 365 nm. Trimethoprim (TRIM) antibiotic, hydroquinone (HQ), and nitrobenzene (NB) were used as target substances to test the efficiency and investigate the contribution of various radicals to the transformation. Both PMS and PDS greatly increased the photocatalytic efficiency of ZnO. In the presence of PMS and PDS, dissolved oxygen was not required for the degradation of the organic substances, proving the excellent electron acceptance properties of persulfate ions. The effect of radical scavengers proved that besides $SO_4^{\bullet-}$, the $^{\bullet}OH$ formation was also enhanced, and its contribution to the transformation was significant. The photocatalytic activity of ZnO did not change during 3 consecutive cycles, even in the presence of persulfate ions.

The effect of biologically treated communal wastewater (BTWW) as a matrix, containing large amounts of Cl^- (3.4×10^{-3} M) and HCO_3^- (8.6×10^{-3} M) was also studied. Inorganic ions can heavily influence the surface properties of the photocatalyst, and processes that occur on the surface. Moreover, they react with $^{\bullet}OH$ and $SO_4^{\bullet-}$ and change the radical set. Their effects on the transformation rate of TRIM and PDS were studied. The co-presence of the organic substances, inorganic ions, and dissolved oxygen results in a competition that occurs between various substances for adsorption sites and photogenerated charge carriers. Besides radical scavenging processes, this is also responsible for the change in the radical set and, in this way, the photocatalytic efficiency.

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