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ABSTRACT

SYNTHESIS AND APPLICATION OF NANOCOMPOSITES Fe_2O_3 – HALLOYSITE AND TiO_2 – HALLOYSITE FOR PHOTOCATALYTIC DEGRADATION OF ANILINE AND ITS CHLORINE DERIVATIVES IN WATER

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Aniline and its chlorine derivatives are used in many industry, including as substrates for the pesticides and herbicides production. Organic nitrogen compounds accumulate in the environment and show high toxicity to living organisms. One of the methods of removing these compounds from the environment, apart from adsorption processes, photolysis or biodegradation, is heterogeneous photocatalysis. The process of heterogeneous photocatalysis is influenced by the parameters of the experiment and the parameters characterizing the photocatalyst used. A higher degree of removal of harmful compounds from the aquatic environment is achieved by using the photocatalyst deposited in the form of nanoparticles on a carrier. This prevents the phenomenon of agglomeration of the photocatalyst particles, which reduces the efficiency of the entire process. Carriers of photocatalysts can be, among others, clay minerals, characterized by low toxicity and easy modification of their surface.

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The subject of this work was the synthesis and application of TiO_2-halloysite and Fe_2O_3-halloysite nanocomposites as photocatalysts in the processes of photocatalytic degradation of aniline, 2-chloroaniline and 2,6-dichloroaniline from water.

Halloysite - a mineral from the group of aluminosilicates - was used as the photocatalyst carrier. It has been shown that acid activation of halloysite removes mineral impurities and produces a carrier with a homogeneous structure and composition. As a result of activation, the specific surface area and the diameter of the nanotubes increase. Activated halloysite has a high specific surface area and is a good adsorbent for aniline and its chlorine derivatives. The physicochemical properties of the obtained nanocomposites were investigated by analyzing the porous structure by the low-temperature nitrogen adsorption method, surface analysis by infrared absorption spectroscopy, X-ray analysis with wavelength dispersion, X-ray powder diffraction and analysis of the surface structure by photoelectron spectroscopy, and measurements by transmission and scanning electron microscopy.

The best parameters of the photocatalytic degradation of the tested compounds were adjusted. The kinetics of the photocatalytic process was investigated using the Langmuir-Hinshelwood kinetic model, considering the adsorption element describing the adsorption on multiple active sites without adsorbate dissociation. Commercial photocatalysts and the obtained halloysite photocatalysts were used in the studies. Higher reaction rate constants were obtained for the photogedegradation of the tested compounds using halloysite photocatalysts compared to commercial photocatalysts. This confirms the high photocatalytic activity of the obtained nanocomposites.

The possible routes of degradation of the tested compounds were determined and the final products of photocatalytic degradation of aniline and its chlorine derivatives were determined by of capillary electrophoresis method.

The synthesized nanocomposites on a halloysite support can be successfully used as photocatalysts in the processes of photocatalytic degradation of the tested compounds.

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