Abstract

The main aim of this study was to determine the applicability of the prototype pilot photocatalytic installation for water purification from organic pollutants. In the proposed configuration the advantages of three Advanced Oxidation Processes: TiO_2 photocatalysis, photolysis and ozonation were utilized. The reactor of this type is novel in Poland and one of the first such solutions in the world.

In the first part of the study a suspension of the photocatalyst Aeroxide® TiO_2 P25 and the model solution of phenol were used. The influence of the process parameters (concentration of the photocatalyst, radiation intensity, temperature, flow rate) on the removal efficiency of water contaminants was examined. It was shown that the UV light intensity should be 384 W/m^2 and the flow of the medium to be purified should be set at ~ 11.5 m^3/h. The concentration of TiO_2 P25 photocatalyst, guaranteeing high degradation efficiency was found to be 1 g/dm^3. Furthermore, no significant effect of temperature on the decomposition and mineralization of phenol in the range of 15-35°C was observed.

In the next part of the study, the three methods of immobilization of the photocatalyst on a solid support were studied. The immobilization was carried out in order to enable the degradation of pollutants without the need for additional step of separation of the purified water from the photocatalyst. The first method of immobilization was based on covering of a steel web with P25 TiO_2 layer by means of a commercial photocatalytic paint. In the second method the TiO_2 was deposited on a glass fiber mat, while in the third one a quartz wool was used as the photocatalyst carrier. The studies have shown that the most effective method was the immobilization of the photocatalyst on the glass fiber mat. Moreover, it was proved that the tested commercial Photospheres-40 should not be used in a photoreactor, in which they can be exposed to a mechanical damage.

Based on the investigations on the degradation of humic acids and the herbicide Roundup a possibility of efficient degradation of organic contaminants of both natural and anthropogenic origin in the discussed installation was revealed. The high efficiency of removal of chlorinated contaminants from groundwater as well as successful final polishing of tap water were also proved.

The results of the study can be treated as guidelines and tips for further development of the technology on an industrial scale.