Photocatalytic Degradation of Organic Pollutants

Gábor Kocsis, Ottó Horváth, Ezsébet Szabó-Bárdos
Department of General and Inorganic Chemistry, Faculty of Engineering, Center for Natural Sciences, University of Pannonia, P.O.Box 1158, 8210 Veszprém, Hungary
Corresponding author e-mail: horvath.otto@mk.uni-pannon.hu

One of the major challenges of environmental protection today is to preserve and improve water quality. Industrial, urban and agricultural effluents contain a wide range of pollutants worldwide, which in many cases are difficult to dispose of by conventional water treatment methods (such as filtration, biodegradation, or chlorination). Wastewaters treated in this way mostly get into living waters, and the natural decomposition of the contaminants in them takes a long period of time, so they can accumulate and even get into drinking waters. Hence, particular attention should be paid to the removal of bioactive contaminants. A common feature of Advanced Oxidation Processes is the use of highly reactive agents such as O_3, $^{\bullet}OH$, $H^{\bullet}$, $HO_2^{\bullet}$ for the decomposition of harmful organic compounds. The processes are usually based on reactions that can be carried out under mild conditions. During these processes, organic impurities can be degraded into carbon dioxide, water and mineral salts, i.e. they can be mineralized.

In our work, we investigated the degradability of various bioactive contaminants of differents types – carbamazepine as a drug, Topas 100 EC and Karate Zeon as pesticides – by heterogeneous photocatalysis using UV and visible light. Generally, these compounds (or the active ingredients of the pesticides) are difficult to remove by bacterial and enzymatic methods, or just very slowly. The efficiencies of the photocatalytic processes were studied under different experimental conditions. Degussa P25 TiO_2 and nitrogen-doped titanium dioxide (N-TiO_2) prepared by sol-gel method were used as catalysts. The degradation processes were monitored by liquid chromatographic analysis of the reaction mixtures, measurements of their pH values and organic carbon contents, and recording of the spectral changes.

The contaminants in the suspensions containing Degussa P25 TiO_2 were mineralized upon UV irradiation. When N-TiO_2 and visible light were applied, the efficiency of the degradation process was significantly lower.

The results of these photocatalytic experiments provided useful pieces of information for development of hybrid systems based on the combination of this method with other advanced oxidation procedures such as non-thermal plasma (NTP) process.

This work was supported by the Széchenyi 2020 program of the Hungarian Ministry for Innovation and Technology under the GINOP-2.3.2-15-2016-00016 project and by the National Research, Development and Innovation Office of Hungary in the frame of bilateral Hungarian-French S&T Cooperation Program (project code 2019-2.1.11-TÉT-2019-00033).