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dedicated to the memory of Academician A.N. Terenin (1896–1967)

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BOOK OF ABSTRACTS

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Influence of UV radiation on the photodegradation of phenol derivatives

A.A. Fedorova, I.V. Sokolova*

National Research Tomsk State University, Russia

** sokolova@phys.tsu.ru*

Phenol and its derivatives constitute an important class of water pollutants because of their stability and solubility in water. There are many conventional methods to destroy phenols, but each method has its shortcomings. Chemical oxidation methods are expensive and lead to the contamination of water with other toxic pollutants. The biodegradation can only be used for dilute wastewater. A study of transformations of stable toxic compounds in nature and a choice of optimal methods of utilization are important problems of environmental protection and rational use of natural resources. Ultraviolet (UV) radiation with quantum energy comparable to the energy of a chemical bond is the unique tool for initiating and performing many physical and chemical processes on the surface and in the volume of various media. UV radiation can be used not only for disinfection of water and air, that is, for removal of pathogenic microorganisms, but also for decomposition of complex organic compounds. This method can be used both independently and in combination with other technologies. In this regard, a study of the efficiency of new UV radiation sources that may influence various electronically excited states of organic molecules becomes relevant. Such sources are exciplex lamps that are increasingly used for toxicant photolysis.

The influence of UV radiation on the spectral properties of 2-amino-4-methylphenol and 4-cyanophenol in water solutions has been studied. The unique pulsed lamp on working KrCl molecules with the parameters $\lambda_{rad} \sim 222$ nm, $\Delta\lambda = 5–10$ nm, $W_{peak} = 18$ mW/cm^2, $f = 200$ kHz, and pulse duration of 1 μs developed at the Institute of High Current Electronics of the Siberian Branch of the Russian Academy of Sciences, Tomsk [1] was used as the UV radiation source. The choice of the source for irradiation was caused by the fact that radiation with $\lambda = 222$ nm is absorbed by high-lying electronically excited states of the examined molecules. From these states, the photodissociative states, participating in the reaction of bond breaking, can be populated. It was established that the process of phototransformation of compounds occurred faster when the concentration decreased. The use of the flow-through photoreactor [2] leads to a more effective degradation of the examined compounds than irradiation in the stationary conditions. The substitution of a hydrogen atom in the ortho-position of the NH_2 group in the 4-methylphenol molecule leads to an increase in the efficiency of photodecomposition. The degree of photodegradation depended on the exposure time. The method of ecotoxicant photodegradation with application of UV radiation sources can be used both independently and in combination with other modern technologies. Among the complex methods, technologies based on combined oxidizing processes [3] or advanced oxidation processes (AOP) are most promising.

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References

[1] A. M. Boichenko, M. I. Lomaev, A. N. Panchenko, et al., The Ultraviolet and Vacuum Ultraviolet Excilamps: Physics, Technology and Applications [in Russian], 2011, STT, Tomsk, Russia, 512 p.

[2] N. O. Vershinin, I. V. Sokolova, and O. N. Tchaikovskaya, J. Appl. Spectrosc., **80**, 600–603 (2013).

[3] T. Oppenländer, Photochemical Purification of Water and Advanced Oxidation Processes (AOPs): Principles, Reaction Mechanisms, Reactor Concepts, 2003, Wiley-VCH Verlag GmbH KGaA, Weinheim.