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APPLICATION OF METAL OXIDE NANOPARTICLES FOR PHOTO-CATALYTIC TREATMENT OF WATER ENVIRONMENT

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Various types of nanoparticles active in photochemical processes, the most important of them being oxides of Ti, Zn, Ni, Re, Zr, etc. have been successfully tested and applied in the water environments treatment, in view to provide the decomposition or even complete demineralization of toxic persistent pollutants, especially or organic nature, as well as to destroy the pathogenic bacteria and other microorganisms detrimental for human health.

The destruction of the aforementioned toxic components in water, under the photocatalytic treatment, is connected with the formation of a series of active radicals, especially formed under the UV-irradiation with the wavelength of 100-400 nm, penetrating through the quartz walls of the reactor. The suspended nanooxide particles acting as photocatalysis promote the production of active free radicals with high oxidative capacity. Under their impact, the destruction of molecules structures of both the organic pollutants and pathogen microflora in water cells occurs, Thus, in the classical case of TiO_2, under the UV-irradiation on the fine dispersive surface of particles the charge separation proceeds, due to the formation of positive holes (h^+) and free electrons (e^-), according to the scheme: $TiO_2 + h\nu \rightarrow e^- + h^+$, which, in their turn, promote the formation of superoxide-radical: $e^- + O_2 \rightarrow \bullet O_2^-$ with subsequent process: $TiO_2 (h^+) + H_2O_{ads} \rightarrow TiO_2 + \bullet H_{ads} + H^+$. Generally, the photocatalytic activity of metal oxides is ensured by generation of two radical types: $\bullet O_2^-$ radicals formed by the reduction of O_2, and $\bullet OH^-$ radicals resulted from oxidation of OH^- anions. Both radicals react with the pollutants and toxicants to degrade or transform them, with the obtaining of non-toxic or less harmful products. After the chemical transformations of the reactants, the chemical composition of catalyst is regenerated.

In case of sunlight action, another series of photochemical reactions will occur, also providing the detoxification of polluted water systems. Thus, as a result of water radiolysis under the IR-irradiation with the wavelength 700-3000 nm and higher, mainly the short-living hydroxide-radicals ($\bullet OH^-$) are formed having even higher reactivity as compared to the longer-living superoxide-radicals. Therefore, a metal oxide can be activated either with the UV-irradiation, visible light or combination of them both, accompanied with the photoexcitation of electrons transferred from the valence band to the conduction band, creating the electron-hole pair capable to rapidly oxidize or reduce a polluting substance in water absorbed on the photocatalyst's surface.

Although titanium dioxide was among the first particles that have demonstrated the high photocatalytic efficiency in treatment processes, the other metal oxides (including the mixed oxides, or even more complex structures) with light adsorption properties and proper electronic structure with charge transporting ability, thus producing the electron-hole pairs, have also been tested showing good results, among them: ZnO_2, SnO, CeO_2, Cr_2O_3, V_2O_5, etc. The detoxified water can be used for the technological needs, whereas the filtered metal oxide particles, following the washing and drying, can be repeatedly applied in the similar treatment processes.

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