

Removal of pharmaceuticals from waste water using titanium dioxide nanoparticles

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Abstract: Water is extremely essential for the survival of life upon this planet. Ecological systems cannot thrive without water as all are dependent on it in one or the other way. To maintain the proper health of ecosystems & ensure supply of safe drinking water, it is essential to treat raw polluted water [1].

Residual pharmaceuticals are regarded among the emerging environmental contaminants in water. Worldwide they have been detected in the natural aquatic environment in small concentrations in ng L⁻¹ and µg L⁻¹ concentration ranges [2-4]. The presence of pharmaceutical residues has also been detected due to unused medications disposed off improperly in the sewage systems. Dumping left over pharmaceuticals into wastes and then to landfills, causes their ultimate leaching into the water streams [5]. These compounds have been found in diverse water sources like drinking water, surface water and sewage effluent. These pharmaceuticals persist in the environment due to their ability to escape the degradation by natural physical processes being used traditionally till date.

About such 2,300 toxic, non-biodegradable and bio accumulative ingredients of pharmaceuticals have been reported in human medicines [6]. Lack of knowledge about the potential hazards of pharmaceutical compounds and their metabolites on human and aquatic organisms is a matter of concern at the global level [7].

For efficient removal of these pharmaceuticals, novel methods of treating water need to be developed and used in tertiary treatment processes. Advanced oxidation processes (AOP) is one of such processes [8] which involves; ultraviolet (UV) irradiation alone [9], combining UV irradiation with hydrogen peroxide [10] and incorporating hydrogen peroxide with Fe²⁺ ions (photo-Fenton) increasing the efficiency of HO· radical generation. AOP generates hydroxyl (HO·) radicals as an effective oxidizing agent for treating the pollutant. Recently, heterogeneous photocatalysts such as titanium dioxide (TiO₂) has been used to generate HO· radicals [11]. TiO₂ is a potential photocatalyst owing to its versatile photochemical properties when used as a semiconductor.

This review discusses the use of TiO₂ mediated photocatalytic degradation of some prominent pharmaceuticals in aqueous solution. The study is important as presence of even minute amounts of pharmaceuticals can't be allowed in drinking water, which may otherwise lead to various complications in humans and other forms of life. The degradation rates of pharmaceuticals using different parameters like nature of radiation, type and amount of TiO₂ loading, pharmaceutical concentration, presence of electron acceptors, treatment time, pH and production of intermediates is also discussed.

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