ABSTRACT

Organochlorine pesticides are highly persistent and the most emerging endocrine disrupting chemicals in the environment. In this study, several emerging advanced oxidation processes (AOPs), i.e., gamma ionizing radiation, sulfate radical based-AOPs, and non-metal doped TiO_2 photocatalysis were investigated for the degradation of lindane in water. The effects of water quality and process parameters, such as solution pH, initial concentration of pollutant, initial concentration of oxidant and/or catalyst etc. were also studied. All of the studied AOPs showed high efficiency and ultimately led to complete degradation of lindane. The degradation of lindane by the studied AOPs followed *pseudo-first* order kinetics. The degradation efficiency of lindane changed with solution pH, and the highest efficiency was achieved at a neutral pH. The presence of natural organic matter and/or inorganic ions in solution significantly affected the lindane degradation, based on the competition of these constituents with lindane for the reactive radicals. The results were discussed in terms of reactivity of hydroxyl radical ($^{\bullet}OH$), sulfate radical ($SO_4^{\bullet-}$) and hydrated electron (e_{aq}^-) with lindane. The rate constants for these fast reactions were also determined using competition kinetics. The hydrated electron played a significant role, as suggested from its higher second-order rate constant of 1.26×10^{10} M^{-1} s^{-1}. Based on the detected by-products via GC-MS analysis, a plausible reaction mechanism was proposed for gamma radiation induced degradation of lindane.

Degradation pathways for UV activated peroxymonosulfate (i.e. UV/PMS) induced degradation of lindane were also investigated, suggesting dechlorination, chlorination, dehydrogenation and hydroxylation via $^{\bullet}OH$ and/or $SO_4^{\bullet-}$ attack.

Photocatalytic degradation of lindane was also investigated, especially using long wavelength light sources. Lindane was successfully degraded by sulfur-doped titanium dioxide (S-TiO_2) photocatalysis under visible and solar light. The outcome of this study will provide useful scientific information on the effectiveness of gamma radiations, S-TiO_2 photocatalysis, and various sulfate radical based-AOPs on the degradation of organic compounds, especially for organochlorine pesticides in water that are difficult to degrade.

Keywords: Lindane; Gamma radiations, Advance Oxidation Processes (AOPs); UV/Peroxymonosulfate; S-TiO_2 photocatalysis; Rate constants; Water treatment.

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