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Investigation of Fumaric Acid Radiolysis Using Gamma Irradiation

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Abstract : Widely used organic products in the pharmaceutical industry have been detected in environmental systems, essentially carboxylic acids. In this purpose, the degradation efficiency of these contaminants was evaluated using an advanced oxidation process (AOP), namely ionization process as an alternative to conventional water treatment technologies. This process permitted the generation of radical reactions to directly degrade organic pollutants in wastewater. In fact, gamma irradiation of aqueous solutions produces several reactive radicals, essentially hydroxyl radical (OH), to destroy recalcitrant pollutants. Different concentrations of aqueous solutions of Fumaric acid (FA) were considered in this study (0.1-1 mmol/L), which were treated by irradiation doses from 1 to 15 kGy with 6.1 kGy/h rate by ionizing system in pilot scale (^{60}Co irradiator). Variations of main parameters influencing degradation efficiency versus absorbed doses were released in the aim to optimize total mineralization of considered pollutants. Preliminary degradation pathway until complete mineralization into CO_2 has been suggested based on detection of residual degradation derivatives using different techniques, namely high performance liquid chromatography (HPLC) and electron paramagnetic resonance spectroscopy (EPR). Results revealed total destruction of treated compound, which improve the efficiency of this process in water remediation. We investigated the reactivity of hydroxyl radicals generated by irradiation on dicarboxylic acid (FA) in aqueous solutions, leading to its degradation into other smaller molecules. In fact, gamma irradiation of FA leads to the formation of hydroxylated intermediates such as hydroxycarbonyl radical which were identified by EPR spectroscopy. Finally, pilot plant irradiation facilities improved the applicability of radiation technology on large scale.

Keywords : AOP, radiolysis, fumaric acid, gamma irradiation, hydroxyl radical, EPR, HPLC
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