Advanced oxidation process based on water radiolysis to degrade and mineralize diclofenac in aqueous solutions

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Abstract

Residual pharmaceutical compounds (PCs) are among the emerging organic contaminants detected in our water cycle. Diclofenac (Dic) is one of the commonly detected pharmaceutical contaminant in aquatic systems. This study was designed to investigate the degradation and mineralization of Dic in aqueous solutions by ionizing radiation emitted from radioactive Co60 under several conditions. Ultra-performance liquid chromatography, ion chromatography and TOC measurements confirmed the radiolytic degradation of Dic. The absorbed doses needed to degrade 99% Dic at 25, 50, 100, 190, 280, and 480 µM were 0.560, 0.950, 1.950, 4.000, 5.400, and 7.400 kGy, respectively. This process follows pseudo-first-order kinetics. The γ-ray/N_2O system decreased the dose required to degrade 99% to 1.47 kGy. The presence of bromide anions inhibits degradation. Remarkably, adding H_2O_2, $S_2O_8^{2-}$, or N_2O promotes mineralization. Conversely, the absence of dissolved oxygen hinders mineralization. This study provides a viable finding that ionizing radiation are useful tolls to remedy water containing pharmaceutical organic compounds.

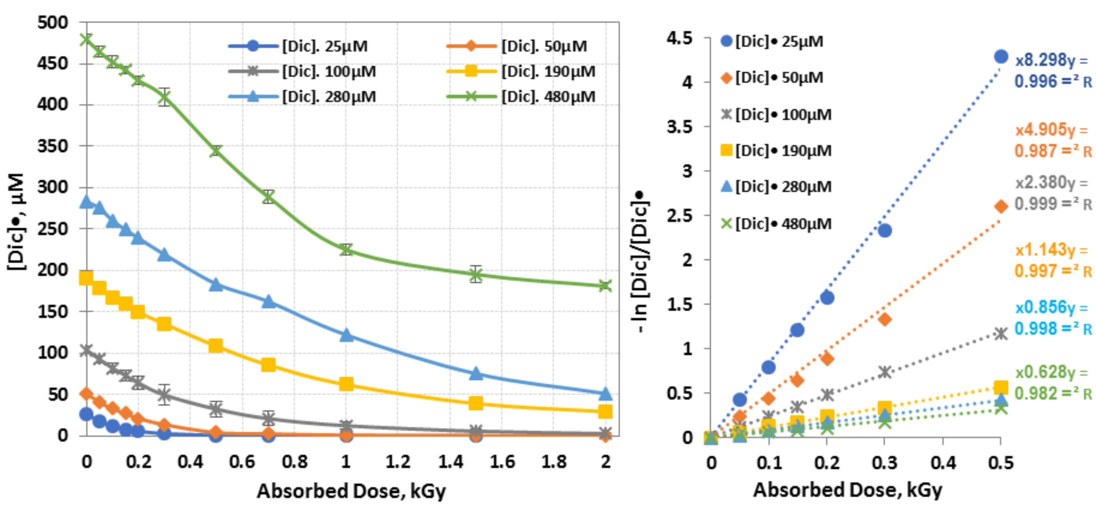

Figure 1. Radiolytic decomposition curves of different concentrations of Dic in ultrapure water and graph of -ln[Dic]/[Dic] versus absorbed doses (kGy). Conditions: pH ≈ 6.1, $[O_2]$ ≈ 7.7 mg/L.

A significant decrease in the different Dic concentrations (25, 50, 100, 190, 280, and 480 µM) with the increasing absorbed dose. This decrease is due to the $^{\bullet}OH$ radicals that formed during water radiolysis caused by the irradiation emitted from the source (Co-60). As shown in Fig. 1

(right), the radiolysis of different Dic concentrations appears to be proportional to the absorbed dose with a linear relationship ($R^2 \geq 0.98$).

References

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