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Enhancement of 2-chlorophenol Photocatalytic Degradation in the Presence Co^{2+} -doped ZnO Nanoparticles under Direct Solar Radiation

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Abstract: The performance of Co^{2+}-doped ZnO nanoparticles, prepared using the sol–gel method, for 2-chlorophenol degradation under direct solar radiation was investigated. Various parameters were investigated during the degradation process, namely solar intensity, Co^{2+} ion concentration, loading concentrations of Co^{2+}-doped ZnO, and pH. The photocatalytic degradation efficiency increased when the initial concentration of 2-chlorophenol decreased; the optimum concentration was 50mg/L under similar experimental conditions. Moreover, optimum values, established on a sunny day, were 0.75 wt% of Co^{2+}, 1g/L loading concentration, and a pH of 6.0, respectively. The highest degradation efficiency observed was 95%, after only 90min of solar light irradiation. The mechanism of visible photocatalytic degradation using Co^{2+}-doped ZnO was explained as a strong electronic interaction between Co^{2+}, Co^{3+} and ZnO, and a promotion in the charge separation, which enhanced the degradation performance. The fragmentation of 2-chlorophenol under the optimal conditions was investigated using HPLC, comparing standards of all intermediate compounds. The pathway of the fragmentation was proposed as involving hydroxyhydroquinone, catechol, and phenol formation, which were then converted to non-toxic compounds such as oxalic acid and acetic acid with further decomposition to CO_2 and H_2O.

Keywords:
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