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Abstract

Zinc Oxide Nanoparticles for the Decontamination of Chemical Warfare Nerve Agents and Blister Agents †

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Abstract: International standards and environmental regulations require the development of new decontamination solutions for hazardous chemicals of military interest (chemical warfare agents) and industrial chemicals (pesticides, insecticides, etc.). It is necessary for them to be more efficient, with a higher decontamination speed and less waste generation. Metal oxide nanoparticles (NPs) have been intensively studied and have shown promising results in various industries (alimentary [1], medicine [2,3], pharmaceutical [4,5] and microbiology [6,7]). Metal oxide NPs offer promising outcomes—such as small particle size, high specific surface area, and unique physicochemical properties—which allow them to both adsorb and degrade toxic compounds due to their catalytic activity [8–10]. The paper presents the influence of zinc oxide nanoparticles, embedded in an internally developed amino-alcoholic decontamination solution, on the decontamination efficiency of chemical warfare nerve and blister agents. In this paper, we aimed to evaluate, using gas chromatography–mass spectrometry/electron impact, the decontamination efficiency of ZnO NPs embedded in the organic decontamination solution. The decontamination efficiency was evaluated against two toxic compounds: sulfur mustard (HD) and soman (GD). Several solutions with different concentrations of ZnO NPs (0.1–2%) were tested and compared with the reference decontamination solutions. The decontamination efficiency was evaluated using GC-MS/EI analysis at 2, 10, and 30 min, and 1, 3, 5 and 24 h. The decontamination product formation was observed and quantified throughout the process. The decontamination procedures were caried out at 25 °C with magnetic stirring. The presence of ZnO NPs in the organic decontamination solution showed better decontamination efficiency, which increased along with the concentration of NPs added, at a concentration interval of 0.1–1%. The solution with 2% ZnO NPs showed a decrease in the decontamination efficiency in the cases of both HD and GD.

Keywords: decontamination; ZnO nanoparticles; chemical warfare agents; GC-MS

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