SOIL LEACHABILITY OF SILVER NANOPARTICLES USING A COLUMN METHOD

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Abstract: Information is limited concerning engineered nanomaterial waste management even as the use of nanomaterials in commercial applications such as anti-odor socks and washing machines continues to grow. There is the potential for nanomaterials to be released into the soil environment through atmospheric deposition, direct application, and accidental spills. Furthermore, many products containing nanomaterials, as well as waste streams from nanomaterial and product manufacturing, will be disposed in traditional landfills, resulting in aging and possible leaching into surrounding soil where these materials can come into contact with soil organisms. The aim of this study was to perform a series of soil column studies to analyze the leachate from engineered nano-Ag, micrometer (µm)-sized Ag, and a polyvinylpyrrolidone (PVP)-coated nano-Ag of sizes 35 nm, 1.5-2.5 µm, and 20 nm, respectively, to determine the Ag particle migration through soil due to size and/or coatings. Uncontaminated field soil was spiked with Ag at concentrations of 0.01 and 100 mg/kg. Samples were collected every hour for 48 hours. Leachate samples were subjected to metal analysis by inductively coupled plasma-mass spectrometry. The analysis revealed that nano- and bulk Ag were not mobilized through the soil when leached with ultra-pure water; however, soil mobility did increase over the two-day study period when leached with a 1% nitric acid solution. In 100 mg/kg spiked soils, it took approximately 11 h for Ag concentrations to increase in soil leachates above baseline levels for both nano and bulk Ag columns. Bulk Ag peaked at 20 h, and then quickly decreased to non-detectable levels by 48 h. Nano Ag leachate also peaked at approximately 20 h, but at a notable 40% decreased concentration compared to bulk-Ag, then more slowly reduced to 0 mg/l by 48 h. Overall, the nano-Ag soil leached less total Ag compared to bulk-Ag soil. In 0.01 mg/kg spiked soils, Ag concentrations increased above baseline at ~12 h in both columns. The peak Ag leachate concentration for both bulk-Ag and nano-Ag columns was at 16 h. When compared to the bulk-Ag soil, less Ag is leached out of the nano-Ag soil. These experiments will provide fundamental insight into remediation strategies to target environmental release and removal of nanomaterials in the environment ultimately protecting consumers, the warfighter, and the environment.

Key words: Engineered nanomaterials, silver, column, leaching, waste management

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