Ceramic Water Filters Impregnated with Silver Nanoparticles for the Removal of Lead and Chromium Ions from Water

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Abstract

The high cost and complexity of existing techniques used to remove heavy metal ions from water have necessitated developing and implementing cost-effective and socially acceptable options that can be applied at the household level. This work examined the ability of ceramic water filters impregnated with silver nanoparticles to remove Lead and Chromium ions from water. Ceramic water filters were fabricated using locally sourced materials to filter water samples spiked with known concentrations of Lead and Chromium ions. The filters were categorized into two categories; without silver nanoparticles (control filters) and filters impregnated with silver nanoparticles using two application methods; dip-soak method and paint-method. The study assessed the effects of the addition of silver nanoparticles, application method of silver nanoparticles, initial water temperature, and initial metal ion concentration on the performance of the different sets of filters. It was observed that the addition of silver nanoparticles improved the ability of ceramic water filters to remove Lead and Chromium ions from water. The relative amounts of Lead and Chromium ions removed in the dip-soaked filters were higher (12.58% and 15.43%) than in the control filters (5.64% and 7.40%). The study also showed that the application method of silver nanoparticles influenced the ability of the filters to remove Lead and Chromium ions. The adsorption of Lead was higher in the Paint-method filter (14.45%) compared to the Dip-Soaked filter (12.58%), whereas the adsorption of Chromium was higher in the Dip-Soaked filter (15.43%) than in the Paint-Method filter (14.22%). The effect of initial water temperature, over the range of 24 °C to 84 °C, was insignificant since the cumulative percentage for the three sets of filters was less than 1%. Further, the initial metal ion concentration had a significant impact on the adsorption capacities of the ceramic water filters. In the control filters (without AgNPs), the relative amounts of Lead and Chromium ions removed decreased with an increase in initial metal ion concentration. However, for the Dip-soaked and Paint-method filters, the relative amounts increase with an initial increase in initial metal ion concentration up to a saturation point (0.6g/l), after which it decreases. Surface morphology studied using a Scanning electron Microscope (SEM) showed an excellent surface binding between the clay particles and silver nanoparticles. Therefore, ceramic water filters impregnated with silver nanoparticles offer a practical, low-cost, and socially acceptable alternative for removing heavy metal ions from water at the household level.

Keywords: Adsorption; ceramic water filters; chromium; heavy metal ions; lead; silver nanoparticles