

Elimination of inorganic mercury from waste waters using crandallite-type compounds

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Abstract: The removal of inorganic mercury from waste water streams arising from mines, using an artificial amorphous compound of the crandallite type synthesized in our laboratory, $\text{Ca}_{0.5}\text{Sr}_{0.5}\text{Al}_3(\text{OH})_6(\text{HPO}_4)(\text{PO}_4)$, has been investigated. This compound exhibits an extremely wide range of ionic substitutions: Ca^{2+} and Sr^{2+} were interchanged with Hg^{2+} , so the mercury content of the waste water, ranging from 70 to 90 ppm, was reduced to less than 0.1 ppm. The process has been studied under batch conditions. The crandallite showed a high capacity for the exchange of mercury from mercuric nitrate solutions, 1.555 meq g^{-1} . The ion-exchange equilibrium isotherms for Hg^{2+} were correlated by the Langmuir equation. The recovery of mercury from Hg-crandallite using HCl solutions and thermal treatment was also studied. Optimum recuperation of mercury is achieved by chemical reaction with HCl solution (pH 2.25). At these conditions, 75% of the mercury is recovered as the HgCl_4^{2-} complex in a simple batch process, and the crandallite (in the protonic form) can be reused.

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Keywords: mercury; ion exchange; crandallite; waste waters

NOTATION

C	Concentration of mercury in solution at any given time (meq dm^{-3})
C_0	Initial concentration of inorganic mercury in the liquid phase (meq dm^{-3})
C_∞	Concentration of mercury in solution at the end of the experiment (meq dm^{-3})
C^*	Equilibrium concentration of inorganic mercury in the liquid phase (meq dm^{-3})
d_{pw}	Mean solid wet diameter (cm)
D_{eff}	Intraparticle effective diffusivity ($\text{cm}^2 \text{ s}^{-1}$)
F	Fractional uptake of mercury
K_{T}	Equilibrium constant
n^*	Solid phase equilibrium concentration of mercury (meq g^{-1} dry solid)
n^∞	Maximum asymptotic solid-phase solute concentration (meq g^{-1} dry solid)
t	Time from the beginning of the experiment (s)
V	Volume of solution (dm^3)
W	Weight of dry solid (g)

1 INTRODUCTION

Over the years mercury has been recognized as having serious impacts both on human health and the environment. This recognition has led to numerous studies that deal with the properties of various forms of mercury, the development of methods to quantify and speciate the forms, fate and transport, toxicology studies, and the improvement of site remediation and decontamination technologies.

Different forms of mercury may exist at a contaminated site, and these compounds may also be transformed from one species to another under certain environmental conditions. Decontamination for different forms of mercury may require several techniques. Because of its high vapour pressure, metallic mercury disperses relatively quickly into the atmosphere and, with suitable air movement, is taken up by plants and animals. Therefore, from the viewpoints of environmental chemistry, geochemistry, marine biology, and limnology, it is important to establish a rapid, simple, sensitive and accurate method for the removal of this element from contaminated waters.

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