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Lead in Residential Water Heaters: An Analysis of Lead Dissolution Kinetics in Non-Ideal Aquatic Environments

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ABSTRACT

Lead dioxide, a lead corrosion product, is an important contributor to residential drinking water contamination. A neurotoxin and endocrine disruptor, lead poses serious human health concerns. Despite previous research on water distribution pipes, lead in water heating and softening systems is unexplored. Standard tank water heaters and water softeners have significantly different aquatic environments compared to distribution pipes, due to increased temperature and ion concentration levels. This research verifies the iodometric method for lead dioxide detection and quantifies total lead and dissolved lead(IV) ions over time in simulated water heater and softener environments. Initial experiments confirmed the iodometric method for lead(IV) and measured absorbance with UV-spectrometry. Another set of experiments quantified the dissolved lead(IV) cation in a filtered lead-water mixture by applying the iodometric method to batch reactors, and varying water source (DI, synthetic tap water), temperature (25, 55°C), and NaCl concentration (0.175, 0.584 g/L). Furthermore, each sample was analyzed by ICP-OES to determine the concentration of elemental lead present. The iodometric method resulted in an 80% recovery of dosed lead over one hour. Dissolved lead(IV) ion, conversely, had very little recovery after a week in each batch reactor. Overall, the iodometric method is an accurate and rapid tool for quantifying and comparing dissolution kinetics of total lead dioxide. In contrast, at the temperatures and ionic strength levels investigated, lead(IV) cations may exist in such low concentrations that iodometry may not be an accurate detection method. Future research should consider additional lead species for complete lead dissolution models of water heating and softening systems.

KEYWORDS

Iodometric method, UV-spectrometry, dissolution rates, solid phase extraction, total lead, inductively coupled plasma optic emission spectrometry (*ICP-OES*)