Design and Performance Analysis of Low-Cost Lead Filtration Systems

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Lead toxicity is an important environmental issue and a major global challenge, particularly in developing countries where water contamination can pose serious health risks. Heavy metals contaminate drinking water through pipe corrosion. Long-term exposure to such harmful elements can cause damage to many parts of the body, including nervous system defects, increased risks of cancer, and lower cognitive function. While commercial filtration systems do exist, they are often too expensive for widespread use, especially in low- and middle-income countries. This project expands upon the findings of previous experimentation, showcasing effective methods of lead filtration. These methods were further investigated and engineered into an accessible filtration component designed for use in standard water systems. The prototype filters were required to maintain a production cost under $10 for affordability while effectively filtering at least 97% of heavy metal solutions to be considered functional. They were also designed to withstand standard water pressure (40 psi-80 psi) and operate without the need for thermal or electrical energy. Iron solutions of 100 mg/l were made to replace previously tested lead solutions. Each prototype underwent ten trials using 1.0 gallon (3.79 liters) of iron solution per test before measuring iron concentrations to assess performance. Experimental results indicate that the constructed ion exchange filter holds the strongest potential to effectively filter heavy metals while maintaining affordable production costs, successfully reducing iron concentrations to nearly 0 mg/L. These findings offer a potential solution to addressing global public health issues and improving access to clean water.

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