Sustainable Animal Bone Filtration for the Design of Water Treatment Devices for Resource-Limited Regions

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There remains to be a purely natural, comprehensive water purification method that can remove both pathogens and heavy metals and is capable of implementation in resource-limited settings. This study proposes the first pure left-over animal bone water filtration devices that can be replicated in under-resourced areas using only readily-available materials and without chemicals. Three major left-over animal bones, cow, lamb, and pig, were ground into three sizes of bone powder particles and arranged into a quad-layered filtration unit in order to balance the filter's contaminant removal performance with filter efficiency. The filters successfully achieved log removal values (LRVs) of > 2 log for Legionella, > 2 log for E. coli, > 1.5 log for lead, and > 1.7 log for cadmium. The filtered water surpassed the WHO's standard for lead and cadmium in drinking water, while also surpassing the US FDA requirement for lead and cadmium in bottled water. Additionally, turbidity and microplastics were also removed. Mechanism analysis experiments suggested that heavy metal removal is primarily due to chemisorption, specifically ion exchange with animal bone chemical components and heavy metal ions, while bacteria removal is likely primarily due to physical blocking in the bone powder. Filter hydraulics study indicated a non-linear, second-order polynomial relation between the amount of filtered water as a function of time. To apply this method into real-world application, three user-centric prototype filters were then fabricated and proven successful through field implementation. This study presents a new approach for nearly-zero-cost, scalable filtration systems tailored towards underserved regions, with broader implications for sustainable infrastructure models worldwide.

Awards Won:

First Award of $6,000

Ricoh USA, Inc: Ricoh Sustainable Development Award of $10,000