



Removal of Pb²⁺ Ions from Consuming Water Using a Fabricated Water Filter for Home Use



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INTRODUCTION

Lead contamination in water is one of the worldwide concerned environmental problems. For example, lead leaking from pipe corrosion and solder has been found contaminated in consuming water in many U.S. areas. The uncontrolled release of effluents containing lead from various industries has also caused lead-contaminated water in Thailand. Exposing to lead-contaminated water can lead to serious symptoms (e.g. headaches, abdominal pain, and seizures) or even death. Therefore, the elimination of lead ions (Pb²⁺) from consuming water is necessary.

In this work, the suitable size ground eggshells, a natural source of calcium carbonate (CaCO₃) and a common household waste, were utilized in conjunction with the fabricated tap water filter for Pb²⁺ removal from consuming water in households.



Experiments and results

Fabrication of a tap water filter

Design the prototype of a tap water filter using Blender program and fabricate it using a 3D printer.

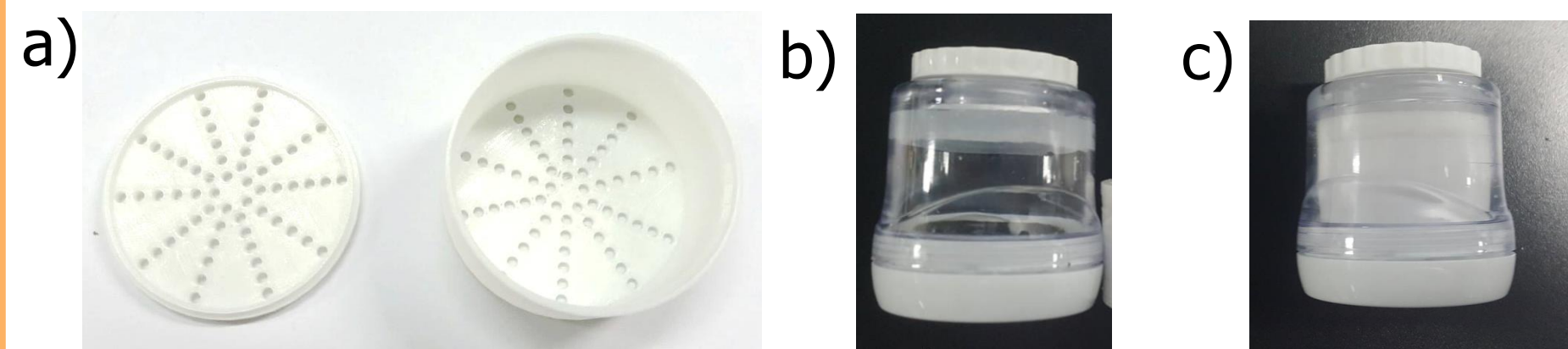
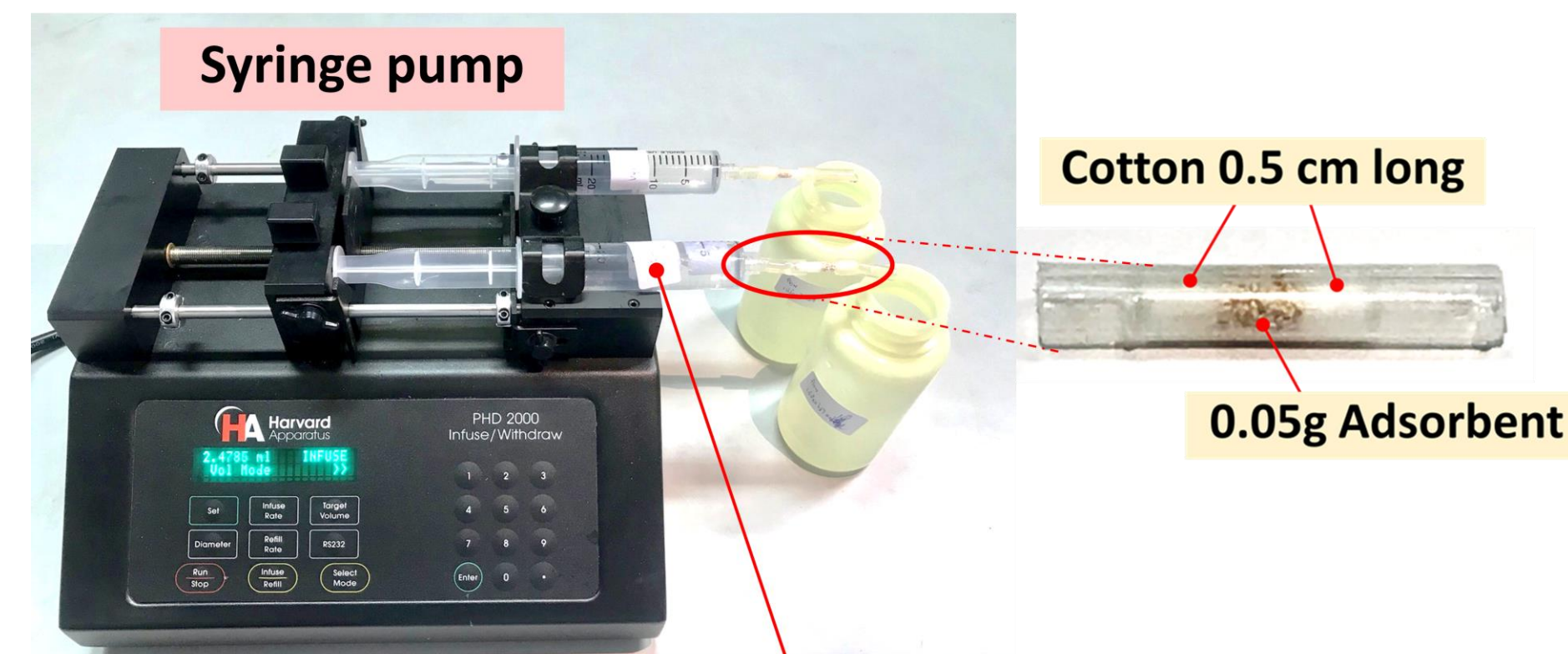


Figure 1. The fabricated tap water filter (a) a lid (left) and an adsorbent container (right), (b) a tap water filter holder and (c) the adsorbent container inside the tap water filter holder.

Effect of adsorbent sizes on Pb²⁺ removal efficiency

1. Flow Pb²⁺ solution through columns packed with 20–63 μm, 63–125 μm or 125–500 μm ground eggshells and collect the eluted solution.
2. Measure Pb²⁺ concentration before and after passing through columns using Atomic Absorption Spectrometer (AAS).

Figure 3. Experimental setup for the study of effect of adsorbent sizes on Pb²⁺ removal efficiency



Flow 100 ppm Pb²⁺ solution at 0.5 mL/min

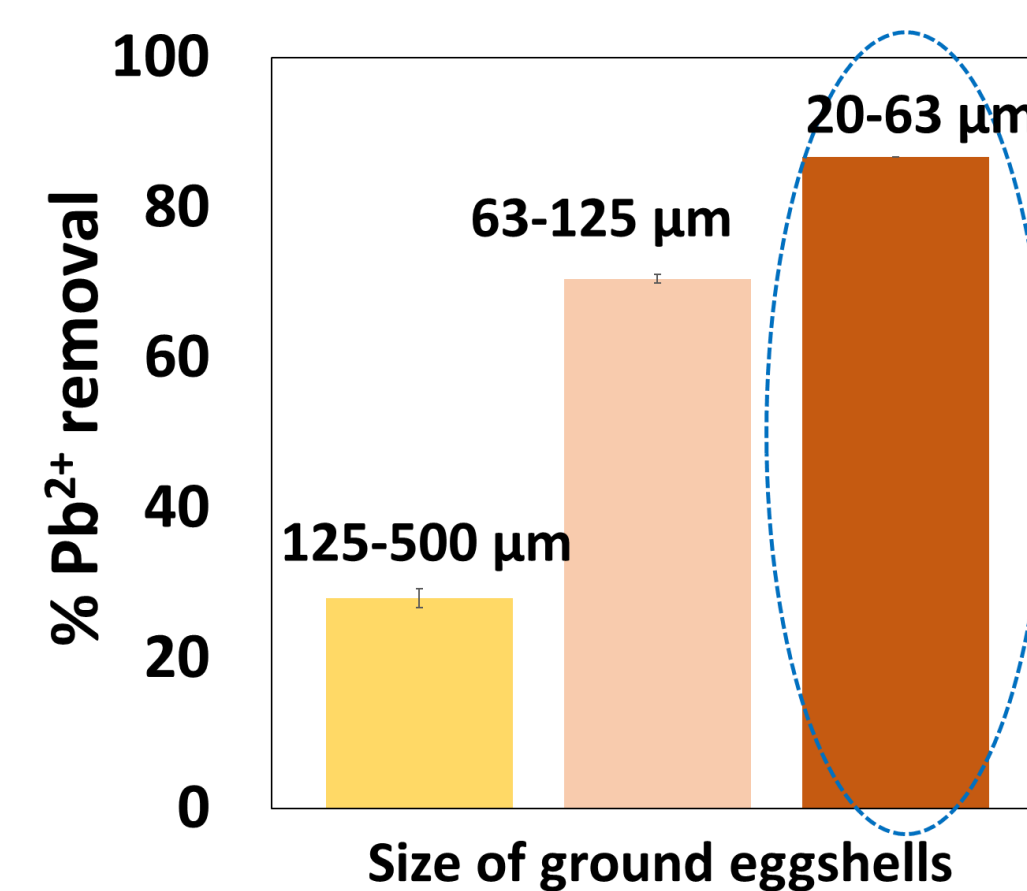


Figure 4. The plot between % Pb²⁺removal and size of ground eggshells. The smaller the size of ground eggshells is, the higher the Pb²⁺removal efficiency is obtained.

Testing the fabricated water filter

Completely fill the fabricated adsorbent container with ground eggshells (~20 g) and assemble all parts of the filter.

Attach the filter to a tap water and measure the outlet flow rate.

The inlet and outlet flow rates were not significantly different.

Pump 50 ppm of Pb²⁺ solution (40 mL/min) through the filter, collect the solution every 10 min and measure the Pb²⁺ concentration using AAS.

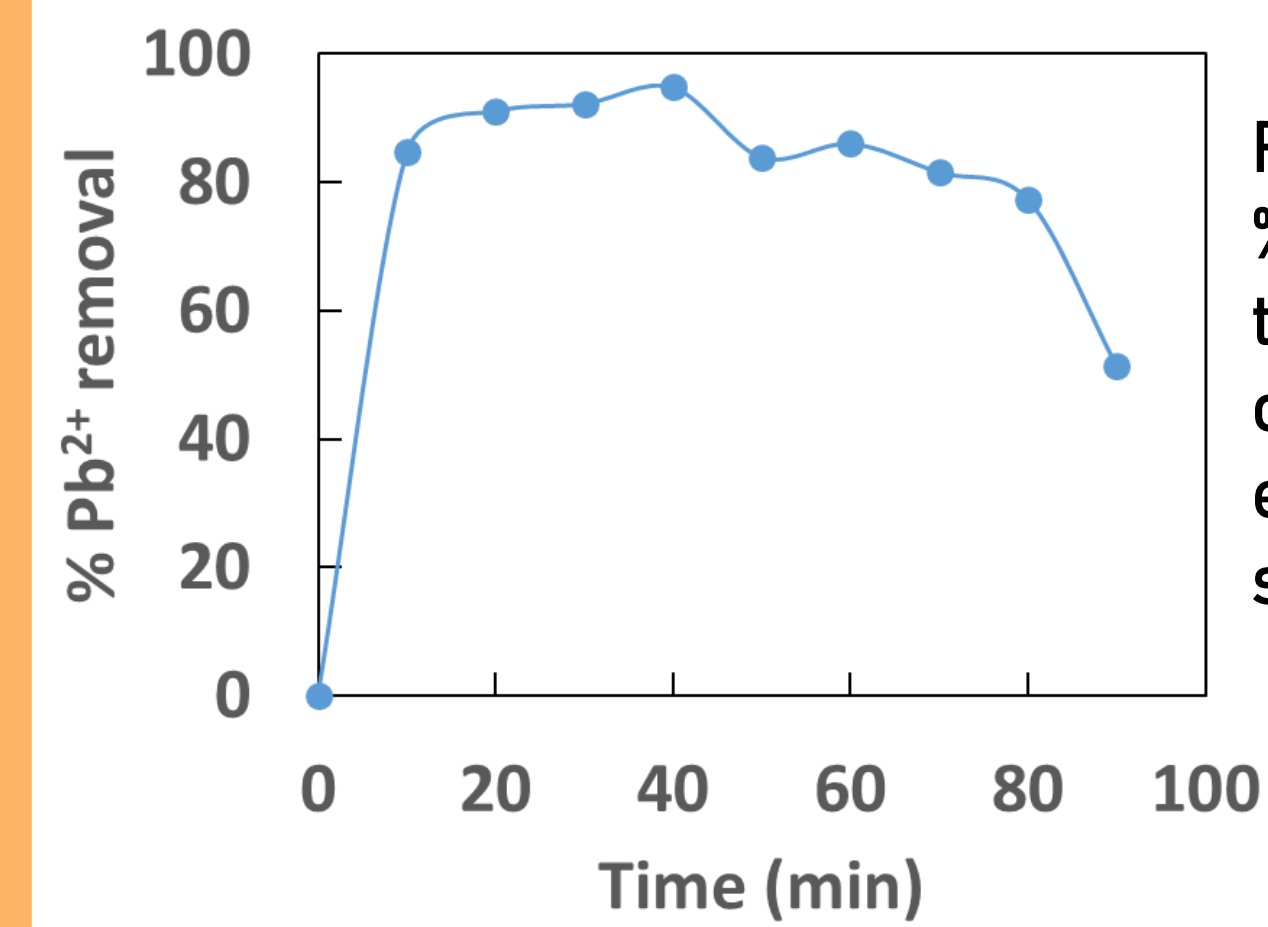


Figure 5. The plot between % Pb²⁺removal and the time the Pb²⁺ solutions were collected. The Pb²⁺removal efficiency decreased significantly after 50 min.

Determining Pb²⁺ adsorption capacity of eggshells

Four batches of 0.2 g of ground eggshells were weighed and were then stirred in 300 mL of 200 ppb Pb²⁺solution for 30, 60, 90 and 120 min. After that the concentration of solutions were measured using AAS.



Pb²⁺adsorption capacity of eggshells 1135 mg/g

Figure 6. Batch experiment for determining Pb²⁺adsorption capacity of eggshells.

Conclusions

- Pros of our fabricated tap water filter....
- Easy to use with taps in households
 - Easily replaced adsorbents
 - Utilize eggshells as cheap and efficient adsorbents for Pb²⁺removal.

How to change eggshells at home? (D.I.Y)

1. Wash eggshells and remove eggshell membranes.
2. Dry eggshells in an oven at 100 °C until dry.
3. Grind eggshells with mortar and pestle.
4. Sieve grinded eggshells through a food strainer and collect eggshells that can pass.
5. Completely fill the filter with eggshells. (~20 g)

Future plan

We will try to investigate the Pb²⁺ adsorption using our device at the same flow rate as the tap water and find the way to eliminate eggshells that we use to adsorb Pb²⁺ solution.

What we learned

This project raised our concern on Pb²⁺ contamination in water in many parts of the world especially in our country, Thailand. This problem made us think how to help people to get access to clean consuming water cheaper and easier. In some day, we hope to be the one who can help this world by our project.

Reference

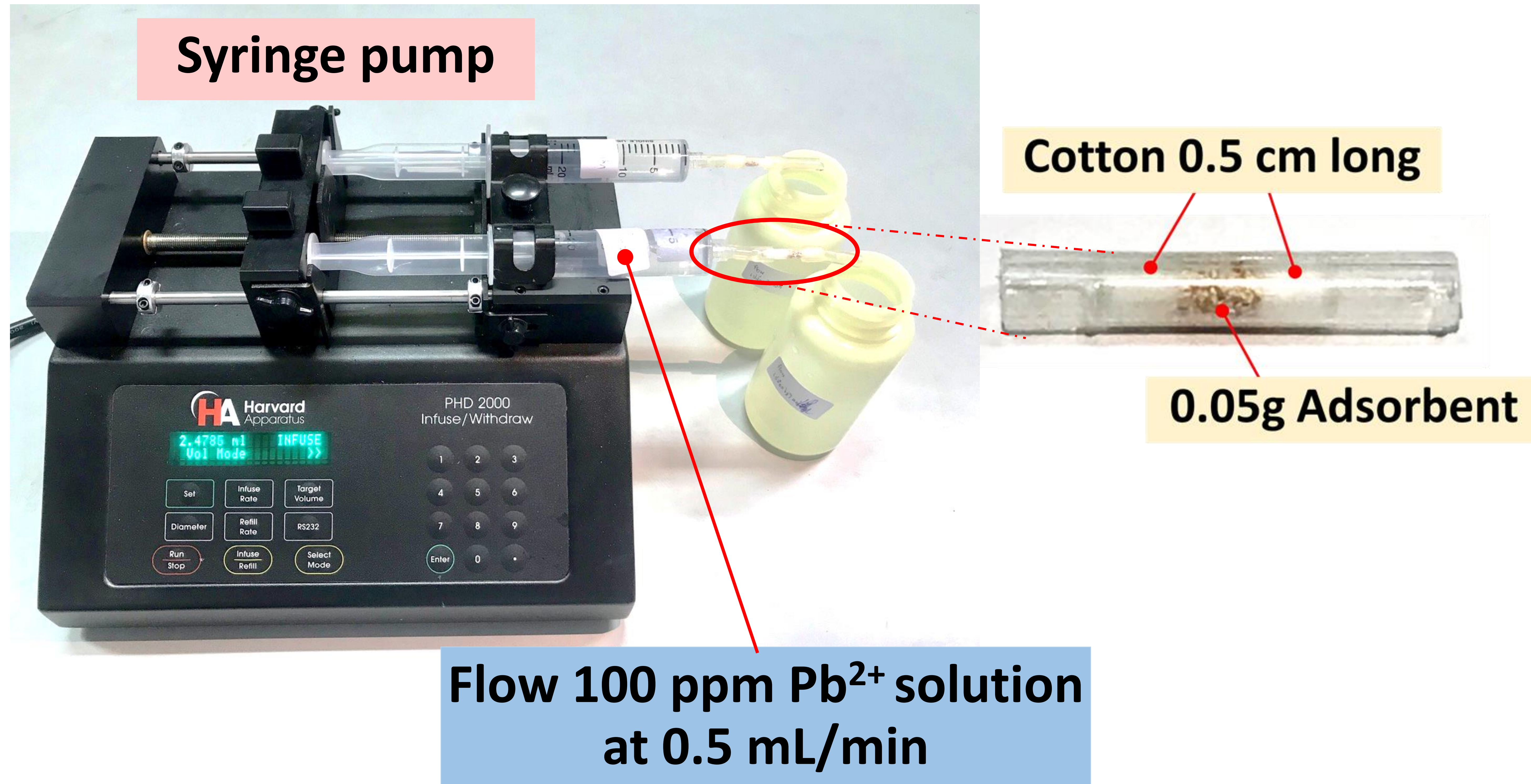
Vijayaraghavan, K., & Joshi, U. M. (2013). Chicken Eggshells Remove Pb (II) Ions from Synthetic Wastewater. *Environmental Engineering Science*, 30 (2), 67-73.

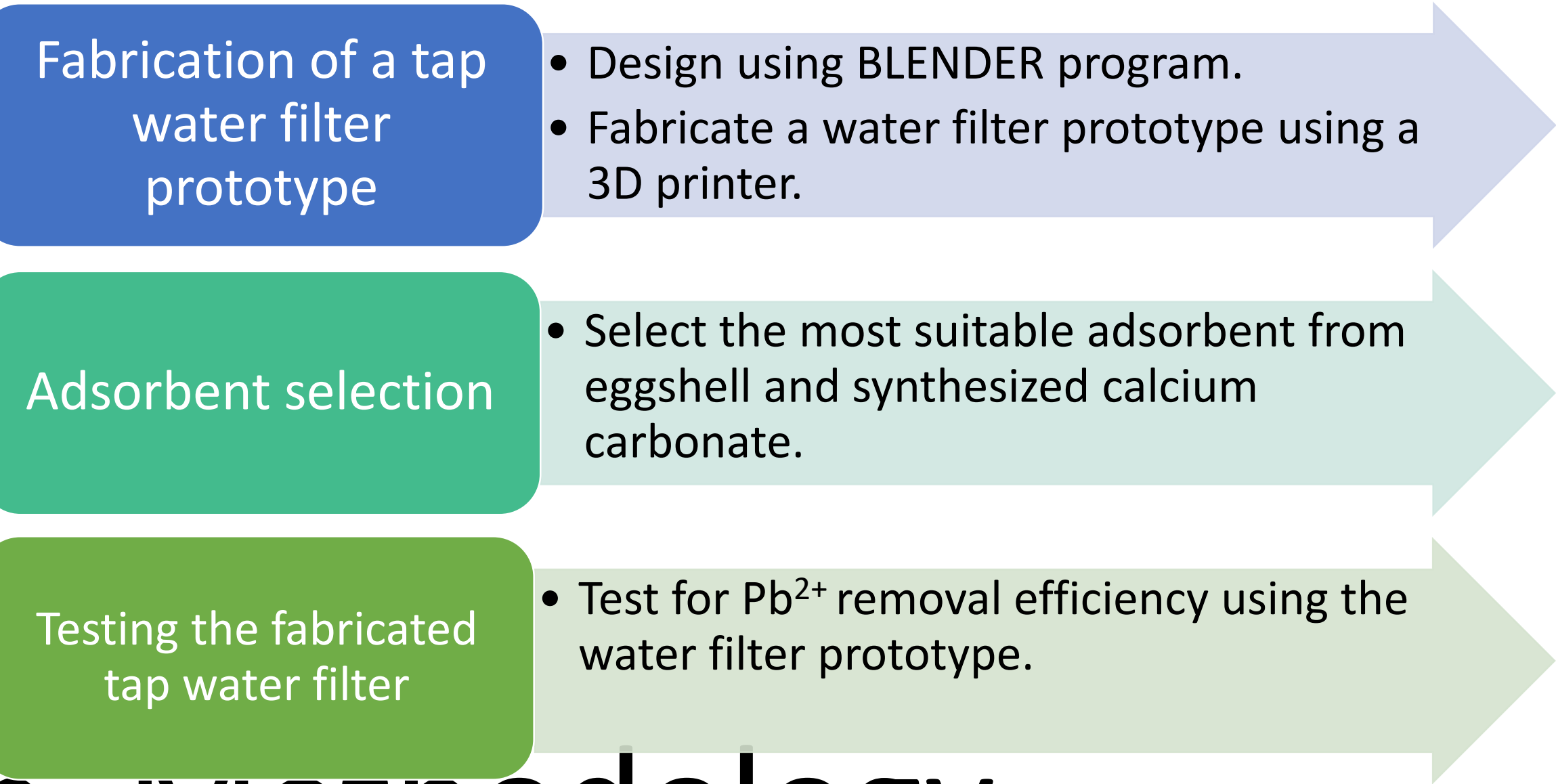
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Test for Pb^{2+} removal efficiency





- Title, Author(s), Introduction/Research Question, Methodology, Results/Conclusions, Acknowledgments, Bibliography of important sources, What I Learned, Future Research

