Cleaning water by using eggshells and eggshell membranes

SGHN106 : Hiroshima Prefectural Hiroshima Senior High School

1. Introduction

Water pollution is a serious problem in developing countries such as Indonesia, India, and Kenya. So, it is necessary to find an easy and inexpensive way to clean water. The water released from factories contains heavy metal ions. One of them is copper (Ⅱ) ions. They cause poisoning if ingested by humans. So, I conducted experiments to remove copper (Ⅱ) ions. The materials I used to remove copper (Ⅱ) ions are eggshells and eggshell membranes. There are numerous holes on the surface of eggshells, and eggshell membranes have a structure in which protein fibers are complexly entangled. So, both eggshells and eggshell membranes are argued to have excellent adsorption abilities and very useful to clean water.

2. Purpose

(Ⅰ) To clarify whether the eggshell or eggshell membrane adsorbs copper (Ⅱ) ions more effectively.
(Ⅱ) To investigate how the adsorption quantity of copper (Ⅱ) ions changes when the surface shape of eggshells and eggshell membranes are changed by heating or crushing.

3. Materials

The way to process eggshells and eggshell membranes


Fig1. Eggshells


Fig2. Eggshell membranes

Table1. The process of preparing eggshells and eggshell membranes samples

Sample name	Part	Drying	Heating	Heating temperature[℃]	Crushing
A	Eggshell	○	×	—	○
B-105	Eggshell	○	○	105	○
B-300	Eggshell	○	○	300	○
B-600	Eggshell	○	○	600	○
B-800	**Eggshell**	○	○	**800**	○
C	Eggshell membrane	○	×	—	○
D-105	Eggshell membrane	○	○	105	○
D-300	Eggshell membrane	○	○	300	○

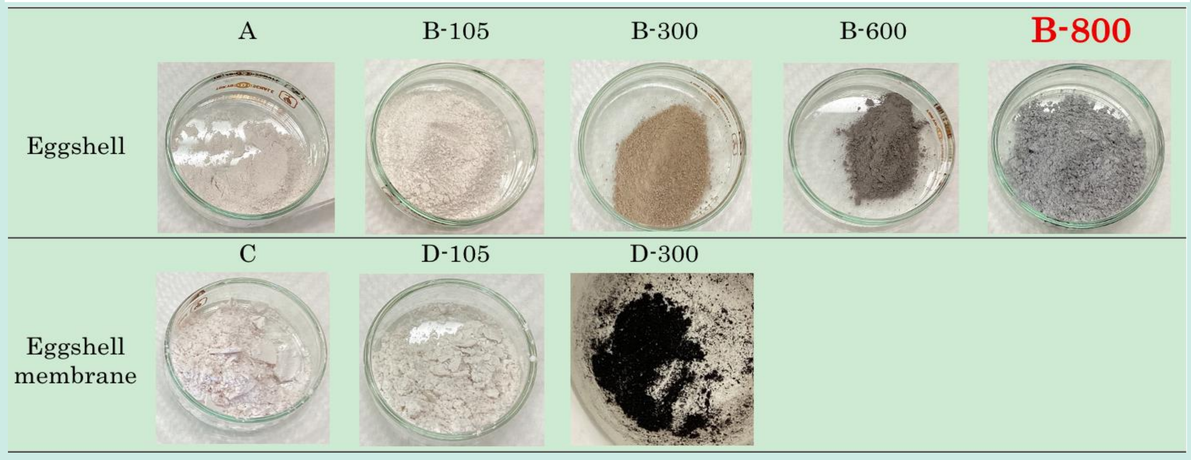
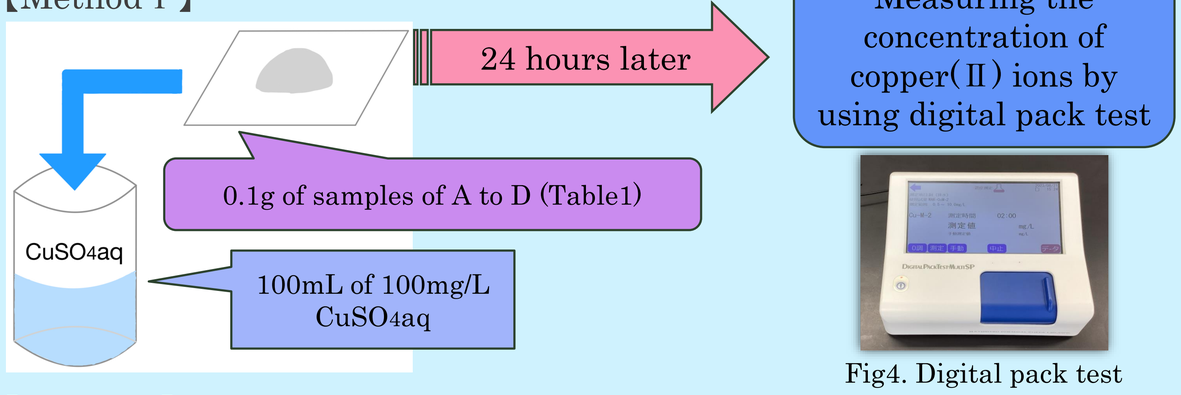


Fig3. Processed eggshells and eggshell membranes

4. Experiment Ⅰ

Comparative experiment on the adsorption quantity of copper (Ⅱ) ions of eggshells and eggshell membranes

【Method Ⅰ】



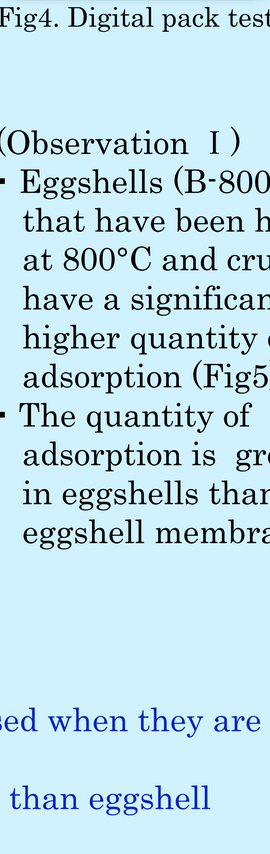
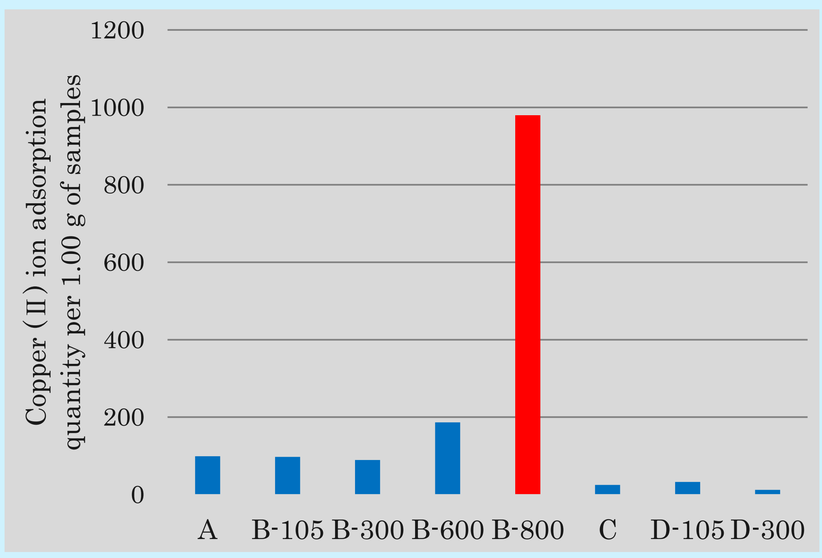


Fig4. Digital pack test

【Result Ⅰ】



(Observation Ⅰ)
- Eggshells (B-800), that have been heated at 800°C and crushed, have a significantly higher quantity of adsorption (Fig5).
- The quantity of adsorption is greater in eggshells than in eggshell membranes.

【Discussion Ⅰ】
- It is argued that the surface area of eggshells is increased when they are heated at 800℃.
- It is argued that eggshells adsorb copper (Ⅱ) ions more than eggshell membranes.

5. Experiment Ⅱ

Comparative experiment on the adsorption speed of copper (Ⅱ) ions of eggshells and eggshell membranes

【Method Ⅱ】

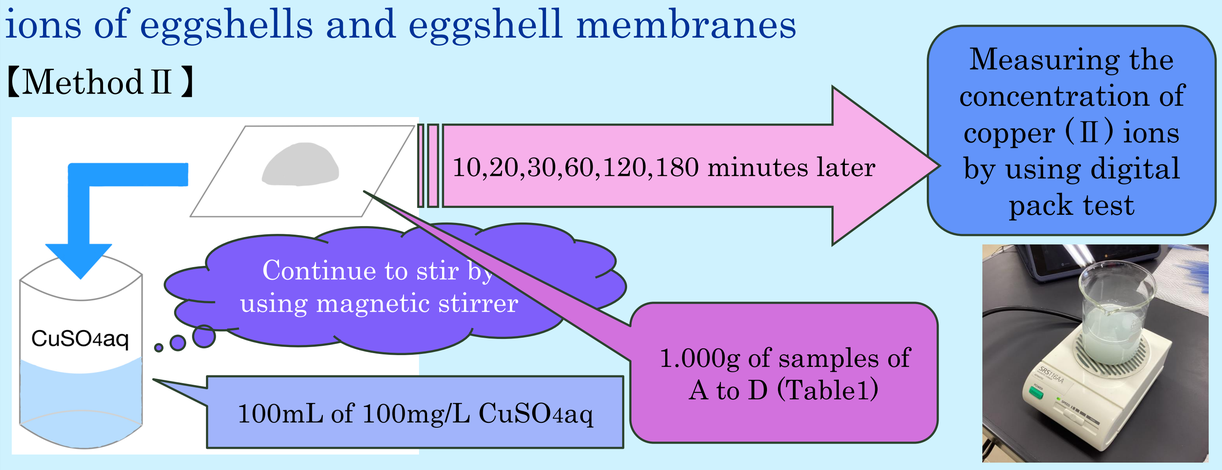


Fig6. Experiment condition

【Result Ⅱ】

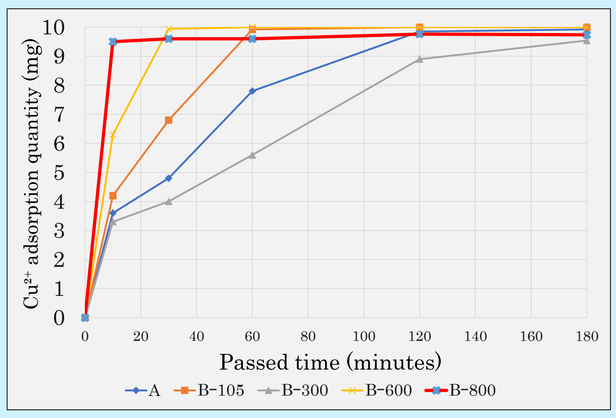


Fig7. Comparison of the adsorption of copper (Ⅱ) ions in eggshells at different heating temperatures

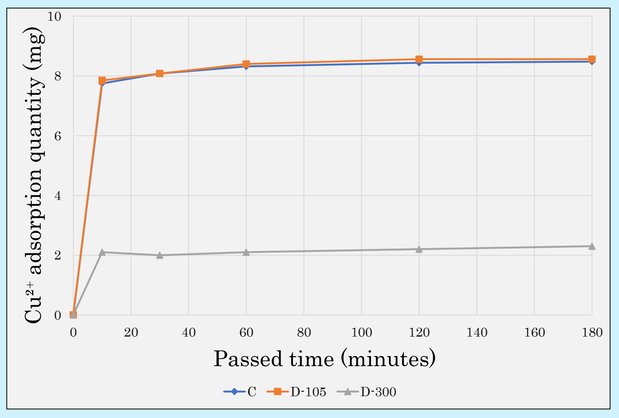


Fig8. Comparison of the adsorption of copper (Ⅱ) ions in eggshell membranes at different heating temperatures

(Observation Ⅱ)
- It is reported that the adsorption speed was faster when eggshells were heated at higher temperatures, except when heated at 300°C (B-300)(Fig7).
- It is reported that the change in adsorption quantity over time for the eggshell membranes which were not heated (C) and the eggshell membranes which were heated at 105℃ (D-105) were almost the same (Fig8).
- The adsorption quantity of eggshell membranes heated at 300℃ (D-300) was smaller than at the other two temperatures.

【Discussion Ⅱ】
- The higher the heating temperature, the larger the surface area, except when heated at 300℃.
- When eggshells were heated at 300°C, the surface area may be reduced.
- It is argued that the physical structure did not change even when eggshell membranes were heated at 105℃.
- When eggshell membranes were heated at 300℃, the physical structure of eggshell membranes was changed and the surface area was decreased.

6. Interview

I gave a presentation about my research to international students at Hiroshima University and asked for their feedback.
What I have learned from the interview :
〈Practicability〉
- Eggs are very expensive in their own countries.

〈Workability〉
- In some countries, people often eat duck eggs.
- Many people in developing countries drink underground water. The composition of this water is different from the water I used in the experiment.

It is necessary to consider the real situations in each developing country.


Fig9. Photos of the discussion and group photo

7. Conclusion

The current research revealed that copper (Ⅱ) ions can be adsorbed by using eggshells and eggshell membranes, and that the adsorbed amount and speed vary greatly depending on the processing conditions.

In the future, I would like to think about how it would be possible to apply my method of cleaning water to developing countries and work on its practical application.

8. References

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[2]Mohamad Rena, Daisuke Yamamoto and Hiroyuki Matsuoka (2012) “Low-concentration copper solution jeopardizes larval movement and ability to survive predation: New insight into malaria eradication via vector control”
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[6]Japan Food Industry Association, HACCP related information database , https://haccp.shokusan.or.jp/haccp/information/chemical_factor/metal/ , (2023.12.2)