

## A Test Comparing the Manganese Removal Capabilities of Pyrolusite, Manganese Greensand, and Manganese Zeolite

### Introduction

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In this experiment, filter media, each coated with pyrolusite, manganese greensand, and manganese zeolite, were tested for their effectiveness in removing manganese from water.

Manganese (Mn) is a water-soluble mineral that will solidify through oxidation. Because it dissolves in low-oxygen water, manganese is often contained in groundwater along with iron. The removal of manganese is generally conducted through sedimentation by oxidation-reduction involving potassium permanganate ( $\text{KMnO}_4$ ) or chlorine ( $\text{Cl}_2$ ).

According to the criteria set by WHO, manganese concentrations in water exceeding 400  $\mu\text{g/L}$  will be toxic to the human body. For drinking water, concentrations exceeding 100  $\mu\text{g/L}$  will lead to a taste and color unsuitable for consumption. Concentrations exceeding 200  $\mu\text{g/L}$  will cause the coating of the filter media to become covered in black sediment.

There are three methods for removing manganese and iron: 1. Catalytic oxidation-reduction by pressurized filters using manganese zeolite, manganese greensand, or birm (sand filtration) as filter media; 2. Oxidation-reduction using a filtration process; or 3. Ion exchange.

In Thailand's manufacturing industry, groundwater is utilized in the manufacturing process, and water purification treatment is required to remove impurities, such as manganese and iron. The most common method used is the catalytic oxidation-reduction process using pressurized filters.

Pyrolusite, one of the testing materials used in this comparative test, is primarily composed of manganese dioxide and can be sourced from northern Thailand. Pyrolusite can be used to coat the surface of filter media to remove manganese and iron from water without the use of other chemicals. However, only a limited number of case studies have been made to verify its effectiveness, which is why the mineral was selected for this test.

Pyrolusite can effectively remove iron, manganese, insecticides, pesticides, and hydrogen sulfide. It can also facilitate the sedimentation of minerals to remove copper, aluminum, antimony, and lead. It is a strong and highly durable filter media that contributes to reducing the use of water treatment chemicals.

Comparisons and verifications were made on the oxidation-reduction performance for manganese removal as well as the re-activation and lifespan of the filter media.

## **Experimental Procedures**

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Methods: Two variations of a pressurized filtration method--with and without the addition of chlorine

A solution was prepared by combining tap water (24 m<sup>3</sup>/day) with a 1.6 mg/L concentration of sodium bisulfite (NaHSO<sub>3</sub>) and a 1 mg/L concentration of manganese sulfate. The solution was filtered using a pyrolusite filter, a manganese zeolite filter, and a manganese greensand filter, with each filter processing an amount of 8 m<sup>3</sup>. Measurements were taken of: 1. Manganese concentration, 2. Chlorine concentration, 3. Flow rate (degree of clogging in filter media), 4. Water clarity, and 5. pH level.

## **Test Results**

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In chlorine-free conditions, pyrolusite was the most effective in removing manganese (2.02g/kg) and maintained its effectiveness for the longest duration (314 hours). Manganese zeolite followed with (0.89g/kg, 73 hours), then followed by manganese greensand (0.62g/kg, 73 hours).

In chlorine-added conditions, comparisons of the manganese removal capabilities showed the same results, with pyrolusite being the best-performing material. However, while its effectiveness remained at 90-99% for the first 24 hours, the rate gradually decreased beyond that point. Pyrolusite was found to regain its performance by backwashing every 24 to 48 hours.

## **Proposal**

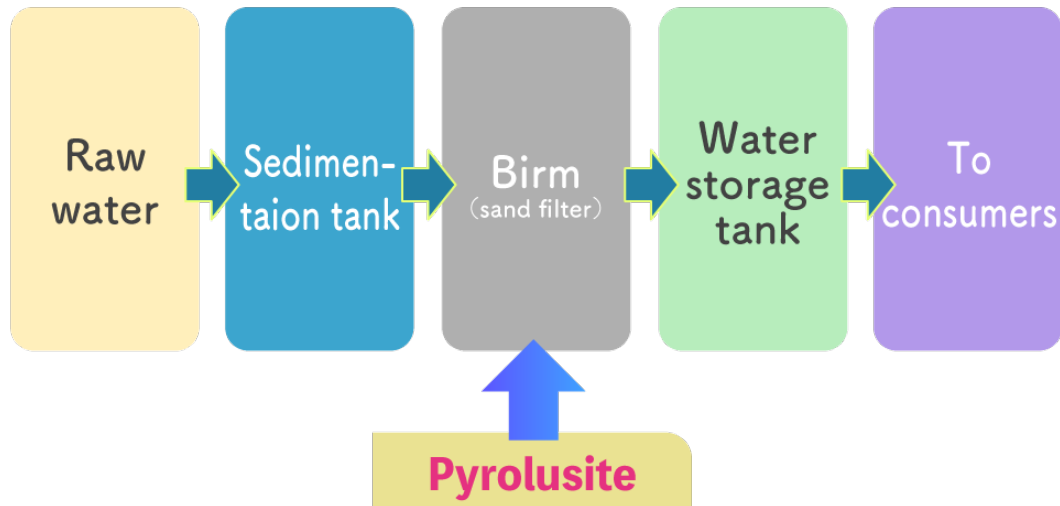
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In chlorine-added conditions: Backwashing every 24 to 48 hours is recommended. Restoring filtration capabilities using potassium permanganate is impractical, considering the cost and labor required.

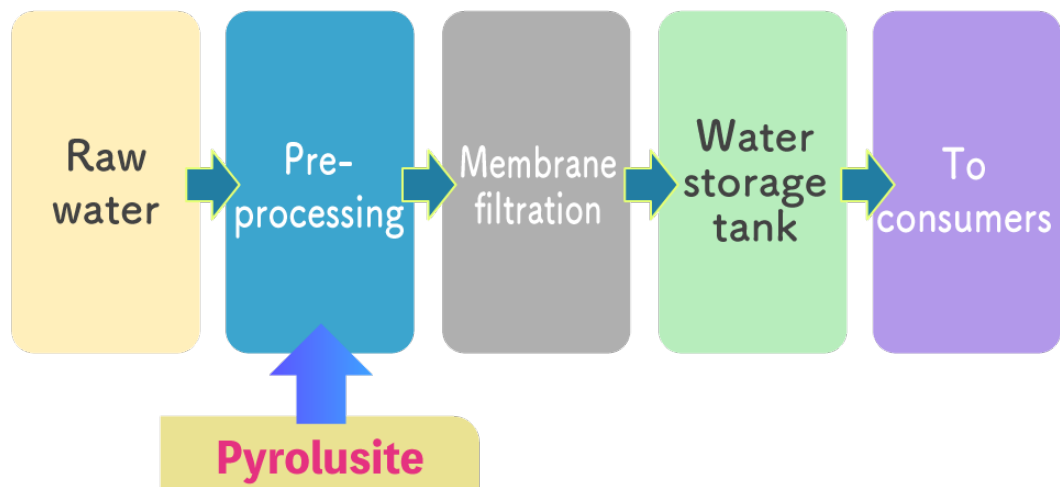
**In chlorine-free conditions: Pyrolusite is the best option.** Filtration capabilities of the filter media can be restored through backwashing every 24 hours.

Tap Water Production Process Using Pyrolusite at Thailand' s Provincial Waterworks Authority and Other Sectors

- General Method



- Membrane Filtration Method



- Pressurized Tank Method

