TITLE

Study on the Effect of Reactor Scale on Hydrogen Generation from Aluminum Powder and Water via Stirring

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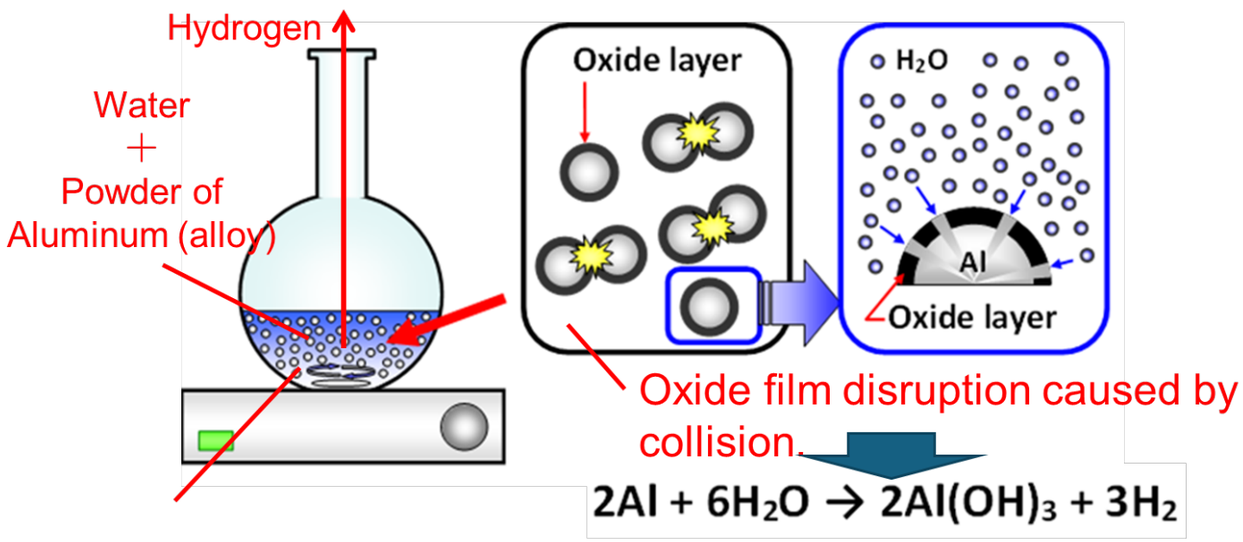
Introduction

Hydrogen is considered a promising solution for mitigating global warming due to its potential to provide CO_2-free power when used in fuel cells and power generation systems. Traditionally, hydrogen production relies heavily on fossil fuel reforming, which emits CO_2. This study investigates an alternative hydrogen generation method by stirring aluminum alloy powder in water. The aluminum alloy powder is derived from waste aluminum, and the process is powered by renewable energy, aiming to combine waste recycling with carbon-neutral hydrogen production. This approach explores the feasibility of establishing a sustainable hydrogen production plant.

Principle



The exact mechanism is not yet understood！

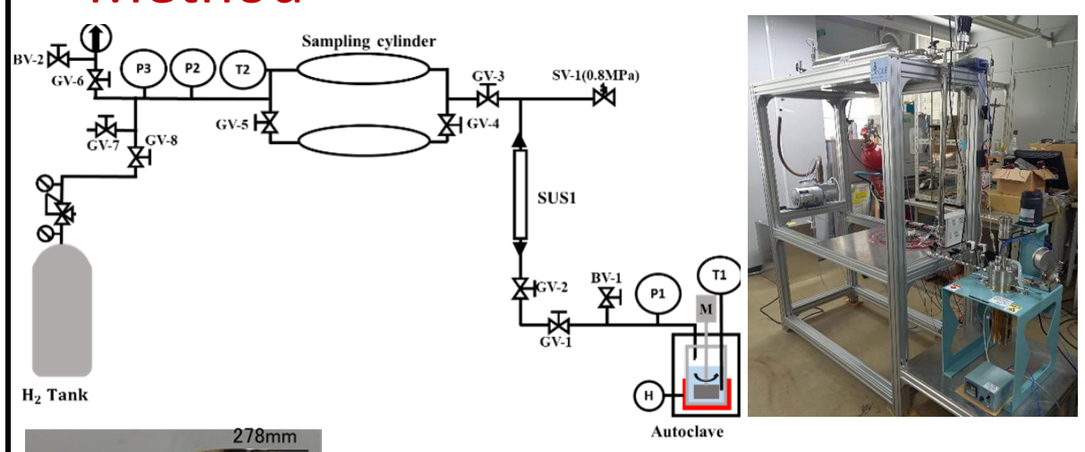
Final target
Realization of a plant for simultaneous valorization of waste and production of CO_2-free hydrogen.

Previous study
Hydrogen production experiments using a 100 mL reactor vessel
Reagent powders used: pure Al powder, Al alloy powder, and recycled Al powder

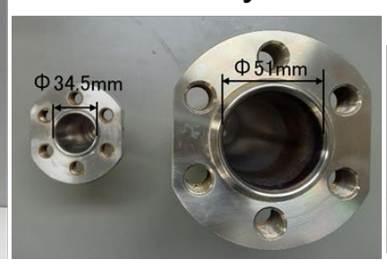
In order to apply this hydrogen production method to a full-scale plant, it is necessary to understand the hydrogen production behavior when scaling up the reactor vessel.

Research objectives
Investigation of scale effects in reactor vessel on hydrogen evolution behavior in Al–water reactions

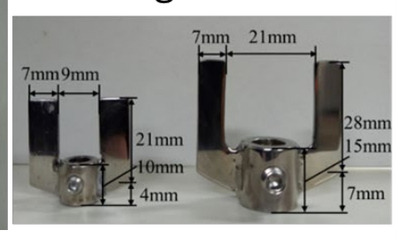
Method



Reaction cylinder

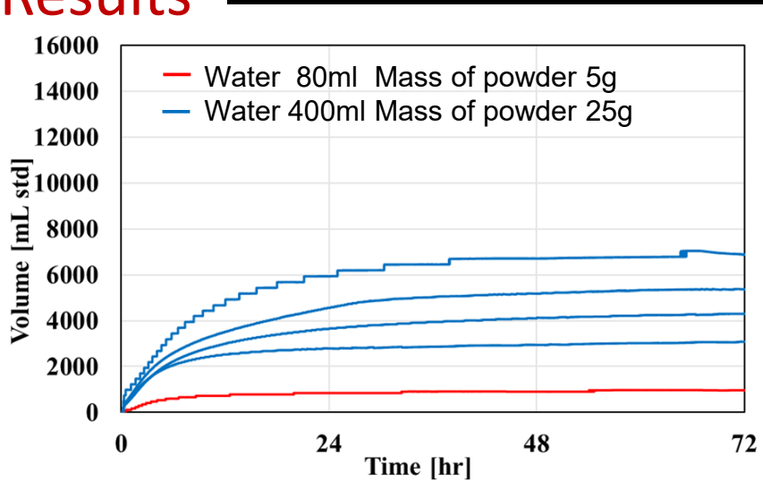


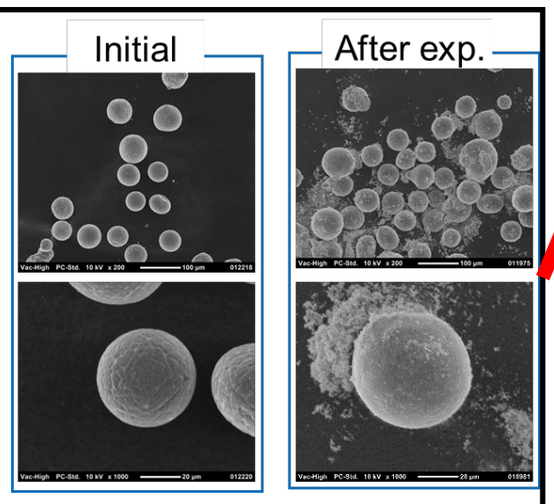
Stirring blade



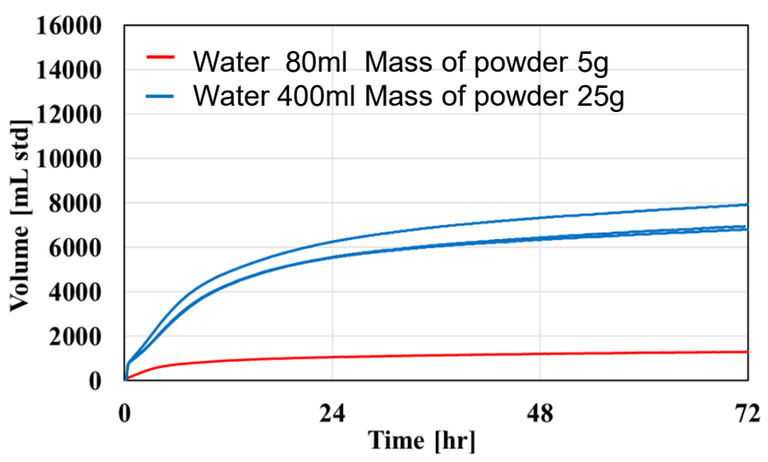
Volume of reactor vessel [ml]	100	500
Volume of pure water [ml]	80	400
Mass of Al powder [g]	5	25
Stirling rotational speed [rpm]	1350	1350
Temperature [˚C]	60	60

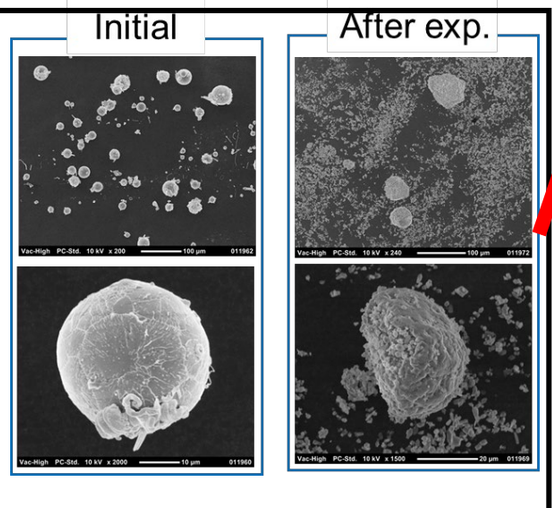
Results





Pure aluminum (size 45-90um, purity 99.7wt%)





Al-50wt%Sn (size <90um)

- The hydrogen generation rate in 400ml water was approximately seven times higher than that in 80ml water.
- Scatter in hydrogen generation rates was observed.

From SEM Image
- Aluminum hydroxide is deposited on the powder surface.
- The spherical shape was maintained.

- The hydrogen generation rate in 400ml water was up to 6.1 times higher than that reported in 80ml water.
- Scatter in hydrogen generation rates was less.

From SEM Image
- - Aluminum hydroxide is deposited on the powder surface.
- - Some particles experienced breakage.

Conclusion

It was demonstrated that the Al–50wt% Sn alloy powder, having the highest Sn content, reliably yields the greatest volume of hydrogen. Moreover, to examine the effect of reactor scaling on hydrogen production, experiments were conducted using 80 mL and 400 mL of distilled water. It was found that the hydrogen yield increased by a factor of 6.1, exceeding the scale ratio.