# Rebuilding the Zeppelin:

Power and Purity of Hydrogen

# Rebuilding the Zeppelin

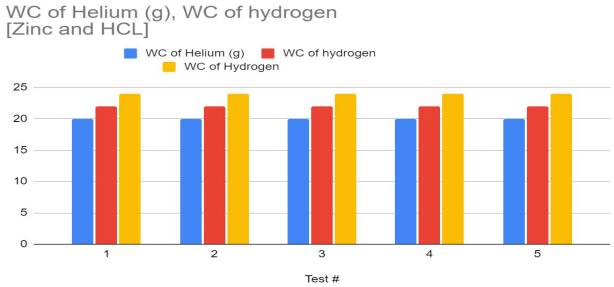
## Research Question

- What is the most practical lighter than air gas to use in an airship?
  Hydrogen gas made from:
  - zinc and sodium hydroxide
  - aluminum and water, or
  Helium

## Methodology

- Made hydrogen gas from:
  - Zinc and Sodium Hydroxide
  - Aluminum and Water
- Filled mylar balloons with each type of hydrogen gas, and one with helium
- Tested the weight lifting capacity of each gas by gradually adding weight to the balloon until it could hold no more weight

## Data Analysis and Results




## Interpretation and Conclusions

- We measured how much each gas could carry, and since we know that the more weight a gas can carry, the lighter it is, and therefore higher in concentration.
- The aluminum-produced hydrogen was the purist and therefore was able to carry the most weight. The zinc produced hydrogen was not as pure as the aluminum but was still able to carry more weight than the helium test.

# Introduction

- The implementation of airships will make a major difference and have a positive impact on the world's modern method for transportation.
- Airships will be able to cheaply move people and goods in a timely manner, and their ability to carry a large amount of weight through the sky is one of its greatest assets.
- The effectiveness of airships greatly depends on how much weight they can carry, so to maximize this strength, the most ideal gas must be produced or used.

# Purpose and Hypothesis

The purpose of this experiment is to determine what lifting gas is most ideal to use for an airship.

We believe that the hydrogen with the highest purity will have the greatest weight-carrying capacity.

# Procedures

I. Balloon 1:
   A. Fill with helium from the tank
   B. Attach hook to the base of the balloon
   C. Add weight until the balloon descends

II. Balloon 2:
   A. Produce hydrogen using zinc and hydrochloric acid
   B. Attach hook to the base of the balloon
   C. Add weight in 1 gram increments until balloon descends

III. Balloon 3:
   A. Produce hydrogen using aluminum, water, and sodium hydroxide
   B. Attach hook to the base of the balloon
   C. Add weight in 1 gram increments until balloon descends

# Materials

- large plastic containers (3)
- hard plastic screw-on caps
- small plastic container
- plastic tubing
- copper-coated zinc pennies
- muriatic acid (diluted hydrochloric acid)
- aluminum foil
- distilled water
- ice
- lye
- stirring rod
- mylar balloons
- protective gloves
- Sharpie
- electrical drill
- grinder drill attachment
- drill bit attachments
- hot glue gun
- Super Glue
- tank of hydrogen gas
- paper clips
- gram scale
- measuring tape
- wire
- party ribbon
- Tape

# Variables

Independent Variable

- The type of gas that is used in each balloon

Dependent Variable

- How much weight each balloon will hold.

Control Variables

- Same method of testing.
- Same location of testing.
- Using the same size balloon.

# Results

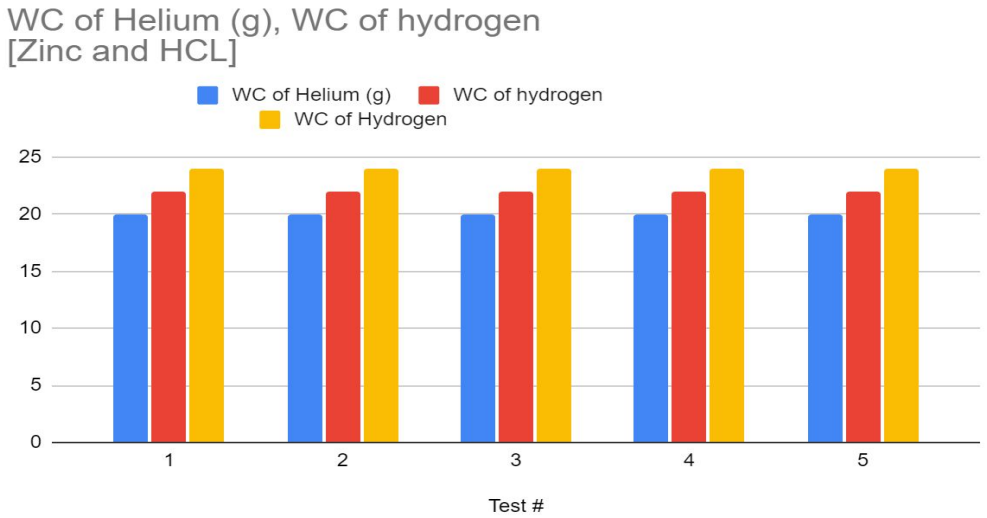
The helium-filled balloon could hold 20 extra paperclips, so it had a weight capacity of 20 extra grams. The hydrogen balloon generated from aluminum, sodium hydroxide, and water held 24 extra paperclips, so it had a weight capacity of 24 extra grams. The hydrogen balloon generated from zinc and hydrochloric acid held 22 extra paperclips, so it had a weight capacity of 22 extra grams.

Table 1. Weight lifting capacity test.

| Test # | WC of Helium (g) | WC of hydrogen [Zinc and HCL] (g) | WC of Hydrogen [Aluminum, water, and lye] (g) |
|---|---|---|---|
| 1 | 20 | 22 | 24 |
| 2 | 20 | 22 | 24 |
| 3 | 20 | 22 | 24 |
| 4 | 20 | 22 | 24 |
| 5 | 20 | 22 | 24 |

# Data Graph and Analysis

Figure 1. Weight capacity of Helium and the two differently generated hydrogen gases




Note: (Blue is helium. Red is hydrogen from the zinc. Yellow is hydrogen from aluminum.)

Additional observations were noted after the date of the experiment. The three balloons were left on the ceiling for approximately three weeks. After five days the hydrogen produced by aluminum lost more pressure than the other two. This is another factor leading us to believe that it is in fact the purist. The purer form of hydrogen will have smaller molecules and therefore be harder to contain in mylar for a long period of time.

# Discussion

The hypothesis was not confirmed because although we know what lifted the most, we do not know if it was the most pure. Since the hydrogen generated from the aluminum carried the most weight, we believe that it was the most pure gas, and that was the reason why the hydrogen aluminum balloon had the highest weight capacity. The tests are not definitive because there are a number of different factors that could have affected the results: air possibly leaking through the containers, the air pressure in the balloon could have been a little different, there could have been water vapor in the balloon even though we limited it as much as possible.

# Further Research and Implications

- Since we were not able to test the exact purity of the hydrogen gases, it is something we can further research in the future.
- Another improvement to be made moving forward is the setup we used to generate the two different types of hydrogen, and also successfully generate an abundant amount of hydrogen via hydrolysis.
- With the constant improvement in airships, it will be infinitely easier to have them commonly used. They are environmentally clean and it saves fuel. The re-institution of airships will change much of the shipping industry making it easier to carry cargo from place to place. This could benefit remote regions greatly because an airship can reach all the places a helicopter can reach but it can carry the cargo load of a large boat, making it easier to transport resources into remote places. Finding the most practical lifting gas could make airships look better in the eyes of the community making them easier to reinstate.

# References


(n.d.). Retrieved from http://chemistry.elmhurst.edu/vchembook/102zinc.html

Admin. (2020, November 16). What is Hydrolysis? - Types of Hydrolysis, General Formula. Retrieved from https://byjus.com/chemistry/hydrolysis/

*Aircraft - Lighter-than-air Aircraft*. Lighter-than-air Aircraft - Balloon, Dirigible, Zeppelin, and Dirigibles - JRank Articles. https://science.jrank.org/pages/156/Aircraft-Lighter-than-air-aircraft.html.

Apogee Components, I. *Apogee Components - Clipped Delta Fins with Through-the-Wall Tab*. Clipped Delta Shape with Through-the-Wall Tab. https://www.apogeerockets.com/Building-Supplies/Rocket-Fins/Clipped-Delta-Fins-with-Through-the-Wall-Tab.

Begum, Rowshan - interview

Dictionary.com. (n.d.). Retrieved from https://www.dictionary.com/

DIY Homemade Hydrogen (Aluminum Water Lye) - YouTube. (n.d.). Retrieved from https://www.youtube.com/watch?v=XEJITyXpghs

DIY Hydrogen Gas (Hydrochloric Acid Zinc) - YouTube. (n.d.). Retrieved from https://www.youtube.com/watch?v=diiYf26LNJ4

DIY Water Electrolysis Kit (Hydrogen Generator) - YouTube. (n.d.). Retrieved from https://www.youtube.com/watch?v=gH-jhN3mV60

Dunbar, B. (2015, May 27). *What Is Aerodynamics?* https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-aerodynamics-58.html.

Granger, A. (2019, August 31). The History and Uses of Hydrogen. Retrieved from https://letstalkscience.ca/educational-resources/stem-in-context/history-and-uses-hydrogen

Helium Depletion. (2021). Retrieved from https://balloonsblow.org/helium-depletion/

Helmenstine, A. M. (n.d.). 4 Easy Ways To Make Hydrogen Safely. Retrieved from https://www.thoughtco.com/how-to-make-hydrogen-gas-608261

Hybrid Airship. (2021, April 12). Retrieved from https://www.lockheedmartin.com/en-us/products/hybrid-airship.html

# References (cont.)


Hydrochloric Acid Formula - Hydrochloric Acid Uses, Properties, Structure and Formula. (n.d.). Retrieved from https://www.softschools.com/formulas/chemistry/hydrochloric_acid_uses_properties_structure_formula/224/ Hydrogen - YouTube. (n.d.). Retrieved from https://www.youtube.com/watch?v=7Om56BAxJJ4

Grossman, D. (2017). The Hindenburg, Graf Zeppelin, and other Dirigibles. Retrieved from https://www.airships.net/

Hydrogen Production: Electrolysis. (n.d.). Retrieved from https://www.energy.gov/eere/fuelcells/hydrogen-production-electrolysis

*Important Announcement*. Lighter Than Air, Better than Gas | College of Engineering. (1961, January 1). https://www.bu.edu/eng/2011/11/10/lighter-than-air-better-than-gas/.

Lavoy, D. (2019, March 02). Physical and Chemical Properties for the Element Aluminum. Retrieved from https://sciencing.com/physical-chemical-properties-aluminum-element-6785380.html

*Lockheed Martin Corporation*. Lockheed Martin. https://www.lockheedmartin.com/en-us/index.html.

Rhodes, Russel. IV E E S G E F E Y - NASA. https:/*The Hindenburg, Graf Zeppelin, and other Dirigibles*. Airships.net. https://www.airships.net/. /www.nasa.gov/pdf/513855main_ASK_41s_explosive.pdf.

"The World Standard in Knowledge since 1768." *Encyclopædia Britannica*, Encyclopædia Britannica, Inc., www.britannica.com/.

Trcka, Ginny - interview

What is the Difference Between Similar But Different Things, Terms, and Objects. (n.d.). Retrieved from https://www.whatisdifferencebetween.com/science/what-is-the-difference-between-ignition-detonation-combustion-and-explosion.html