BS 192 - Chemistry

Experiment 6: Water Splitting Experiment

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I. Introduction

Compounds are broken down by an electric current in the basic chemical process known as electrolysis. This experiment looks at the effects of electrolysis on various electrolytes and on the production efficiency of hydrogen gas. To comprehend the connection between ion concentration, conductivity, and the rate of hydrogen gas production, we will investigate the impacts of deionized water, tap water, sodium chloride (NaCl) solution, and magnesium chloride ($MgCl_2$) solution. This study aims to clarify electrochemical processes and their practical applications in water treatment and energy storage. The experimental setup, outcomes, and inferences drawn from our findings are described in the following report.

II. Experiment Details

A. *Apparatus Used:*

- Beaker
- Graduated burette
- Graphite electrodes
- Battery
- Wires
- Foam sheet
- Bulb

B. *Chemicals used:*

- Deionized water
- Tap Water
- NaCl solution
- $MgCl_2$ solution

C. *Procedure:*

1) Take 150 mL of deionized water in a beaker.

2) Place electrodes in the inverted burette and place that inverted burette in the beaker and cover the beaker with a foam sheet.

3) Using a rubber bulb, fill the burettes completely with water and close their nozzles so that water does not fall back into the beaker.

4) Connect the electrodes to the power source (battery).

5) Hydrogen and oxygen gas will evolve at the cathode and anode respectively.

6) Observe the hydrogen bubbles at the cathode for 15 minutes.

7) Repeat the same for tap water.

8) Collect electrolytic solution of NaCl and $MgCl_2$.

9) Do the same for the electrolytes for 30 minutes and note the readings of the volume of hydrogen gas present in the burette after every 3 minutes.

III. Results

The reactions taking place at the cathode and anode are:

$$\text{Cathode: } 2H^+(aq.) + 2e^- \rightarrow H_2(g)$$
$$\text{Anode: } 2H_2O\ (l) \rightarrow\ O_2(g) + 4H^+(aq.) + 4e^-$$

A. *Observations:*

1) Deionized water: As, the name suggest, the number of ions present in deionized water is very neglible. Therefoe, the conductivity of this solution is negligible. Therefore, the amount of H_2 (g) formed is very negligible in this case.

2) Tap Water: The tap water has comparitively more ions compared to the deionized water due to presence of salts. Therefore, the conductivity of tap water is slightly higher than the deionized water and as a result the amount of H_2 (g) collected in this case is more than deionized water.

3) NaCl solution: The NaCl is a strong electrolyte and in water, it completely dissociates into Na^+ and Cl^- ions. The presence of these ions, increase the conductivity of the solution greatly. Therefore, a large amount of hydrogen gas is collected by the hydrolysis of this solution. The following graph shows the amount of H_2 gas formed (in ml) vs the time.

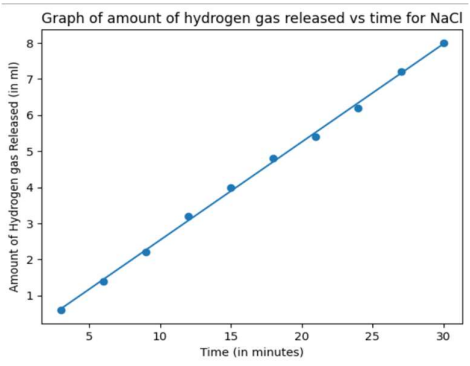

FIGURE 1. GRAPH OF AMOUNT OF HYDROGEN GAS COLLECTED VS TIME FOR NACL SOLUTION

4) $MgCl_2$ solution: $MgCl_2$ is a strong electrolyte and in water, it completely dissociates into Mg^{2+} ions and Cl^- ions. As it is a stronger electrolyte than NaCl, the conductivity of the solutions is more than that of NaCl. Therefore, amount of hydrogen gas released is more than that in NaCl.

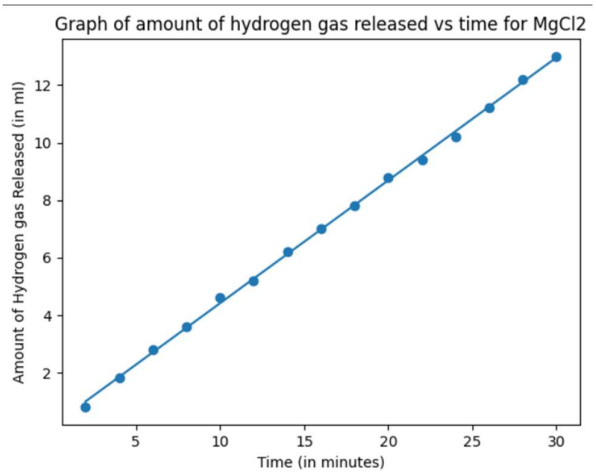

FIGURE 2: GRAPH OF AMOUNT OF HYDROGEN GAS COLLECTED VS TIME FOR MGCL2

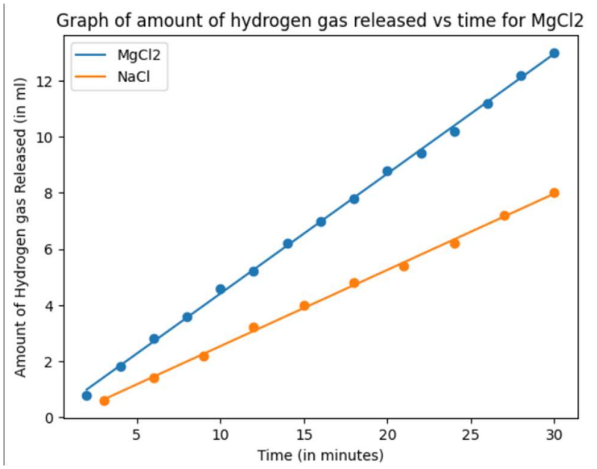

FIGURE 3: GRAPH SHOWING THE COMPARISON BETWEEN THE AMOUNTS OF HYDROGEN GAS RELEASED FOR NACL AND MGCL2 SOLUTIONS

From Figure 3, we can see that the amount of hydrogen gas released in the $MgCl_2$ is more than that in the NaCl solution. This is because NaCl dissociates into 2 ions i.e. Na^+ and Cl^-. Whereas, $MgCl_2$ dissociates into 3 ions i.e. 1 Mg^{2+} and 2 Cl^- ions. Therefore, due to larger number of ions, the conductivity of the latter is more and therefore, the amount of hydrogen gas released is more in the second case. Moreover, the amount of oxygen gas liberated is much less than that of the hydrogen gas.

IV. CONCLUSION

In the water spitting experiment, we used 4 electrolytes: DI water(deionized), tap water, NaCl, and $MgCl_2$. We aim to produce hydrogen with the help of electrolysis, as hydrogen can be used as fuel. In electrolysis, oxidation (loss of electrons) happens at the anode and reduction (gain of electrons) at the cathode. When DI water and tap water were used, barely any bubbles were visible as no ions were produced. When NaCl was added to 10 ml water, the rate of production of hydrogen gas increased, as bubbles were seen. The production increased more when $MgCl_2$ was added to water because of the higher ion count, as $MgCl_2$ has 3 ions, whereas NaCl has two ions. When the water level reached zero, we started the timer to take readings and took the readings every 3 minutes for 30 minutes. The ions formed when NaCl and $MgCl_2$ were put in water and moved to the cathode producing Hydrogen gas.
This experiment provided valuable insights into the production of hydrogen gas as, it is called the fuel of the future.

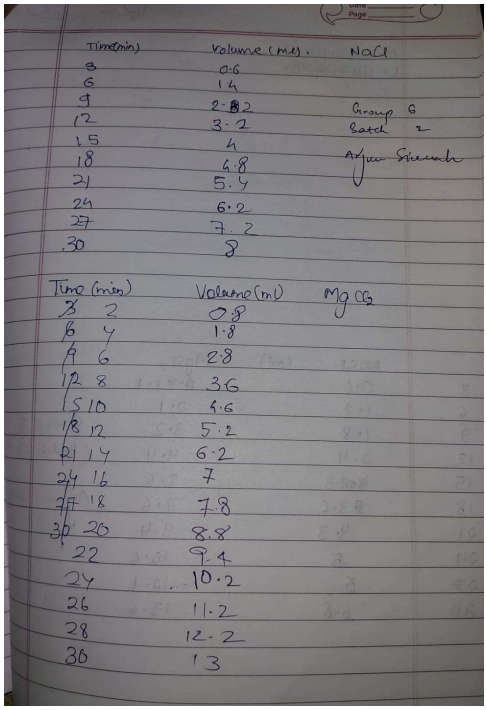

IMAGE 1: READINGS OBTAINED IN THE LAB WITH SIGNATURE OF TA

V. AUTHOR'S CONTRIBUTION

1) Dongre Shreyas Ramprasad (23110105):
- Wrote the Conclusion in the report

2) Gawali Sai Sanjay (23110114):
- Wrote the procedure in the report

3) Guda Avinash Ready (23110123):
- Wrote the introduction of the report

4) Shah Harshil Hardik (23110132):
- Wrote the results part of the report

5) Jadhav Anvesh (23110142):
- Wrote the introduction part of the report