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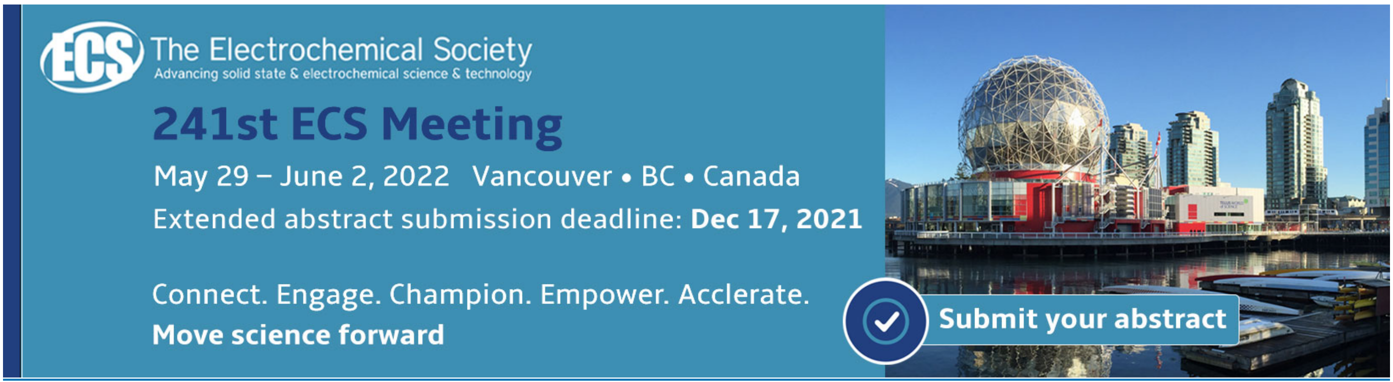

The Hydrogen Evolution of Zinc-Potassium Hydroxide Reaction via Volumetric Measurement

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Abstract Zinc (Zn) is immersed in different potassium hydroxide concentrations (KOH), aiming to prepare the volumetric measurement of Zn in KOH, which is led by producing hydrogen evolution gas. A 99.9% of Zn purity was used in this study. The Zn characterization includes the hydrogen evolution gas and structural analysis by using is X-ray diffraction (XRD). Based on the XRD evaluation, the Zn determine as ZnO after immersion in KOH.

1. Introduction

Zn is one of the widely used metals in electroplating and it is a promising anode in primary batteries due to its superior discharge productivity and safety characteristics correlated with its production [1-3]. Indeed, Zn metal is an advantageous anode in primary batteries because of its high capacity of 0.82 Ah/g [4]. Zn electrode with a large surface area has three times lower in volume consumption compare to magnesium. In fact, it has superior presentation at the greater current drains, better shelf life and low temperatures [1, 2, 5, 6].

Zn is preferred because the Zn properties that get it as valuable corrosion resistance are its ability to form a protective layer consisting of zinc oxide (ZnO) and hydroxide (OH^-) or various essential salts. The layers of protective function is to cover the metal's surface, the corrosion proceeds at a significantly reduced rate [7]. Nevertheless, in the alkaline battery, the electrolyte is vital as it is operating as a catalyst that conducts the transfer of ions from the cathode to anode during charge or vice versa on discharge [8-11].

The usage of KOH in different concentrations in different applications will determine the limits of the free charge carrier when the intensity increases. The free ions might be inclined to get nearer to for each other. On the other hand, KOH with a concentration of 30 wt.% demonstrates the greatest ionic conductivity, low viscosity and a decent solubility of ZnO. This is valuable for high power intensity of flow battery [14]. Besides, the battery can give some effect where it can undergo the leakage. The battery leaks because of batteries' discharge (the battery's chemistry changes and some hydrogen gas is generated). This out-gassing process raises pressure in the battery. Ultimately, the additional pressure ruptures the isolating stoppers at the ending of the battery. Corrosion's disadvantages to the materials will make the materials facing severe problems that tend to damage internal and external material such as cracking.

In the alkaline battery, the problem with Zn is frequently facing corrosion because of the electrolyte. For this reason, the behavior of the Zn depends on the concentration of KOH is being used. Basically, in corrosion understanding of metal behavior, corrosion happens when the metal reacts to the environment such as the presence of O_2, reaction toward acidity and alkaline level of environment and the moisture content of surrounding. Inherently, at low KOH concentration, insufficient charge carriers occurred so that ionic conductivity consistently retained low value so that the corrosion towards the Zn is least. The adding of higher of KOH improved the ionic conductivity because the availability the amount of OH^- ions obtainable in the electrolyte [15].

The volume of hydrogen evolution gas is expected to increase as a function of KOH concentrations. 6 M of KOH maximizes corrosion behavior as stated in the previous study [16]. In the previous research, many researchers study on the concentration of 2, 4 and 6 M of KOH with Zn to reveal their characterization and conductivity [17]. Up to date, no researcher is doing towards KOH concentration in 2, 4, 6 and 8 M with Zn by showing the Zn plate's volume hydrogen evaluation gas.

2. Methodology

The materials used are Zn plate with dimension 2cm x 1 cm (99.9% purity), KOH (Merck), commercial Zn plate and diesel oil. The volume of producing hydrogen gas was taken out by immersing the Zn in the different KOH concentrations (2, 4, 6 and 8 M) and attached a tube to the burette within the beaker containing water as demonstrated in Figure 1.

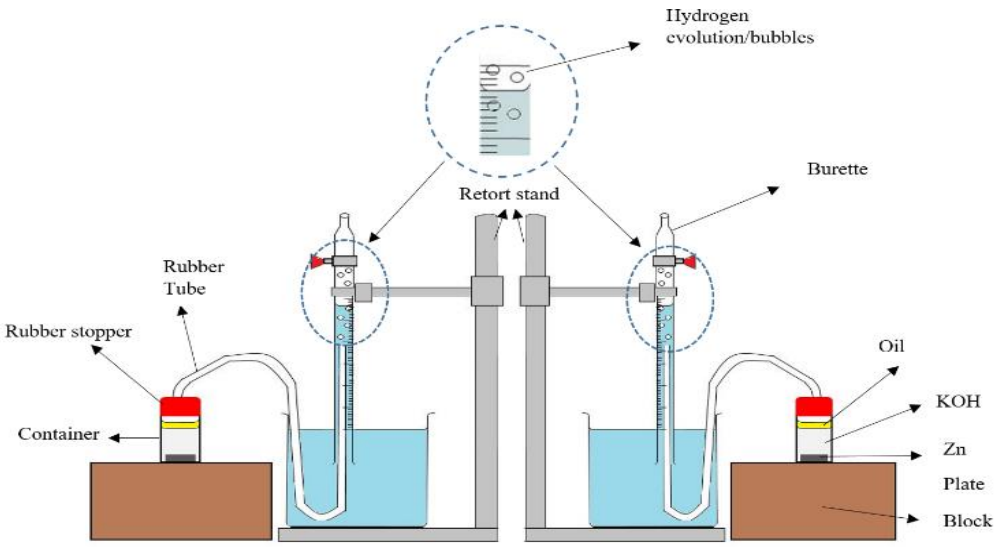

Figure 1. Diagram of volumetric experiment arrangement.

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The container enclosed of Zn plate that submerged in the various KOH concentration. On top of the KOH solution is oil. The KOH solution was topping with oil to avoid the bubble generated during the experiment. The purpose of the oil is to accumulate or avoid the bubbles generate from shifting indiscriminately. The bubbles were promptly flowing to the rubber tube. This technique was to estimate and compare the volume of hydrogen gas released by the Zn to the concentration of KOH. XRD (Bruker) was to examine the composition of the Zn plate. The crystalline phase was identified using the International Centre of Diffraction Data (ICDD) powder diffraction database. The angle of 2° at the range of 10° to 90°.

3. Results and Discussion

Figure 2 shows the hydrogen consumption of Zn commercial that immersed in KOH. 0.1 mL of water was decreased every eight hours due to the low of KOH concentration. This will slow the ion's movement to attack Zn's surface and an unproductive air bubble is produced.

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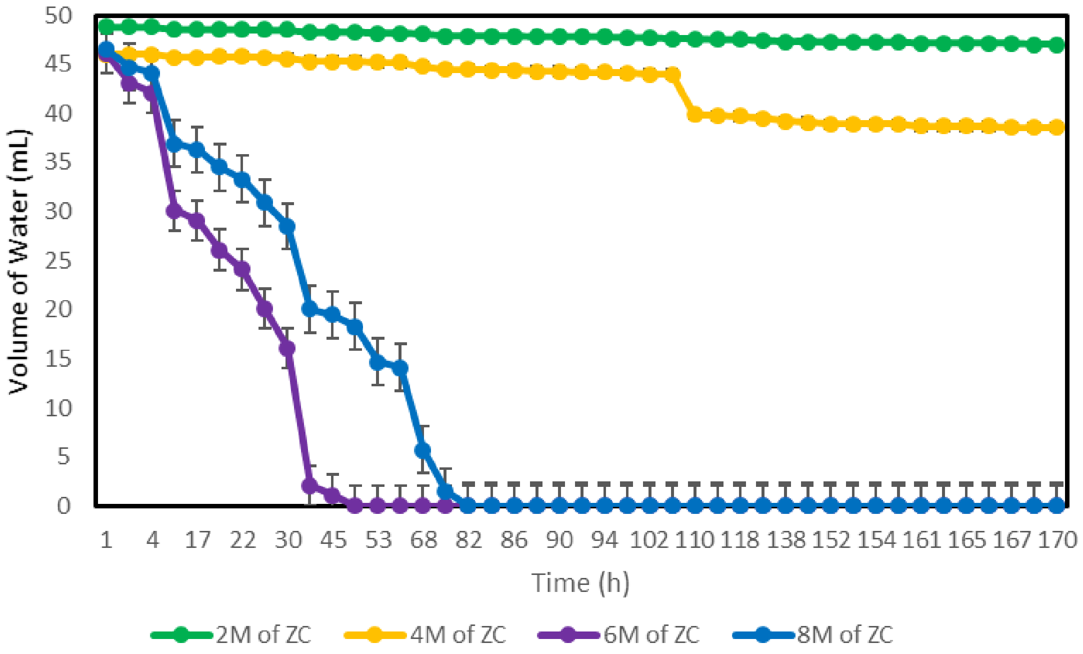

Figure 2. Rate of hydrogen gas for Zn immersed in different concentration of KOH.

However, surprisingly at 110 hours, there is a small difference indicating a lower volume of water at the increasing of time. Every four hours the volume of water decreasing by 0.1 mL. Compared to 6 M that slightly reduce in pattern until at the 17 hours, but then steeply dropped up to 45 hours and steadily until 170 hours. The water continually decreases by 1.0 ml every hour. While at 8 M of KOH, data steadily reduced for 82 hours, and water volume remained constant from 82 hours until 170 hours. The water keeps diminished by 0.6 ml for every hour.

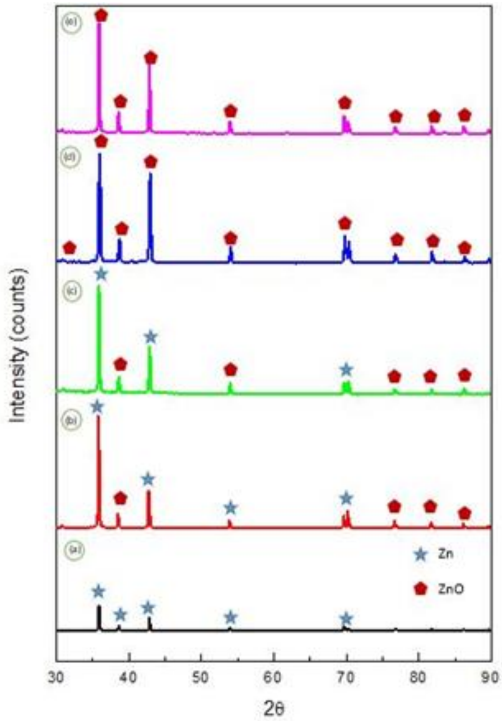

Figure 3. Comparison peak analysis for XRD of (a) Zn commercial and Zn after reaction with (b) 2, (c) 4, (d) 6 and (e) 8 M of KOH.

Figure 3 show the comparison peaks analysis for XRD of Zn before and after reaction with 2, 4, 6 and 8 M of KOH. Hence, the ZnO form after the reaction in KOH. Figure 4 shows the illustration of reactions that happen in the media. The existence of hydrogen evolution is causing by the corrode in the responses of KOH and Zn by reactions of $Zn + 2H_2O \rightarrow ZnO + H_2$. After Zn is reacted to the KOH, forms a white patch at the surface after the observation at the end of the experiment. The higher concentration of KOH, the reactions and corrosion to Zn will be faster.

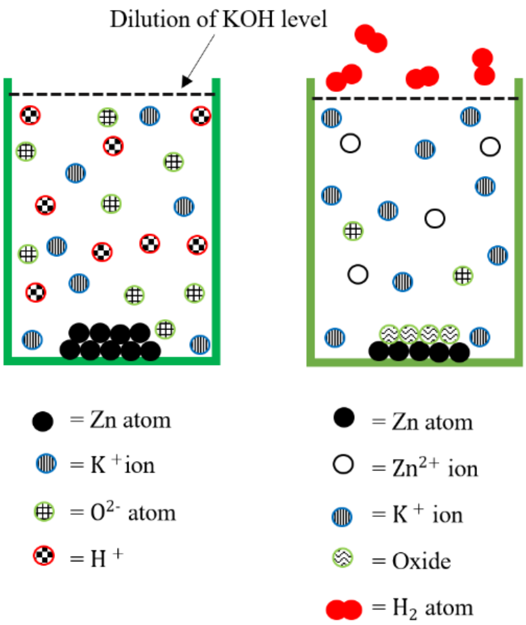

Figure 4: Illustration of Zn reaction in KOH solution.

4. Conclusion

The volume of hydrogen evolution gas was increasing until it attains the maximum level concentration of KOH, 6 M and the higher concentration of KOH will produce more oxygen that can lead the Zn deposited to ZnO.

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