Aluminium as Electricity Conductivity

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Abstract. Electricity is one of the important sources of energy for daily use, specifically for residential and industrial areas. Electric sources now day generated by coal, hydro, wind, petroleum, sun, etc. The objectives of this research are to produce electricity from various aluminum resources and to examine the effect of various waste cans in the production of sources of electricity. Aluminum waste can have recorded as the largest source of aluminum in the waste stream. Therefore, aluminum waste was chosen as the research material divided into two samples, waste food can and waste beverage can. Application of alkaline electrolysis, aluminum-based electrodes and porous electrodes along with zero gap cell is carried out using ionic liquid electrolyte made from vacuum dries NaCl, NaOH, and seawater. The NaOH reaction with various aluminum has recorded as the best solution of all. Comparison with the different types of aluminum resources shows NaOH solution produced the highest electric reacts for pure aluminum with 34.1\% and 35\% for aluminum foil respectively. Meanwhile, aluminum waste food can, 24.3\% and waste beverage can, 6.6\%. Pure aluminum with NaOH solution shows highly readable compared to aluminum recycling reactions. T-test result obtained show the mean of two data in favor majorly have data reading differences except for the mean for foil vs. plate data which is 0.2 (more than 0.05). Electricity testing on various types of aluminum proved that aluminum waste can as an electric resistivity using a different solution in electrolysis.

1. Introduction
Malaysia is known as one of the developing countries in the world. Electric power industry in Malaysia has played an important role in the dramatic economic development. In Malaysia, electricity generation is mostly fossil-based, in particular natural gas and oil. Malaysia have been majored in main resources which are gas, coal, oil, hydro and renewable energy. In 2000, Malaysia began to recognize the potential of biomass, biogas and other renewable energy resources in the Fifth Fuel Policy (1). The wide use of crude oil and fossil fuels in general has also given rise bad issues regards on human’s health and environment conditions. Besides, the improvement in living standards and the advancement of technology is growing rapidly, resulting in increased request for energy use continuous and at the same time cost is getting higher too (15). If we too depend towards the non-renewable resources it will over if we do not find the new alternative way to replace it. Even though this resources that mentioned before give us ease in life but it brings harm to nature without us being aware. For example, logging for dam construction can cause habitats in the forest to be threatened (2).
The objectives of this research are to produce electric energy from different aluminum resources and to study the effect of different wasted cans in producing electricity sources. Then, to measure the pH value from different electrolyte solution. Lastly, to determine the optimum condition of this study results. The study focuses on full-scale of aluminum product fully besides also uses other chemical substances such as activated carbon, seawater and other electrical tools. Moreover, this purpose studies focusing on the uses of electrochemical experiment. This energy production is able to make the electric energy and can decrease environment pollution. This workability of aluminum can provide a positive change in our country. This suitability of this material can contribute to innovation in preserving natural resources.

2. Electrolysis

Electrolysis of water assumes an essential job in the generation of hydrogen dependent on power from sustainable power sources. Hydrogen got from electrolysis is portrayed by high immaculateness (99.9%, paying little mind to the kind of electrolyzer), while the electrolysis procedure itself is anything but difficult to utilize and does not require a long start-up time. (3). Hydrogen (H₂) is a basic atom in this response and has drawn much consideration throughout the decades. H₂ creates multiple times bigger response vitality than hydrocarbon powers when it responds with air. Moreover, the burning of H₂ produces zero carbon outflow and is likely made through water electrolysis. In any case, the creation cost is dependably the issue because of the traditional strategy to deliver H₂ (essentially water electrolysis) is neither affordable nor practical. Next, capacity and transport of H₂ present security concern and has dependently been a test. Along these lines, an increasingly basic, cheap and safe technique to produce H₂ is liked. As aluminum metal is abundant in Earth's crust and the reaction by-product can be recycled, aluminum-water reaction is considered as an alternative method of producing H₂. A full reaction with water under ambient conditions, 1 g of aluminum can generate 1360mL of H₂ gas. However, the protective alumina layer's restrictive properties lower the reaction rate and the output of H₂ production. Therefore, in order to increase the yield of H₂ gas production, aqueous alkaline solution is applied to remove the passive aluminum layer. As reported by Huang et al., the H₂ production rate has been improved by NaOH and KOH. Thus, a cheaper source of H₂ gas is tested for electrolysis process through aluminum-water reaction in this study. (4)

2.1. Alkaline electrolyzer

This is the most widely recognized innovation utilized in water electrolysis. The effectiveness of electrolysis in such gadgets can achieve 82%. Alkaline electrolyzers are describe by high proficiency and moderate cost. The purity of hydrogen acquired by electrolysis utilizing this sort of equipment is extremely high, running from 99.7% to 99.9%. In this procedure, water ought to be furnished with a conductivity of under 5 µS/cm. The response happening at the cathode (HER—Hydrogen Advancement Response) and anode (OER—Oxygen Development Response) are appeared by equations (1) and (2) while the general response is appeared in equation (3).

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\text{anode : } 20H^- \rightarrow \frac{1}{2}O_2 + H_2O + 2e^- \quad (1)
\]
\[
\text{cathode : } 2H_2O + 2e^- \rightarrow H_2 + 2OH^- \quad (2)
\]
\[
\text{overall : } H_2O \rightarrow H_2 + \frac{1}{2}O_2 \quad (3)
\]

This electrolyzer typical consists of two electrodes that are immersed in the electrolyte and separated by a membrane. Maximizing ionic conductivity is the solution's role. OH⁻ ions penetrate this membrane, resulting from the cathode reaction. Hydrogen from the cathode is obtained and water from the anode is obtained with a small amount of oxygen. It is most likely that alkaline solutions like sodium hydroxide (NaOH), potassium hydroxide (KOH), and calcium hydroxide (Ca(OH)₂) will be used. (10)
2.2. PEM water electrolysis
Proton exchange membrane (PEM) electrolyzers produce very high purity hydrogen and require very pure water of approximately 1 μS/cm low conductivity. Figure 1 shows a PEM water electrolyzer schematic diagram. Only on the anode side, where it is divided into hydrogen and oxygen ions, is water supplied. The membrane only allows hydrogen ions, which at the cathode are then reduced. Oxygen with moisture is obtained from the anode, while hydrogen is obtained from the cathode with a small amount of moisture which may penetrate the membrane rate. There is a very thin polymer membrane separating the cathode and anode in this type of electrolyzer. The anode oxidation process produces free ions of hydrogen and oxygen, while hydrogen ions are reduced in the cathode. (3)

![PEM water electrolyzer schematic diagram](image)

Figure 1. Schematic of PEM water electrolyzer.

Alkaline electrolyzers are similar to PEM electrolyzers, but use the electrolyte instead as an alkaline solution. Polymer electrolyte water electrolysis (PEM) has more advantages than alkaline water electrolysis, advantages are ecological cleanliness, small size and mass, high hydrogen gas purity, low gas crossover, low power consumption, high electrical conductivity control, high pressure operation, high safety level, easy handling and maintenance (5).

2.3. Zero gap
The use of a cell design based on the zero-gap concept is an important step towards these' Advanced Alkaline Electrolysers.' The zero-gap cell design works in alkaline electrolysis by compressing two porous electrodes on either side of a membrane or gas separator conductive hydroxide ion. This results in a gap for the traditional setup between the two electrodes equal to the thickness of the membrane (< 0.5 mm) rather than (> 2 mm), thus significantly reducing the contribution of ohmic resistance from the electrolyte between the two electrodes. A gas diffusion layer provides an electrical connection from the porous electrode to the bipolar plate while allowing electrolytic solution feed and the removal of gas products simultaneously. Figure 2 shows that the main difference between traditional configuration and zero-gap design is the use of porous electrodes rather than solid metal sheets. This enables very small inter-electrode gap cells with compact design and high efficiency. It forces gas bubbles to be released from the electrodes ‘backside, reducing their cell voltage contribution. Figure 2(a) Standard setup, (b) zero gap setup–showing the main design differences, the porous electrodes are pressed on either side of the gas separator to reduce the inter-electrode gap, and the conducting gas diffusion layer provides an electrical connection between the electrodes and the bipolar current collector. (6,11)
3. Material and method
To prepare 500ml of 1 molar solution of Sodium Chloride, NaCl which is combine by 14.61g of NaCl powder and distilled water. To prepare 500ml Sodium Hydroxide, NaOH solution is same method with NaCl solution but use different mass which is 10g for 1 molar (Figure 3).

The methodology employed in this chapter is we constructed Al-Graphite cells in simple cells, using an aluminum foil or sheet and recycled cans as anode, a graphitic cathode, and an ionic liquid electrolyte made from vacuum dried NaCl and NaOH and another solution is seawater. See Methods the cathode was made from either pyrolytic graphite or a three-dimensional graphitic foam. We used activated carbon as cathode (6,8). This is show in Figure 4 below.

pH value of all solution measured by using pH meter (Figure 5). Voltage of sample is measured by using multimeter which is electrical instrument to measure different electrical quantities such as voltage, current and resistance (Figure 6).
Figure 5. Al-Graphite cells in simple cells.

Figure 6. Voltage of sample is measured.

4. Results and discussions

4.1. Effect of alkalinity on aluminiums

The pH scale of acidic is less than 7 averages, for neutral is 7 and alkaline pH is more than 7. In Figure 7, the parameters of pH results for NaOH and NaCl solution at alkaline range. Meanwhile, seawater show at acid range.

Based on the Figure 8, NaOH solution on pure aluminum can make the electric presence of aluminum with a relatively high reading but not in aluminum recycle. NaOH solution only produces high readings on food cans only. Similarly, with NaCl solution, pure aluminum has the highest majority reading as a whole. In addition, seawater is only capable of generating a relatively satisfactory voltage readings for all types of aluminum used.
Based on the Figure 9, the voltage readings for the waste aluminum on food cans are higher than the beverage cans with the difference of 57 %. Whereas for pure aluminum, aluminum foil has higher voltage readings than aluminum plate with difference 1.3%. However, all voltage readings for all four samples show the presence of voltage by using NaOH solution.

By using the same method, the sample is carried out using the NaCl solution. Based on the Figure 10, the voltage readings for the waste aluminum on food cans are higher than the beverage cans with the difference of 25%. Meanwhile for pure aluminum, aluminum plate has a higher voltage reading than aluminum foil with a difference of 6.1 %. All values of voltage readings for all four samples show the presence of voltage by using 1 mol of NaCl solution.
Figure 10. Average voltage by using sodium chloride, NaCl.

Based on the Figure 11, the voltage readings for the waste aluminum on food cans are higher than the beverage cans with the difference of 6.6%. Whereas for pure aluminum, aluminum foil has higher voltage readings than aluminum plate with different 5.1%.

Figure 11. Average voltage by using seawater.

Based on overall result, NaOH is the best solution to be used as an electrolyte in electrolysis among the all solution. Between all the resources aluminum, aluminum plate is the best choice to produce the higher voltage than other it is proved based on the data that we got in Figure 8. T-test analysis is used to determine if there is a significant difference between the means of two groups, which may be related in certain features. Based on the data obtained in table 1, it can be concluded that there are differences between two data sets. In conclusion, data that obtained the value of 0 at p value proved that there was a difference in reading between two data with data reading less than 0.05 while the data obtained more than 0.05 indicates that there was no reading difference between the two data as found on the foil versus plate in Table 1.
4.2. Resistance during reaction

Some response resistances in the electrolyte were also identified through this experiment. At high current densities, the obvious resistance is the Ohmic loss in the electrolyte, which includes bubble resistance, diaphragm and ion transmission, and corrosion of aluminum.

4.2.1. Resistances due to Bubbles

Additional resistance to ion transfer and electrochemical responses is caused by the existence of bubbles in the electrolyte and electrode surface. Hydrogen and oxygen-gas bubbles occur on cathode and anode surfaces during electrolysis and are separated only when large enough from the surface. The coverage of bubbles decreases the contact between the electrolyte and the electrode, blocking electron transmission and improving the overall system’s Ohmic loss. Energy losses are always comparatively low in the power circuit, but at greater current densities those caused by ionic transfer become more important. The development of gas bubbles on the surface of the electrode makes a significant contribution to complete energy loss. A greater reaction rate therefore produces greater quantities of gas bubbles, which can prevent the electrode from entering into contact with the electrolyte. In short, the bubble impact is a issue which must be solved by changing the electrode surface, decreasing the surface tension of the electrolyte or using mechanical flow to force the gas bubbles to leave the cell. (9)

4.2.2. Resistances due to corrosive

The use of an aqueous NaOH solution creates aluminum corrosion due to aluminum and water reactions (Al-H$_2$O reaction). The most easy and efficient strategy to promote the Al-H$_2$O response is to add hydroxides, mainly sodium hydroxide (NaOH). Aluminum, however, suffers from a severe restriction issue, which arises when a consistent and adhering oxide layer is formed on the aluminum surface. (12)

The dissolution of the surface oxide layer to aluminum due to a chemical attack on the hydroxide ions OH$^-$ also depends on other variables, such as OH$^-$ concentration, and aluminate ions Al(OH)$_4^-$ at the layer or resolution interface. The transport of OH$^-$ and Al(OH)$_3^-$ ions to and away from the metal or solution interface through the solution is, therefore, anticipated to affect anodic aluminum dissolution process. (13)

In the presence of the oxide layer, the anodic dissolution response of aluminum ions can be categorized by the motion of the aluminum through the layers and an indirect metal dissolution response by the subsequent creation and dissolution of the oxide layer. (14)

5. Conclusion

In conclusion, after the completion of the study, the objective of the study was well implemented. Testing the presence of electricity on various types of aluminum has been carried out well and the results obtained can be used as reference for future research. Various types of aluminum have proven to be able to flow electrical current thereby reducing the amount of environmental pollution caused by
many aluminum discharges. Through the results of this study, food cans can produce high voltage readings compared to drinks in the aluminum recycle category with NaOH solution. This solution is selected because it produces high voltage readings in bulk for the four aluminum. The highest reading for food cans for a sample is 1.11V. If 208 samples are connected in parallel it will produce 230V which is suitable for residential area in Malaysia.

6. Acknowledgments
This research has funded by Centre for Diploma Studies, University Tun Hussein Onn Malaysia. Authors are also grateful to technicians in Environmental Laboratory, Pagoh Campus, Universiti Tun Hussein Onn Malaysia (UTHM) for their help in completing this project research.

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