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PRODUCTION OF HYDROGEN FROM SEA WATER AS RENEWABLE ENERGY USING THE ELECTROLYSIS METHOD

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***ABSTRACT**--Electrolysis is one of the acknowledged means of generating chemical products from their native state. This study looks into the possibilities of hydrogen production from seawater. This is true for hydrogen production from water. The use of seawater (saline water) as a feedstock for producing hydrogen by electrolysis is examined in this paper. Little consideration is given however, to the availability and the quality of the raw material used in the production of hydrogen; that is water. Under normal conditions of operation, the electrolysis cell behaves to produce H_2/NaOCl rather than H_2/O_2. Experimental results are presented for the electrolysis of a wide range of power (DC voltage), kinds of the electrode (stainless steel, copper, aluminum), and times of electrolysis process. The results of the study indicate that the amount of DC voltage is very influential on the H2 flow rate and the highest H2 flow rate was 2.22 cc/sec (7,992 ml/hr).*

***Keywords**-- Seawater, electrolysis, hydrogen, electrode, voltage*

I. INTRODUCTION

The current energy crisis problems caused by world problems in the use of fossil energy such as oil, natural gas and coal-related to natural resources can be used to produce pollutant gases such as COx and SOx which can pollute the environment and cause the greenhouse effect.

Asked to come is to find alternative energy that can be approved and cause environmental problems. One alternative energy that has great potential to overcome these problems is hydrogen gas (H_2). The element hydrogen is the most element in nature, so it is a very cheap energy raw material.

Hydrogen gas is an alternative energy source that is environmentally friendly and has a high fuel value. Hydrogen gas cannot be mined directly and must be extracted from materials containing hydrogen.

At present many methods for producing hydrogen gas commercially use steam reforming methods with fossil-based raw materials. The steam reforming method is widely used because it can be applied to various types of raw materials but the operating temperature used is very high. The use of high temperatures in the process

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because some of the energy needed. This prompted researchers to look for alternative methods that do not require high temperatures and can be applied to raw materials that can better be added.

One method for producing hydrogen gas is the electrolysis method with raw materials for seawater while in the process only uses room temperature. But it is unfortunate the use of electrolysis methods so far have not yet developed like the steam formation method. This is because the value of production efficiency is still very low at 25-45% (1). Therefore it is necessary to have a serious and ongoing study of this electrolysis method in producing hydrogen gas sourced from renewable materials (renewable). The purpose of this study is to examine the factors that can increase the value of hydrogen gas efficiency by electrolysis methods for cheap raw materials and can be provided such as seawater and its side products in the form of sodium hypo chloride (NaOCl). Seawater is a source of lots and cheap so that producing hydrogen gas from sea air is very possible and can increase the value of the efficiency of hydrogen production by electrolysis. Besides Indonesia is a maritime country that makes the prospect of developing energy from the sea very promising for our country. Reviewing and evaluating the byproducts produced and the electrolysis process itself is also the object of research so that efficiency can be improved.

II. HYDROGEN

Hydrogen gas was first discovered by a scientist named Henry Cavendish in 1766 (1) the periodic table which has the symbol H and atomic number 1. At standard temperature and pressure, hydrogen is colorless, odorless, non-metallic, of a single validity, and is a highly flammable diatomic gas (2). Hydrogen is the most abundant element that is 75% of the total mass of the elements of the universe. In the universe, hydrogen exists in the form of compounds with other elements, such as with oxygen in water or with carbon in methane (3). Hydrogen can be produced from water through the electrolysis process (4), but its production is more expensive when compared to the natural gas reformer method. Hydrogen gas applications are very often found in the petrochemical and chemical industries. The biggest use of hydrogen is for the process of absorption of sulfur in fuels and making ammonia. The industry that is the main consumer of hydrogen gas is in the petrochemical industry which includes the process of hydrodealkylation, hydrodesulfurization, and hydrocracking. As the most abundant element and has the highest energy content, hydrogen has the potential to be made as renewable energy. The development of vehicle technology at this time has led to the use of hydrogen gas as fuel. A water-fueled car is a car that uses the element hydrogen in water as fuel or converts water into a power source (5). As an example of technology that is developing rapidly today is fuel cell technology, fuel cell technology is one way out of various obstacles that already exist, namely energy-chemical processing by using hydrogen as fuel and oxygen burners. As for the wider use in the industrial world, namely as:

1. The energy industry is used as an environmentally friendly fuel.
2. The chemical industry is used as a raw material for making H2O2 or hydrogen peroxide.
3. The fertilizer industry is used as a raw material for making ammonia (NH3).
4. Oil and gas industry is used in the process of desulfurization (removal of sulfur)
5. in petroleum fuel.
6. The hydrogen glass industry is used in the hollow glass heat treatment process

7. (oxy-hydrogen flame) and optical fiber.
8. Food and beverage processors are used in the process of hydrogenation amines and fatty acids.
9. The laboratory is used as a gas carrier in chromatography and other lab analysis tools.

III. ELECTROLYSIS

Electrolysis according to Romdhoni [6], is the decomposition of an electrolyte by an electric current. In electrolysis cells, chemical reactions will occur if an electric current is carried through an electrolyte solution. Electric energy (electric current) is converted into chemical energy (redox reaction). An electrode that receives electrons from an electric current source is called a cathode, while electrodes that flow electrons back to an electric current source are called anodes. While the electrolyte is something that has an ion form conductivity value. Electrolytes can be in the form of water, acid-base solutions or in the form of other chemical compounds.

a. Hydrogen Gas Producing Electrolysis *Methods*

The electrolysis method is a simple method for producing hydrogen gas and oxygen. The workings of the process in this electrolysis method are energized by decomposing hydrogen and oxygen in water (11). The reactions that take place are:

Cathode : $2H_2O(l) \rightarrow O_{2(g)} + 4H^+_{(aq)} + 4e^-$ ..... (1.1)

Anode : $2H_2O_{(l)} + 2e^- \rightarrow H_{2(g)} + 2OH^-_{(aq)}$

Total : $2H_2O_{(l)} \rightarrow O_{2(g)} + H_{2(g)}$

The cathode is where the reduction reaction is represented as negative (-) and the anode is where the oxidation reaction is represented as positive (+) [7]. Three main features of electrolysis, namely:

1. Using an electrolyte solution containing free ions, these ions can give or receive electrons which can flow through the solution.
2. Using an electric current source from outside, such as a running battery
   direct current (DC).
3. Using 2 (two) electrolysis cell electrodes.

b. Mekanisme Reaksi Metode Electrolysis

In an electrolysis cell that is given an electric current oxidation and reduction reactions will occur, the reaction that occurs on the anode side is an oxidation reaction, where anions (negative ions) are drawn by the anode and the number of electrons is reduced to make the oxidation number increase (8,9). The reactions that take place are as follows:

a. OH-ions are oxidized to H2O and O2 reactions:

$4OH^-(aq) \rightarrow 2\ H_2O\ (l) + O_{2(g)} + 4e^-$ .....(1.2)

b. Oxygenated residual acid ions (for example NO3-) are not oxidized, which is oxidized to water, the reaction

$$2H_2O(l) \rightarrow 4H^+_{(aq)} + O_{2\,(g)} \quad \text{.....(1.3)}$$

c.The remaining acid ions are oxidized to molecules, which are:

$$2Cl^-(aq) \rightarrow Cl_{2(g)} + 2e^- \quad \text{.....(1.4)}$$

On the cathode side, a reduction reaction occurs, namely cations (positive ions) are drawn by the cathode and receive additional electrons so that the oxidation number decreases. The reactions that occur are as follows:

a. The H+ ion is reduced to H_2, the reaction is:

$$2H^+(aq) + 2e^- \rightarrow H_2\,(g) \quad \text{.....(1.5)}$$

b. Alkaline metal ions (IA) and alkaline earth (IIA) are not reduced, what is reduced is water, the reaction is:

$$2H_2O(aq) + 2e^- \rightarrow H_2(g) + 2OH^-_{(aq)} \quad \text{.....(1.6)}$$

c. Other metal ions (Al^{3+}, Ni^{2+}, Ag^+ and others) can be reduced, the reaction is:

$$Al^{3+}(aq) + 3e^- \rightarrow Al(s) \quad \text{.....(1.7)}$$

$$Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$$

$$Ag^+(aq) + e^- \rightarrow Ag(s)$$

IV. EXPERIMENTAL

The process of seawater electrolysis is carried out in a cylindrical electrolysis container with a volume size of 1 liter as shown in Figure C.1. The hydrogen gas produced is measured flow rate using a bubble flow meter. The electrolyzed seawater is seawater around the Dewantara sub-district, North Aceh-Indonesia, which has a salinity of 3.4-3.5% measured using a Refractometer Salinity

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Figure C.1: Flow Meter Equipment Series

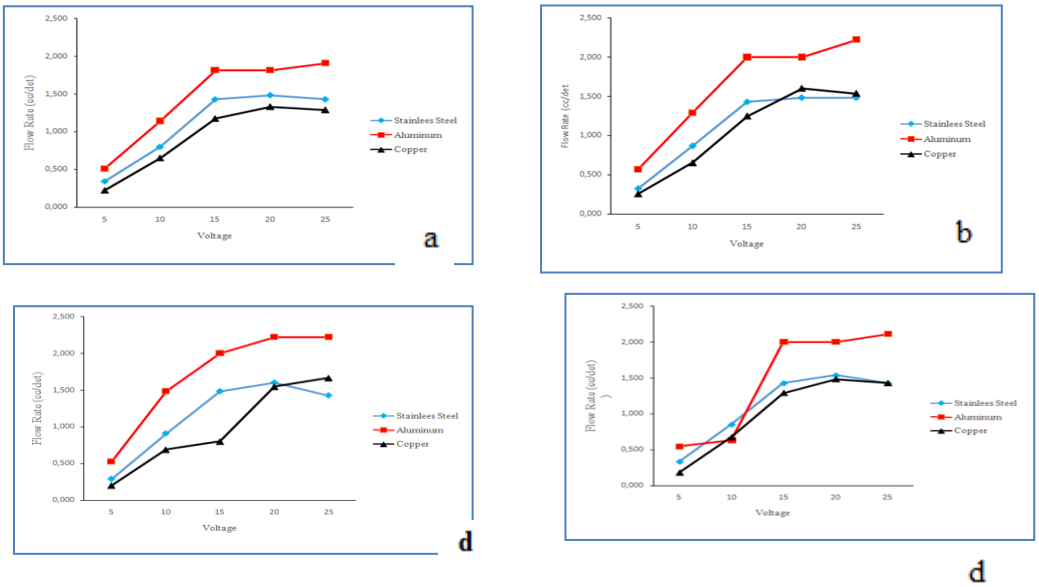
The electrolysis process uses electrodes which are varied with 3 types of electrodes namely; stainless steel electrodes, aluminum electrodes and copper electrodes (cooper). The process of electrolysis of seawater uses a DC electric current generated from the Cody 15D20 power supply (Figure C.2a) and H2 gas rate using a Buble Flowmeter (Figure C.2b)

Figure C.2: Electrolysis devices, a) Power Supply, b) Bubble Flow meter

The voltage used during the electrolysis process is varied into 5 variables namely; 5, 10, 15, 20 and 25 volts with an electrolysis time of 2, 4, 6, 8 minutes. During the process of seawater electrolysis, the resulting gas flow rate is flowed to the Bubble Flow meter to obtain the hydrogen gas flow rate that is formed during the electrolysis process.

V. RESULT AND DISCUSSION

The flow rate (flow meter) of hydrogen gas produced in the hydrolysis process is a factor that is studied and observed with variations in voltage (volt) and type of electrode can be seen in Figure C.3



a) 2 minute, b) 4 minute, c) 6 minute, d) 8 minute

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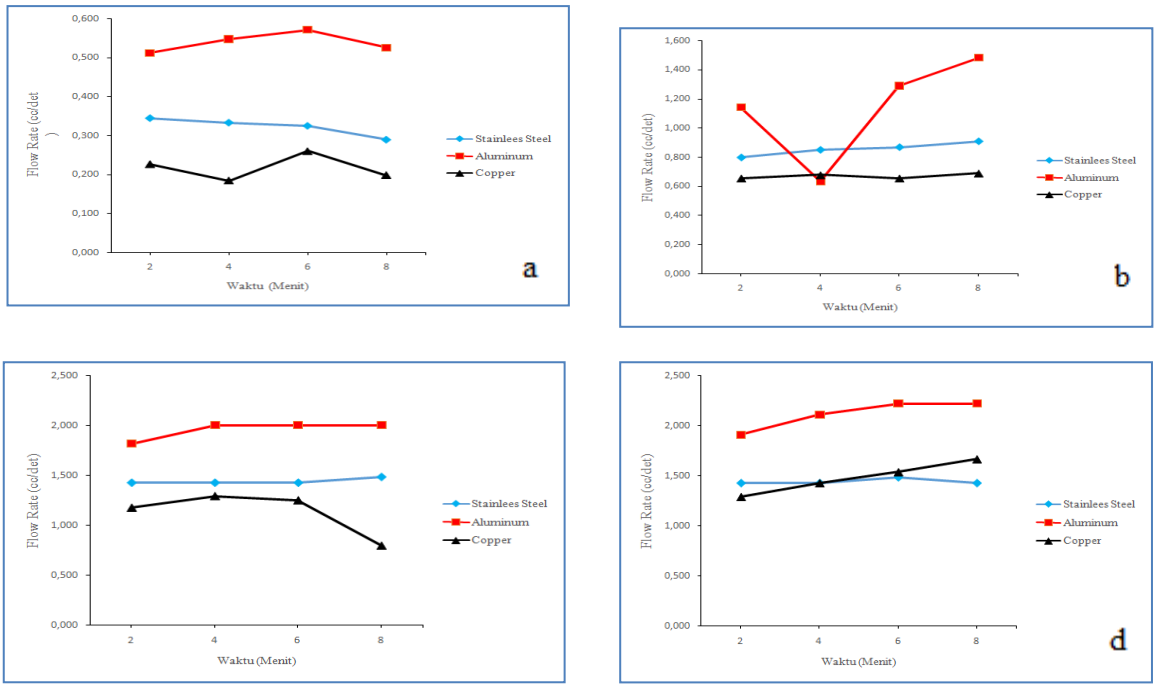
Figure C.3: Effect of electrolysis time on hydrogen flow rate:

From the results of the electrolysis process in Figure C.3 and flow rate measurements using a Bubble Flow Meter, it can be seen that the effect of voltage (volt) and type of electrodes shows a significant effect on the hydrogen flow rate produced, where the higher the voltage used is 5, 10, 15, 20, and 25 volts indicate an increase in the hydrogen gas flow rate. This is due to the voltage that will provide a certain amount of energy through the electrodes to break down into hydrogen gas and a solution of Sodium Hypochlorite (NaOCl). The highest hydrogen gas flow rate from the results of this study is to use a 25 volt voltage with the highest hydrogen gas flow rate of 2.22 cc/sec (7,992 ml/hour) using Aluminum electrodes. This is due to the increase in electrical voltage will affect the increase in electron density, the process of electron excitation will increase so that more hydrogen gas is produced in the decomposition of water [(10).]

This study also examined the effect of the use of the types of electrodes on the hydrogen flow rate produced. The results of the research shown in Figure C.3 show that aluminum electrodes can produce a higher hydrogen gas flow rate than using stainless steel and copper electrodes where at 8 minutes the highest hydrogen gas flow rate with an average flow rate hydrogen produced above 1.8 cc/sec (> 6.5 liters /hour). The use of aluminum electrodes can produce hydrogen gas flow rates higher than the other two electrodes, namely stainless steel because aluminum electrodes are more resistant to corrosion by seawater and have high conductivity compared to stainless steel and copper [(10)]. In this study also observed the effect of the length of the electrolysis process on the flow rate of hydrogen gas produced as shown in Figure C.4

c



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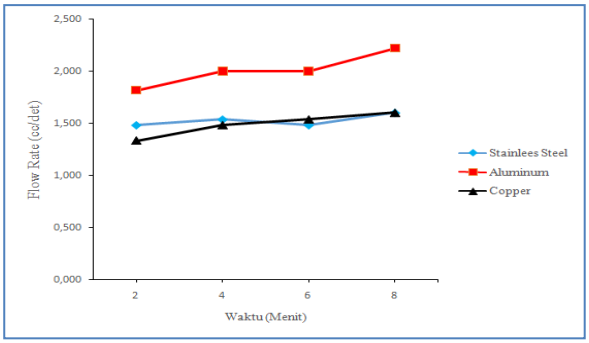

Figure C4: Effect of voltage on hydrogen flow rate:a) 5 volts, b) 10 volts, c) 15 volts, d) 20 volts, e) 25 volts

Figure C.4 shows that the electrolysis time at all voltages (5,10,15,20,25 volts) generally shows an increase even though at a certain time and the type of electrode there is a decrease as in 4 minutes with aluminum electrodes. Although the flow rate of hydrogen gas shows an increase, the increase is not so significant. This shows that the electrolysis process time does not significantly affect the decomposition of seawater to produce hydrogen gas and NaOCl [(11)]. Similarly, from the results of the previous discussion, that in Figure C.4 also shows that aluminum electrodes produce higher hydrogen gas flow rates compared to stainless steel and copper type electrodes. Figure C.4 shows that the electrolysis time at all voltages (5,10,15,20,25 volts) generally shows an increase even though at a certain time and the type of electrode there is a decrease as in 4 minutes with aluminum electrodes. Although the flow rate of hydrogen gas shows an increase, the increase is not so significant. This shows that the electrolysis process time does not significantly affect the decomposition of seawater to produce hydrogen gas and NaOCl [(12,13)]. Similarly, from the results of the previous discussion, that in Figure C.4 also shows that aluminum electrodes produce higher hydrogen gas flow rates compared to stainless steel and copper type electrodes.

VI. CONCLUSIONS

From the results of research into the production of hydrogen from seawater using the electrolysis method, it can be concluded that hydrogen can be produced by supplying energy through electrodes to break down water into hydrogen. Several research variables carried out namely voltage, type of electrode and electrolysis time showed that the applied voltage and the type of electrode used greatly affected the decomposition of water into hydrogen. The higher the voltage applied, the more hydrogen flow rate obtained with the highest flow rate is 2.22 cc /sec (7,992 ml/hr) using an Aluminum electrode. Electrolysis time does not significantly affect the flow rate of hydrogen produced and even time can affect the electrode degradation so that it can affect reducing the conductivity of energy at the electrode to do the decomposition of water.

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