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Effect of Concentration of NaOH and H_2SO_4 Catalysts on Hydrogen Gas Production Efficiency

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Abstract— Indonesia has an ocean area of 5.8 million km^2, water is the event of the decomposition of water compounds (H_2O) into hydrogen gas (H_2) and oxygen (O_2) by using an electric current through water. In this study, the electrolysis of water at an electrolytic concentration containing NaCl can take place quickly with various catalysts of NaOH, and H_2SO_4 with concentrations of 0.1M, 0.25M, 0.5M, 0.75M, and currents of 15A, 25A and 35A. From the results of the study, it was found that the greater the current and the concentration of the catalyst, the greater the volume of gas produced and the efficiency of the flow, and a significant effect. The highest hydrogen gas produced was 0.4745 L at a concentration of 0.75M with a current of 35A for a NaOH catalyst and with a H_2SO_4 catalyst, gas with a volume of 0.48823L was produced at a current of 35A and a concentration of 0.75M and the highest current efficiency at a current of 35A the highest efficiency at a concentration of 0.75M was 89.354% for the NaOH catalyst, and the H_2SO_4 catalyst obtained the highest current efficiency at a concentration of 0.75M, which was 43.325%.

Keywords: electrolysis, electric current, efficiency, catalyst, concentration, hydrogen, gas production

1 Introduction

Electrolysis of water is the event of decomposition of water compounds (H_2O) into hydrogen gas (H_2) and oxygen (O_2) by using an electric current through water [1], [2], [3]. Hydrogen is one of the new renewable energy sources that can reduce exhaust emissions namely by using water as fuel, through the process of electrolysis of water compounds (H_2O) converted into its constituent components, namely oxygen and into hydrogen [4], [5], [6].

The production of hydrogen gas from electrolyte solution containing NaCl can take place quickly, because NaCl itself functions as a natural catalyst. Hydrogen gas production can be maximized by adding strong electrolyte catalysts such as NaOH, KOH and H_2SO_4 [7], [8]. The production of H_2 gas with the highest concentration was obtained by electrolysis of a salt solution with a NaOH catalyst with a voltage of 12 volts at 4500 ppm. In the study [9], [10] the volume of H_2 gas produced by the addition of NaOH catalyst was 3.9 mL with the addition of 1 mL NaOH, 7.95 mL for the addition of 2 mL NaOH, and 12.8 mL for the addition of 3 mL NaOH with a volume of water. 25 mL. Production of H_2 gas with sulfuric acid catalyst, the greater the current and the number of electrodes provided with the same sulfuric acid concentration, the greater the concentration of hydrogen gas produced. The greater the concentration of the catalyst, the greater the precipitate formed during the electrolysis process, this causes obstruction of the process of forming gas bubbles at the electrode [11], [12].

In this study, based on previous research references, the researchers then conducted a study of how the effect of variations in catalyst concentration using NaOH and H_2SO_4 and variations in electric current in the electrolysis process of electrolyte solutions to obtain optimum hydrogen gas conversion results [13], [14].

2 Research Method

The material used in this study was water with a salinity of 0.05 ppt, 3 ppt, and 8 ppt which was taken according to seawater sampling standards (SNI 6964.8:2015). After knowing the salinity that produces hydrogen gas optimally, the catalyst variations are NaOH and H_2SO_4 with concentrations of 0.1M, 0.25M, 0.5M, 0.75M and 1M with variations in current 15A, 25A and 35A, as well as variations in the type of filler Arrestor in the form of iron, copper, stainless steel, and aluminum.

The electrolysis process is carried out using the Hydrogen Generator Using Water Electrolysis Process method based on ISO 22734-1:2008 with adjustments to the design and condition of the tool [15]. The electrolysis process in the electrolysis reactor used is the feed will be pumped into the electrolyzer as much as 17 L, then the electrolysis process is carried out with a certain current. The results of the electrolysis obtained are in the form of hydrogen and oxygen gas which are in the electrolyzer which will then be temporarily accommodated in the gas holding tank [15]. During the electrolysis process, data is collected every 2 min in the form of operating condition data in the form of pressure, temperature and voltage, after hydrogen gas is obtained then temperature data is taken on the arrestor for every 2 min. The design of the electrolysis device can be seen in Figure 1.

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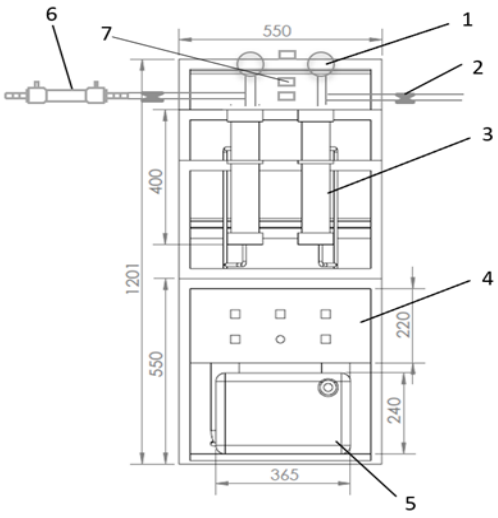

Information:

1. Pressure Gauge
2. Gas Output Valve
3. H_2 and O_2 Storage Tubes
4. Control panel
5. Feed Tank

Fig. 1. Electrolysis Reactor

3 Result and Discussion

Effect of Concentration of NaOH and H_2SO_4 Catalysts on the Volume of Hydrogen Gas Produced

TABLE 1
RESULTS OF HYDROGEN GAS VOLUME AND EFFICIENCY OF NAOH CATALYST

No	Concentration (M)	Current (A)	Volume (L) 120 sec	Efficiency (%)
1	0.1	15	0.2057	42.142
		25	0.3499	75.258
		35	0.4698	88.470
2	0.25	15	0.2079	42.857
		25	0.3443	54.838
		35	0.4749	89.372
3	0.50	15	0,2101	43.178
		25	0,3394	89.032
		35	0,4702	89.348
4	0.75	15	0,2100	43.179
		25	0,3442	54.709
		35	0,4745	89.354

TABLE 2
RESULT OF HYDROGEN GAS VOLUME AND EFFICIENCY OF H_2SO_4 CATALYST

No	Concentration (M)	Current (A)	Volume (L) 120 sec	Efficiency (%)
1	0.10	15	0.20715	15.117
		25	0.34031	41.706
		35	0.46900	48.782
2	0.25	15	0.16573	12.089
		25	0.34288	41.815
		35	0.46909	43.718
3	0.50	15	0.18517	14.174
		25	0.34321	41.815
		35	0.47121	42.927
4	0.75	15	0.21174	18.214
		25	0.34821	42.231
		35	0.48823	43.325

Figure 2 shows the effect of NaOH catalyst concentration and current on the volume of hydrogen gas in the electrolysis process carried out for 120 seconds. In the electrolysis process, hydrogen gas will be formed at the cathode, where the negatively charged cathode will undergo a reduction reaction and attract cations which will form hydrogen gas, while at the anode it will undergo an oxidation process with a positive charge which will attract anions which will be oxidized into oxygen gas [16].

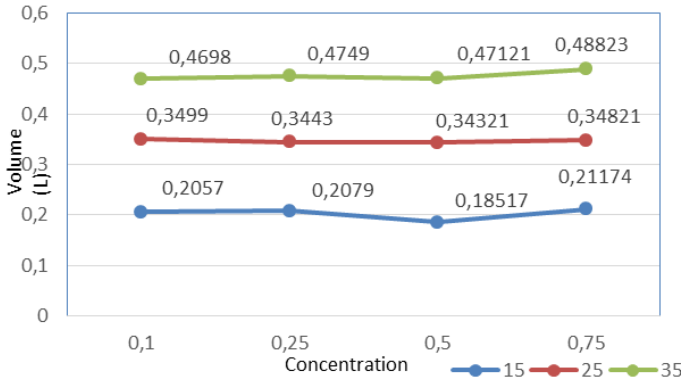

Fig. 2. The volume of product H_2 to the concentration of NaOH catalyst and current strength

The addition of NaOH catalyst at a current of 15A obtained the lowest results at a concentration of 0.1M is 0.2057L while the highest result is at 35 A at a concentration of 0.1M at 0.4698L. While the highest volume for a current of 35A at a

concentration of 0.5M is 0.4712L and at a concentration of 0.75 M is 0.4745 L.

The research was conducted using an alkaline NaOH catalyst, and also electrolysis in an acidic environment with the addition of a H_2SO_4 catalyst to determine the volume of gas produced when carried out in an acidic environment [17]. From the results of the calculation of the amount of gas that is electrolyzed by the addition of a H_2SO_4 catalyst, then it is converted to a graph, and can be seen in Figure 3.

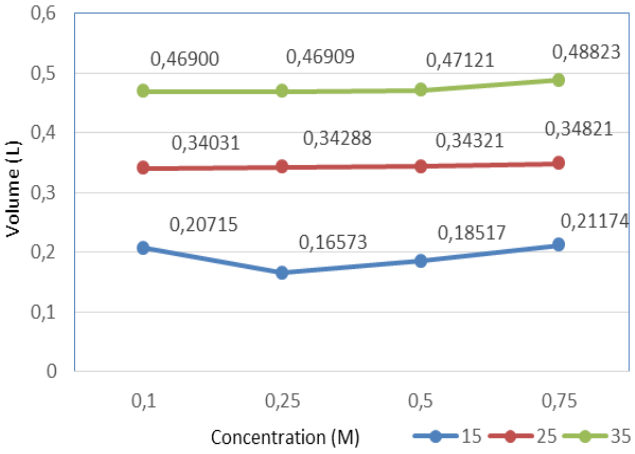

Fig. 3. The volume of product H_2 to the concentration of H_2SO_4 catalyst and current strength

Figure 3 the electrolysis process using H_2SO_4 catalyst with a current of 15A obtained the lowest yield of hydrogen gas at a concentration of 0.25M at 0.16573L while the lowest was at concentration. the highest yield was at a concentration of 0.75M at a current of 35 A with a volume of 0.4882L and a concentration of 0.5M was 0.47121L. Based on Table 2, there is a decrease in the volume of hydrogen gas produced at a concentration of 0.25M then relatively stable at each subsequent concentration and at variations in current strength, this is presumably due to the greater number of catalysts, the easier it is to saturate a solution which will cause electron transfer to be slower. and produces a reduced amount of gas from the previous concentration. The concentration of the catalyst which is electrolyte affects the behavior of the electrolytic cell of water and gas produced and the reaction time [17]. According to the research, the addition of a catalyst can increases the activation energy, and increase the amount of hydrogen gas produced. The greater the current used in the electrolysis of water, the more gas is produced [18]. Previous studies have strengthened the experimental results, namely the NaOH and H_2SO_4 catalysts with the highest conditions to produce hydrogen gas, namely at a current of 35 A and at a concentration of 0.75M [19].

4 Conclusion

Obtained in the seawater electrolysis process which was carried out for 120 seconds with the addition of variations in the concentration of NaOH and H_2SO_4 catalysts as well as strong currents. In the study, the hydrogen produced was 0.4745L at a concentration of 0.75M with a current of 35A for the NaOH catalyst and with the H_2SO_4 catalyst, gas with a volume of 0.48823 L was produced at a current of 35A and a concentration of 0.75M. Based on the calculation results, the higher the current and the catalyst concentration in line with the amount of gas production, the higher the efficiency. In this study, the highest efficiency was at 35 A, the highest efficiency at a concentration of 0.75M was 89.354% for the NaOH catalyst, and the H_2SO_4 catalyst obtained the highest efficiency at a concentration of 0.75M, which was 43.325%. For further development, it is recommended to carry out electrolysis with other types and make electrolysis reactors that are resistant to heat so that electrolysis processes can be carried out with variations in temperature.

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