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ANALYSIS OF THE INFLUENCE OF ADDITIONAL PERCENTAGE OF CATALYST ON THE ELECTROLYSIS PROCESS ON HYDROGEN VOLUME AND FLAME PROFILE

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ABSTRACT

Utilization of new and renewable energy is an important point for Indonesia for development, science and technology. On the other hand, the use of fossil fuels is very limited so the alternative fuel solutions are vegetable oil (BBN) and methane gas and others, even in the future the substitute for these fuels will use electricity. The material used in this research is stainless steel. The independent variable tested was the catalyst percentage of NaCl, NaOH and $NaHCO_3$ of 40%. The dependent variables are the volume of hydrogen and flame characteristics. The control variable uses a voltage of 12 volts using water and distilled water as solvents with a volume of 1000 ml. The data collection procedure starts with 12 Volt DC current energy which will produce electrical energy from the cathode pole and anode pole. The electrolysis process will occur causing the catalyst and solution to undergo a chemical process, namely the separation/decomposition of H_2O, the catalyst and solution producing hydrogen bubbles which are stored in a tube. The data is then analyzed empirically and using Image-J software or similar to determine the characteristics of the flame. The analysis of the experimental data above can be compared with previous research, namely producing the highest volume of hydrogen at a percentage of 16% of 367 mL and the lowest volume of hydrogen at a percentage of 8% of 198 mL. The highest flame temperature at a percentage of 16% is 54.7 ºC and the lowest temperature at a percentage of 8% is 31.7ºC with the highest flame height at a percentage of 16% being 5.72cm and a flame width of 2.98cm and the flame brightness level (Red Green Blue) is highest at a catalyst percentage of 16% at 16 RGB and the flame brightness level (Red Green Blue) is lowest at a percentage of 8% at 2 RGB.

Keywords electrolysis; HHO; NaCl; NaOH; NaHCO3
Paper type Research paper

INTRODUCTION

Utilization of new and renewable energy is an important point for Indonesia for development, science and technology. On the other hand, the use of fossil fuels is very limited so the alternative fuel solutions are vegetable oil (BBN) and methane gas and others, even in the future the substitute for these fuels will use electricity. The use of renewable energy results from things that are considered useless, such as various waste materials or goods and livestock waste. To reduce the impact of global warming, new innovations in alternative energy are needed, namely hydrogen fuel (H_2). Hydrogen fuel is obtained by decomposing the H_2O (water) compound into H2 (Hydrogen) and O_2 (oxygen) through electrolysis [1]. This situation supports society not to be completely dependent on oil. One alternative fuel is brown gas (HHO gas) by electrolysis using electric current [2]. Water (H_2O) can be used as an alternative energy source. Basically, water is not fuel, but one way to use water as fuel is by electrolysis of water. Water electrolysis is the decomposition of water compounds (H_2O) into hydrogen (H_2) and oxygen (O_2) using an electric current [3]. Sodium Chloride (NaCl) is used as a catalyst. NaCl is a compound that is included in the salt group and is a fairly good electrolyte, so it can increase the amount of hydrogen electrolyzed in water. Sodium Hydroxide (NaOH) or commonly called caustic soda is used as a catalyst to increase the desired amount of hydrogen production. Sodium Bicarbonate ($NaHCO_3$) or commonly called baking soda is also used as a catalyst to increase the amount of hydrogen production through the electrolysis process. This research aims to analyze the effect of adding the catalyst percentage of Sodium Chloride NaCl), Sodium Hydroxide (NaOH), and Sodium Bicarbonate ($NaHCO_3$) on the hydrogen volume and flame characteristics of the HHO wet cell generator.

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Hydrogen-hydrogen oxygen (HHO) gas or commonly known as brown gas is a renewable energy source that is being developed as an alternative to fossil fuels. Brown gas can be obtained from water (H_2O) using the wet cell electrolysis process. Hydrogen is the same indirect energy as natural gas, oil, or coal. Hydrogen is secondary energy produced with other energy sources such as petroleum, coal, nuclear energy, solar energy and various other types of energy. Because it is a secondary fuel, in the initial stages of using hydrogen as a fuel, users must combine it with the main fuel (Hydra). Therefore, hydrogen's function as a companion fuel serves to help the engine reduce main fuel consumption. Electrolysis is the process of breaking down a chemical compound into its elements or forming new molecules using an electric current. The most important parts of the electrolysis process are the electrodes and the electrolyte solution. The electrode used in this research was a stainless steel electrode type ST40 [4]. The electrolyte is a mixture of solvent and catalyst. The solvent in this research is water and distilled water. A catalyst is a substance that speeds up the rate of a reaction but does not scientifically change when the reaction is complete. Catalysts are used to produce HHO gas in the electrolysis process. In the electrolysis process, NaCL, NaOH and $NaHCO_3$ solvents are used as solvents in the form of 1000 ml of water and distilled water. Sodium Chloride is used because the standard electrode potential of sodium is more negative than water, so sodium does not react, but water does. In addition, sodium chloride is easily available [5]. Sodium Hydroxide (NaOH) is used as a solvent because it has the potential to increase gas production in the electrolysis process and has sodium properties that are more negative than water and only causes water to react [6]. Sodium Bicarbonate ($NaHCO_3$) is used as a solvent because it has the potential to increase good results in the production rate of HHO gas or brown gas. Based on several studies, it shows good improvement when trials are carried out using Sodium Bicarbonate ($NaHCO_3$) solvent [7].

A catalyst is a substance added to a reaction system to speed up a reaction. The electrolysis process requires the role of catalysts such as sodium chloride, sodium hydroxide and sodium bicarbonate. In general, increasing the percentage of catalyst affects the electrolysis process. The higher the catalyst percentage, the faster the reaction will be [8]. The HHO generator is a tool that functions to produce HHO gas using water using an electrolysis process system. The gas produced in the electrolysis process is hydrogen-hydrogen oxygen gas or with a composition of 2 hidrogen.

METHOD

This research was conducted at the Mechanical Engineering Laboratory, Widyagama University, Malang using experimental methods. The material used in this research is stainless steel [10]. The independent variable tested was the catalyst percentage of NaCl, NaOH and $NaHCO_3$ of 40%. The dependent variables are the volume of hydrogen and flame characteristics. The control variable uses a voltage of 12 volts using water and distilled water as solvents with a volume of 1000 ml. The data collection procedure starts with 12 Volt DC current energy which will produce electrical energy from the cathode pole and anode pole. The electrolysis process will occur causing the catalyst and solution to undergo a chemical process, namely the separation/decomposition of H_2O, the catalyst and solution producing hydrogen bubbles which are stored in a tube. . Then hydrogen gas is flowed through a pipe and nozzle and ignited with a flame, creating a constant hydrogen diffusion flame, this depends on the hydrogen gas supply in the reservoir tube.

The analysis process is carried out by recording empirical data from measurements and observations as well as videos and images of flames. The data is then analyzed empirically and using Image-J software or similar to determine the characteristics of the flame.

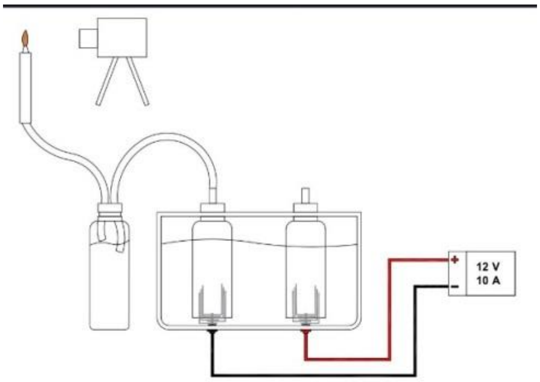

Figure 1. Research Tool

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Information:

1. Wet cell HHO Generator
2. Bubler Box
3. Measuring Cup
4. Power Supply
5. Voltmeter
6. Thermometer
7. Thermokopel
8. Bubbler drain valve
9. Measuring cup drain valve

DISCUSSION

The data that can be obtained is processed using calculations. From the calculation data is then tabulated in the form of graphs. The calculations used are as follows:

1) The calculation data of the volume of hydrogen produced can be calculated by the following equation:

$$V= \pi/4\ D^2 \text{ x } t \quad (1)$$

Where v is the volume of hydrogen (cm3), π phi (3.14 or 22/7), D2 is the diameter of the tube (cm), and t is the height of the tube (cm).

2) Solution Concentration
To determine the concentration of the solution can be calculated using the following equation:

$$C= m/v \quad (2)$$

Where c is the concentration of the solution (%), m is the mass of solute (gr), V is the volume of the solution (mL).

TABLE I. FLAME CHARACTERISTICS

No	Catalis	Solvent	Pixel Width	Convert Width to Pixels (mm)	Pixels Height	High Conversion to Pixels (mm)	Extent of Flame Brightness (Pixels)
1	NaCl	Water	109	2,95	143	3,86	212.012
2			82	2,22	162	4,38	217.089
3			80	2,16	128	3,46	283.375
4			88	1,54	128	2,25	192.604
1	NaCl	Aquades	82	1,45	122	2,16	188.438
2			92	1,48	127	127	182.32
3			96	1,55	134	2,16	211.091
4			92	1,48	122	2,16	189.378
1	NaOH	Water	70	0,48	123	0,84	205.584
2			56	0,38	80	0,55	211.107
3			95	0,65	118	0,81	211.111
4			240	1,64	344	2,35	216.881
1	NaOH	Aquades	76	1,43	125	2,36	171.344
2			79	1,49	128	2,42	189.277
3			75	1,42	124	2,34	214.171
4			78	1,47	118	2,23	209.375
1	$NaHCO_3$	Water	91	1,12	180	2,22	235.994
2			79	0,98	182	2,25	235.442
3			88	1,09	180	2,22	237.447
4			94	1,16	79	2,21	235.789
1	$NaHCO_3$	Aquades	92	0,98	186	1,99	180.465
2			95	1,02	172	1,84	217.542
3			98	1,05	169	1,81	184.428
4			98	1,05	202	2,16	193.742

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Screening Stage

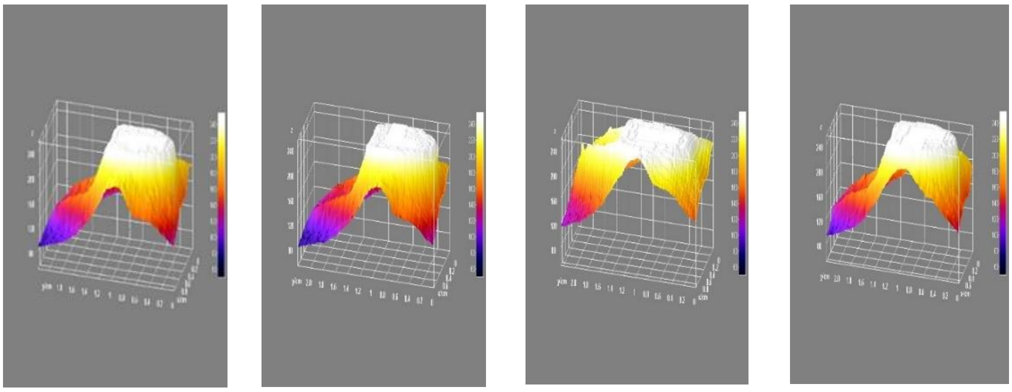
The test was carried out 8 times with variations in 40% Sodium Chloride (NaCL) solution, 40% Sodium Hydroxide (NaOH), and 40% Sodium Bicarbonate ($NaHCO_3$) with water and aquadesh solvent of 1000 ml. as well as determining the volume of hydrogen and the characteristics of the flame for 1800 seconds using AC electric current from a 12 volt 10 ampere power supply.

TABLE II. CALCULATION RESULT

No	Catalis	Time(s)	Solvent	Volume of Hydrogen (mL)	Gas Production Rate (I/s)	$\pi/4$	Tube Diameter D^2 (cm)	Tube Height t (cm)
1	NaCl	1800	Water	226,08	0,0000122	3,14	36	8
2				197,82	0,0000109	3,14	36	7
3				197,82	0,0000109	3,14	36	7
4				214,776	0,0000118	3,14	36	7,6
5			Aquades	288,252	0,000016	3,14	36	10,2
6				254,34	0,0000141	3,14	36	9
7				254,34	0,0000141	3,14	36	9
8				254,862	0,0000141	3,14	36	8,7
1	NaOH	1800	Water	226,08	0,0000122	3,14	36	8
2				226,08	0,0000122	3,14	36	8
3				259,992	0,0000143	3,14	36	9,2
4				240,21	0,0000133	3,14	36	8,5
5			Aquades	282,6	0,0000156	3,14	36	10
6				271,296	0,0000150	3,14	36	9,6
7				310,86	0,0000172	3,14	36	11
8				268,47	0,0000148	3,14	36	9,5
1	$NaHCO_3$	1800	Water	254,34	0,0000141	3,14	36	9
2				268,47	0,0000148	3,14	36	9,5
3				299,556	0,0000166	3,14	36	10,6
4				310,86	0,0000172	3,14	36	11
5			Aquades	310,86	0,0000172	3,14	36	11
6				341,946	0,0000189	3,14	36	12,1
7				274,122	0,0000152	3,14	36	9,7
8				291,078	0,0000161	3,14	36	10,3

RESULTS AND DISCUSSION

Flame Result using Image-J Software



NaCl Flame Recording **Water Mixture** using Image-J Software

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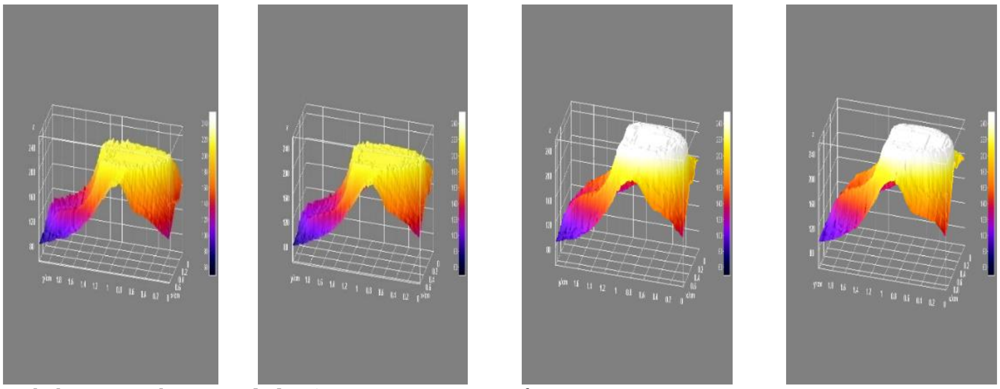
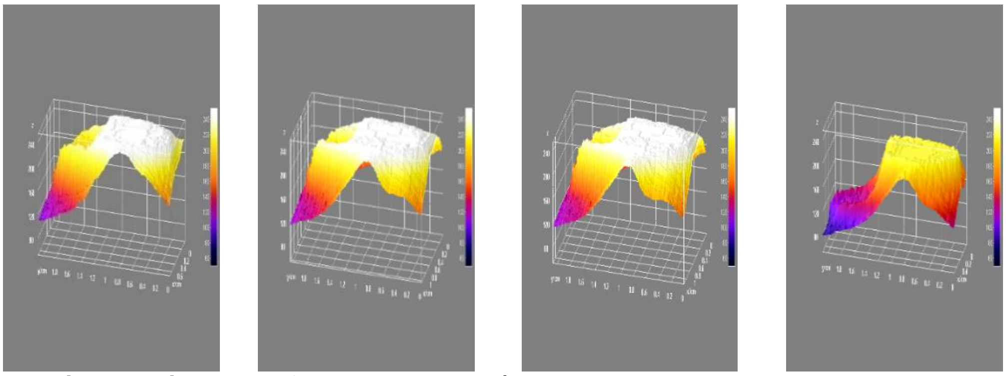
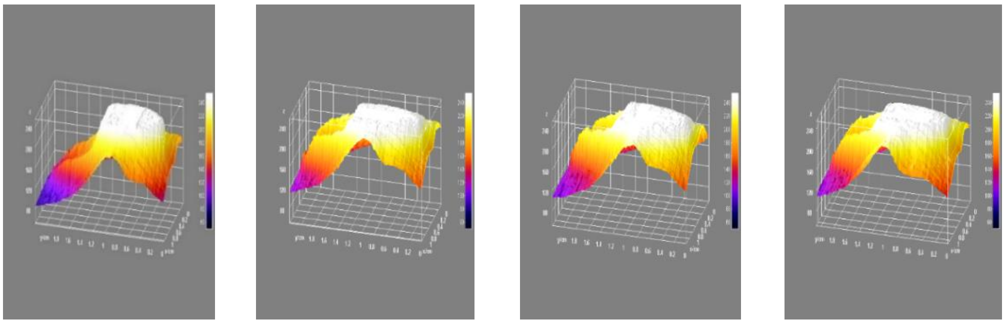


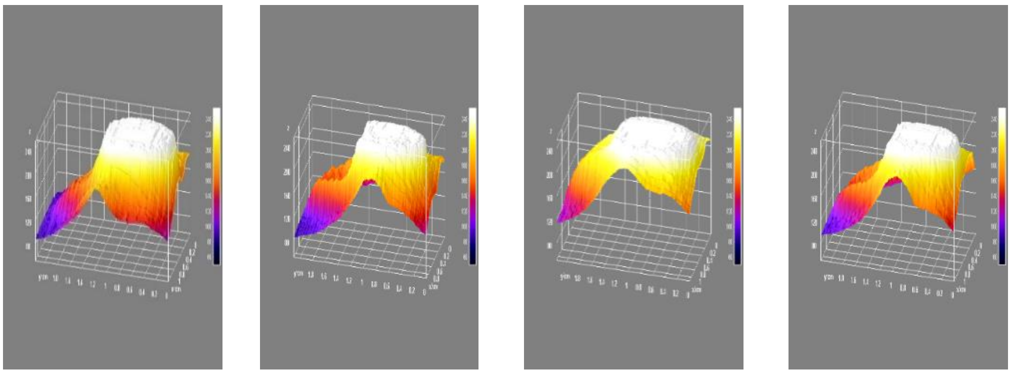
NaCl Flame Recording **Aquadesh Mixture** using Image-J Software



NaOH Flame Recording **Water Mixture** using Image-J Software



NaOH Flame Recording **Aquadesh Mixture** using Image-J Software



NaHCO3 Flame Recording **Water Mixture** using Image-J Software

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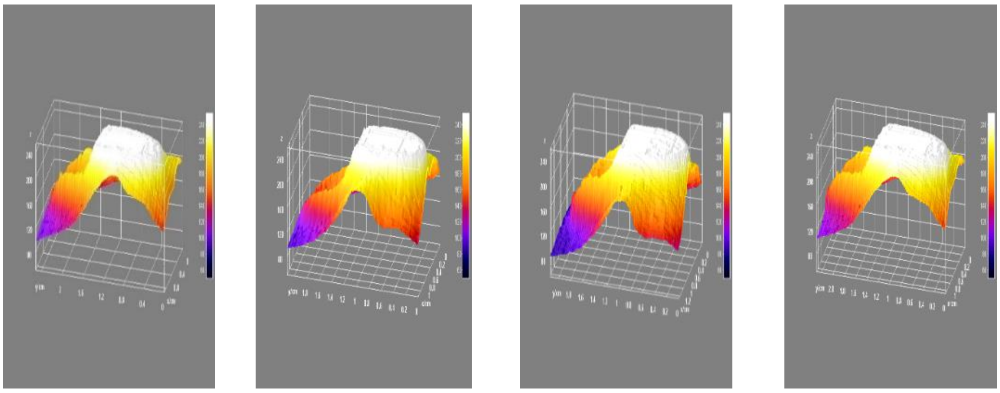

NaHCO3 Flame Recording **Aquadesh Mixture** using Image-J Software

Figure 2. Flame Processing using Image-J Software

Based on the research table data, it can be seen that the best hydrogen production rateuses the $NaHCO_3$ catalyst with distilled water as a solvent with a yield of 0.0000189 l/s, thus increasing the yield of hydrogen volume by 341.946 mL. This is because the better the production of HHO gas that occurs in the electrolysis process, the comparable volume of hydrogen will be produced. Meanwhile, the ratio of height, width and flame area shows the best. The result was a water solvent with aquadesh NaCl catalyst with a width of 2.95 mm and a height of 4.38 mm, and a flame brightness area of 283.38 pixels. This is because the flame color produced by the NaCl catalyst is brighter because it shows a dominant yellow color which, if the data is entered into the Image-J software, becomes brighter than other catalysts. Temperature and flame time data show results at the highest temperature with the Aquadesh NaCL solvent catalyst of 42.2ºC and the flame time with the Aquadesh NaOH catalyst solvent of 3.44 mS. This highest temperature is caused by the large amount of hydrogen produced, but the amount of hydrogen with this flame is less because if it is lit with a fire it will burn quickly and the flame time will be shorter because of the flammable nature of hydrogen. . The ignition time or ignition time can occur due to the stable rate of hydrogen production during the electrolysis process which causes the hydrogen to burn a little longer.

CONCLUSION

The analysis of the experimental data above can be compared with previous research, namely producing the highest volume of hydrogen at a percentage of 16% of 367 mL and the lowest volume of hydrogen at a percentage of 8% of 198 mL. The highest flame temperature at a percentage of 16% is 54.7 ºC and the lowest temperature at a percentage of 8% is 31.7ºC with the highest flame height at a percentage of 16% being 5.72 cm and a flame width of 2.98 cm and the flame brightness level (Red Green Blue) is highest at a catalyst percentage of 16% at 16 RGB and the flame brightness level (Red Green Blue) is lowest at a percentage of 8% at 2 RGB.

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