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ELECTROLYSIS PROCESS OF ACID ACETIC AND SUGAR WATER SOLUTION AS AN ALTERNATIVE FUEL

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ABSTRACT

One alternative energy that can be developed is hydrogen. To obtain hydrogen gas by decomposing water compounds (H_2O) into hydrogen hydrogen oxygen gas (HHO) through electrolysis. The solution used in this electrolysis process uses sodium chloride (NaCl) with electric current energy. In this research, a dry cell type HHO generator was used, the electrode used was a type 304 stainless steel plate with a catalyst percentage (NaCl) of 8%, 10%, 12%, 14% and 16%. The aim of this research is to determine the hydrogen content in a solution of vinegar and sugar water which can be used as an alternative fuel. This research produced the highest hydrogen volume at a percentage of 16% of 367 mL at the highest temperature of 547 ºC, the lowest 317 ºC and the lowest hydrogen volume of 198 mL. The highest flame height is 5.72 cm and flame width is 2.98 cm and the highest flame brightness level (Red Green Blue) is 16 RGB and the lowest brightness level is 2 RGB.

Keywords Catalyst; HydrogenVolume; Temperature; Flame Profile; Flame Brightness
Paper type Research paper

INTRODUCTION

The development of industrial technology is so rapid that many things are undergoing changes and updates. In this case, new renewable energy is a breakthrough to support the balance of energy needs that can be utilized and are environmentally friendly, alternative fuels are one solution option. Researchers are developing methods to find useless or wasted materials as alternative fuels. The trending methods are pyrolysis, electrolysis, hydrolysis and more. Utilization of water is already a useful energy in the form of hydroelectric power plants, but its utilization is expanded by using water to power vehicles with one of the flammable hydrogen elements. On the scale of experimental studies, electrolysis of chemical solutions into HHO gas.

Restrictions on fuel use are getting tighter, while energy needs still rely on fossil energy which is increasingly depleting and difficult to renew. In addition, the use of fossil energy also has a negative impact on the environment, the main impact being air pollution. To reduce this impact, new innovations are needed. namely alternative fuel hydrogen (H_2). To obtain hydrogen gas by separating water (H_2O) into hydrogen hydrogen oxygen (HHO) or brown gas by electrolysis using electric current [1].

Alternative fuel that can be used is water (H_2O). Water can be obtained anywhere and is free to use, water is not fuel but water can be used as fuel, one way is by the electrolysis method. Electrolysis is a chemical reaction process that occurs when an electric current is applied, this chemical reaction does not occur spontaneously. A non-spontaneous reaction occurs if an external electric current enters with a negative value, while water electrolysis is the decomposition of water compounds (H_2O) into oxygen gas (O_2) and hydrogen gas (H_2) electrically locally [2]. Other research related to HHO generators related to electrolytes has been carried out and developed. One of these developments is how to produce abundant hydrogen gas using simple and easily available tools so as to save and get good energy [3]. The research that has been done [4], hydrogen will appear at the cathode if the electrode is connected to a negative current and oxygen gas gets twice as much oxygen

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with the energy level used. [5], researched and tested the electrolysis of water which can act as a conductor under current through the movement of ions. In test [6] the electrolyte is sodium chloride (NaCl). Sodium chloride is a compound that belongs to the salt group and is a strong electrolyte. If it is dissolved in water, the conductivity will increase because the addition of electrolyte during electrolysis will produce the required energy, so the rate of reaction for decomposing water molecules will be faster. [8] have investigated that hydrogen gas can decompose H_2O electrolytically into HHO gas (hydrogen hydrogen oxygen) using a stainless steel wet cell type HHO generator. [9] in observing and analyzing the relationship between the volumetric number of Cu-Zn cells and the NaCl concentration. The results showed that the higher the NaCl concentration, the lower the generated voltage, conversely, the higher the NaCl concentration, the greater the resulting current. [10] Taking into account the effect of the cross section and concentration of the electrolyte solution with variations in input current on the formation of hydrogen gas through water electrolysis, the electrolyte solution used is brine (NaCl) indicating that the higher the concentration. electrolyte solution, the larger the cross-sectional area and the greater the supply current. , the greater the volume of gas produced. The neutral plate is the plate that is located between the cathode plate (negative) and the anode plate (positive) at a predetermined distance. The advantage of adding a neutral plate is that the electrolysis area is wider so as to produce Brown gas and besides that the reaction will be more stable [11]. Acetic acid or better known as acetic acid (CH_3COOH) is a liquid compound, colorless, pungent smelling, has a sharp sour taste and dissolves in water, alcohol, glycerol, ether. At atmospheric pressure, the boiling point is 118.1 ^{0}C. Physical Properties of Acetic Acid (CH_3COOH) Formula and molecular weight Acetic acid has the molecular formula CH_3COOH and a molecular weight of around 60.5 grams per mole. The clear liquid smells and tastes sour. Acetic acid (CH_3COOH) is an acid in the form of a clear (colorless) liquid. However, it has a pungent sour smell as well as a sour taste. Acetic acid is insoluble in carbon disulfide. Flammable. Acetic acid, especially pure, is highly flammable. Acetic acid can burn at 39 °C. The results of research [12] show that the degumming process using 0.4% volume sulfuric acid has the best characteristics as follows: Flash point 52 ^{0}C, Pour point 30 ^{0}C, Density 0.916 g/cm³, Water content 0.15% Vol, Viscosity 2.0 mm^2/s , Heat Value 9759.66 cal/grm, and FFA 0.16% by Weight. Electrolysis is a way to separate water (H_2O) into hydrogen (H_2) and oxygen (O_2) gas by using an electric current through the water. [6], The accuracy level of the developed electrolysis monitoring system devices is generally in line with scientific research standards. Then, in water electrolysis, it can be seen that using a voltage of 12 volts produces the highest concentration of hydrogen gas, namely 847 ppm, and the electrolysis process is faster, namely 6 hours 7 minutes, which is indicated by the absence of flowing current. [13] The use of base catalysts in the biofuel manufacturing process usually uses NaOH or KOH as a homogeneous catalyst which has the disadvantage of forming side products such as soap and the complexity of separating the catalyst. One of the renewable energies, produces hydrogen products by the reaction of carbohydrates (sugar) and water which will be converted into electrical energy (small and large scale). Both regarding the need for sugar biofuel cell material, the process of generating electricity from chemical energy (the result of chemical reactions), the advantages of this sugar biofuel cell both in terms of output power and so on, as well as its development based on hypothesis H_2. power plants, electric generators, high voltage energy dense batteries, to sugar powered vehicles. Glucose solution is non-electrolyte, so it does not break down into its ions in water. In a simple electrolyte cell, a substance must be broken down into cations (positive ions) and anions (negative ions) in order to move towards the cathode and anode. At the cathode, there is a reduction in cations while in Anions. Oxidation occurs at the anode. This reaction is called electrolysis, which is a non-spontaneous redox (reduction-oxidation) reaction assisted by electrical energy. Chemical properties of CH_3COOH or acetic acid. Contains a carboxyl group which is a functional group of the carboxylic acid group. CH_3COOh is a weak acid with a dissociation constant in water reaching 4.76. So when it reacts with water it will produce hydroxonium ions and ethanoate ions. CH_3COOH is a polar solvent such as inorganic salts and sugar, oil, iodine and sulfur.

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CH_3COOH can decompose at high temperatures when heated to 440 °C. The properties of CH_3COOH or Acetic Acid have various benefits, including as a regulator of acidity, giving a sour taste and aroma to food. According to [14] glucose is a promising raw material for hydrogen production but existing microbial electrolysis processes have low efficiency. In the research that has been done, fuel cells and electrolyzers can be regenerated by themselves without using external electricity. Consequently, the glucose stock is converted to pure hydrogen at the cathode, and carbon dioxide at the anode. The net reaction of this process is the breakdown of glucose into hydrogen and carbon dioxide on thermal heating at 85 ^{0}C

The research that has been carried out [15] is that the diffractogram pattern of the synthesized solids shows characteristic peaks at 2θ of 7.4° and 8.5° which are the characteristic peaks of the standard UiO-66. The FTIR spectrum of the synthesized solid shows absorption bands at wave numbers around 1550-1630 and 1450-1580 cm^{-1}, and strong absorption bands at 1400 cm^{-1}. Research [16] proved that the density value of the solution produced by the glucose substrate was higher than that of the acetate substrate. The higher number of carbon and hydrogen compared to the glucose compound and the neutral system conditions caused the power density value of glucose to be higher compared to the variation of acetic acid. In his research [17] tested the use of HHO (dry type cell generator) produced from the production of H_2 (hydrogen gas) using the MQ-8 sensor as a measuring tool to calculate the concentration of H_2 gas (hydrogen gas). The result is capable of producing a maximum hydrogen gas concentration of 37 ppm. GCMS results [18] show that propolis consists of 42 types of bioactive compounds and are grouped into four categories: terpenoids, phenolics, steroids, fatty acids. The most dominant bioactive compound is (Z)-3-(pentadec-8-en-1-yl) phenol ($C_{21}H_{34}O$) (23.32%) from the phenolic group. The aim of the research to be carried out is to determine the hydrogen content in a solution of vinegar and sugar water which can be used as an alternative fuel.

From the description above, it is necessary to study more deeply the effect of a mixture of vinegar (CH3COOH) and sugar water ($C_{12}H_{22}O_{11}$) in the HHO electrolysis process on hydrogen volume and flame profile. This can be compared to the use of a solution as a catalyst in terms of alternative fuel energy sources as an effort to obtain general biofuel references with an electrolysis process using an HHO generator.

METHOD

The research method uses an HHO generator as a 12 Volt DC current power source, with a solution of acetic acid (CH_3COOH) and sugar water ($C_{12}H_{22}O_{11}$) as catalysts, so that when electricity flows in the solution a chemical reaction occurs, namely the separation of hydrogen (H_2) and -accompanying elements. other. From the separation of the two elements, the volume of hydrogen is obtained, the profile of the flame in it includes the temperature of the flame, the height and width of the flame, the brightness of the flame. The independent variable is the solution, the dependent variable is the volume of hydrogen and the flame profile while the control variable is the 12 Volt DC current and the water used with distilled water with a volume of 500 mL. Data collection was carried out using observation, measurement and mathematical calculation methods. Empirical data is tabulated, analyzed and displayed in graphical form, then processed using Image-J software or similar which can help analyze experimental data.

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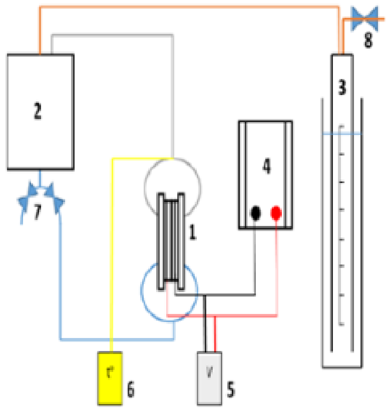

Figure 1. Tool Plan

Information:
1. Dry cell type HHO generator
2. Bubbler Box
3. Measuring Cup
4. Accu
5. Voltmeter
6. Thermometer
7. Bubbler Box Drain Valve
8. Measuring Cup Drain Valve

DISCUSSION

From direct trials data was obtained in the form of hydrogen volume and flame profile on a dry cell type HHO generator with varying percentages of acetic acid and sugar water of 8%, 10%, 12%, 14% and 16%. . By using distilled water as a catalyst. When distilled water reacts with acetic acid, chemically it is a weak acid if it reacts in water because it is polar and can undergo decomposition at high temperatures, causing the production of more hydrogen ions (CH3COOH). Meanwhile, the chemical reaction is treated by electrolysis of sugar water (glucose solution) and non-electrolyte compounds. The electrolysis process is very profitable because the cathode and anode can move positive and negative ions so that the chemical reaction of glucose can be active and reactive as the temperature increases. This produces a non-spontaneous redox reaction (reduction-oxidation) which is assisted by electrical energy from a 12 volt battery.

Image Recording Result of Acetic Flame

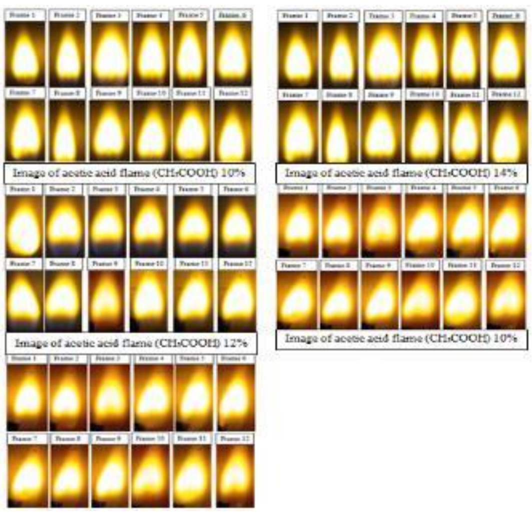

Figure 2. Recording Results Of Acetic Flame (CH_3COOH)

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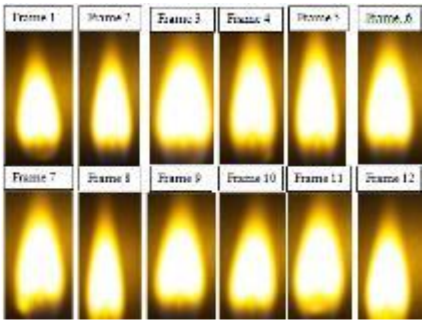
Image of Acetic Acid Flame 8%

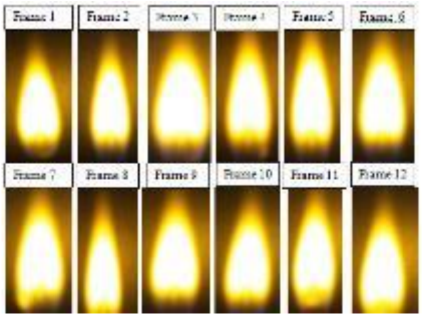
Image of Acetic Acid Flame 14%

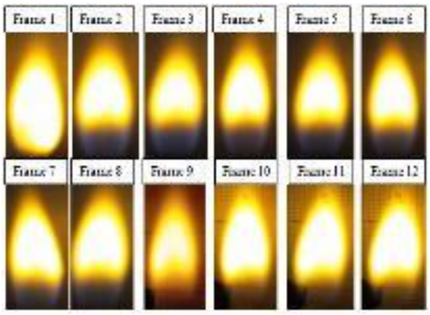
Image of Acetic Acid Flame 10%

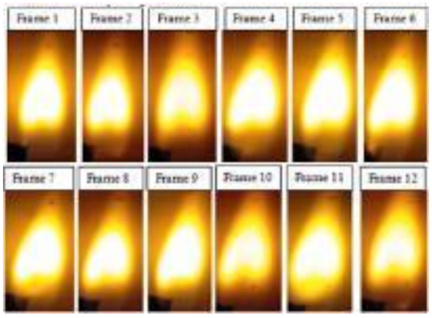
Image of Acetic Acid Flame 16%

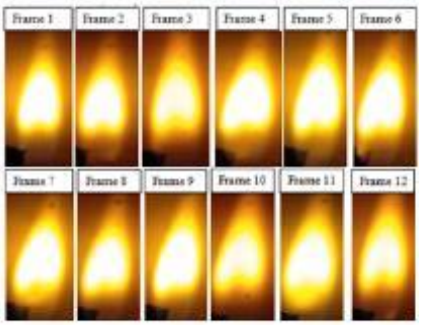
Image of Acetic Acid Flame 12%

Image Recording of Sugar Water Flames

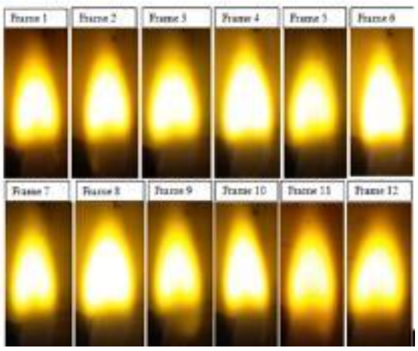
Image of Sugar Water Flames 8%

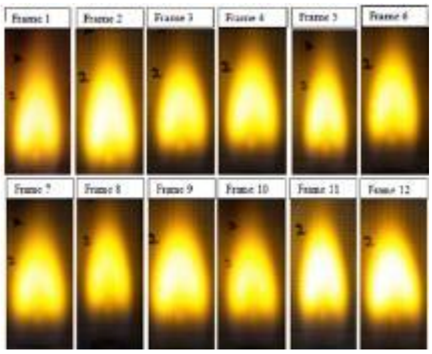
Image of Sugar Water Flames 14%

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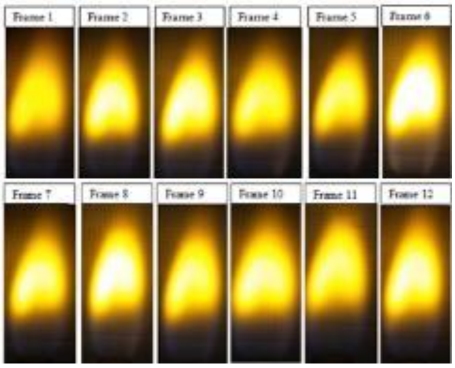

Image of Sugar Water Flames 10%

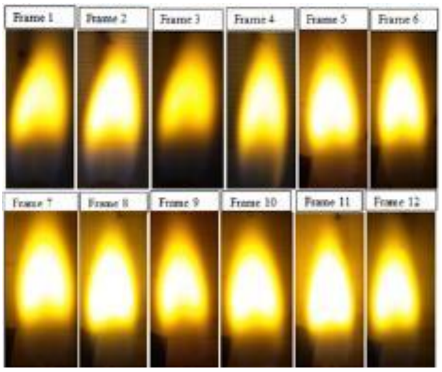

Image of Sugar Water Flames 16%

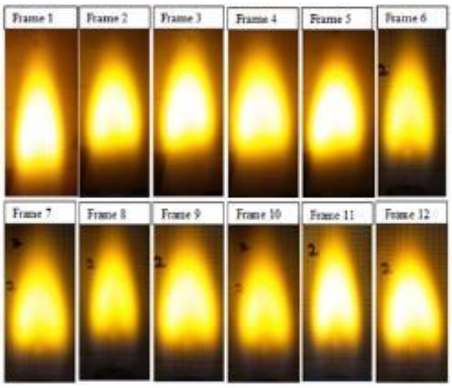

Image of Sugar Water Flames 12%

Figure 3. Recording Results Of Water Sugar Flame ($C_{12}H_{22}O_{11}$)

How to measure the height and width of the flame and the brightness of the flame using image-j software is shown in the image below.

GRAPHIC ANALYSIS

Graph of the Effect of Flame Brightness Level on the Percentage of Acetic Acid Catalyst and Sugar Water

From table 3.2 it can be graphed the effect of the brightness level (red green blue) with the addition of the percentage of acetic acid and sugar water catalysts of 8%, 10%, 12%, 14% and 16%.

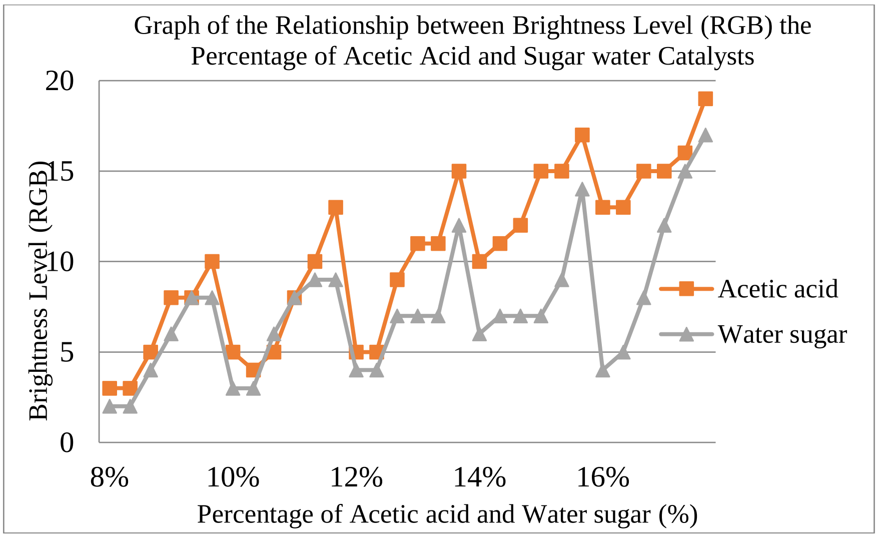

Figure 4. The effect of the brightness level (Red Green Blue) of the percentage of Acetic acid and Water sugar

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Seen in Figure 4. the effect of the brightness level (Red Green Blue) with the addition of the percentage of Acetic Acid and Sugar Water in the test 6 times with variations in the addition of the percentage of Acetic Acid and Catalyzed Sugar Water from 8%, 10%, 12%, 14%, and 16 %. At the percentage of 16% Acetic Acid and Sugar Water catalyst, the highest brightness levels (Red Green Blue) were 19 RGB and 17 RGB. And the lowest brightness level (Red Green Blue) of 8% is 3 RGB and 2 RGB. caused by the volume of hydrogen, the more the percentage of Acetic Acid and Sugar Water catalyst, the greater the level of brightness (Red Green Blue) produced from the electrolysis process in the HHO generator.

Graph of the Influence of the Percentage of Acetic Acid and Sugar Water (%) on the Width of the Flame (cm)

From table 3.2 it can be graphed the effect of the height and width of the flame with the percentage of acetic acid and sugar water catalysts of 8%, 10%, 12%, 14% and 16%.

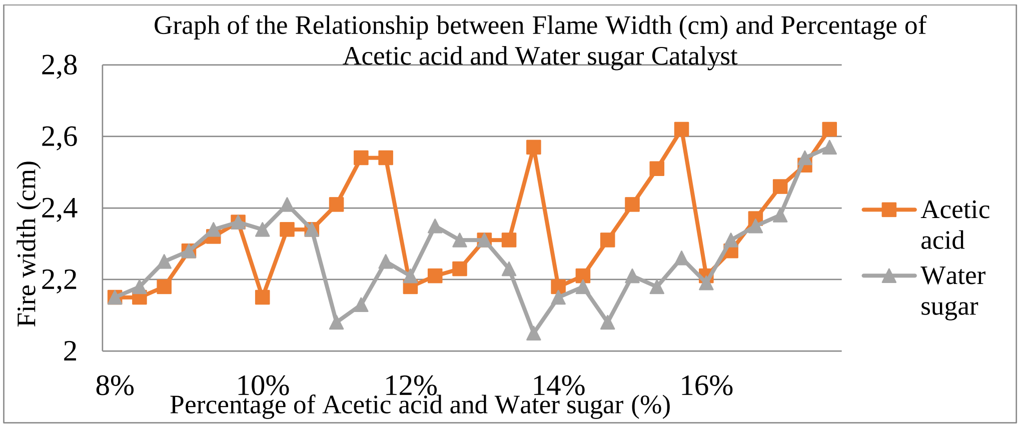

Figure 5. Graphs of the effect of flame width with of the percentage of acetic acid and sugar Water catalysts

Seen from Figure 5, the relationship between flame width and variations in the percentage of acetic acid catalyst and sugar water used is 8%, 10%, 12%, 14% and 16%. It can be seen that the highest flame widths produced at the percentage of 16% acetic acid catalyst and sugar water are 2.62 cm and 2.67 cm. and the lowest flame width at a percentage of 8% Acetic Acid was 2.15 cm and sugar water was 2.15 cm.

Graph of the Effect Percentage Acetic Acid Catalyst and Sugar Water (%) on Flame Height (cm)

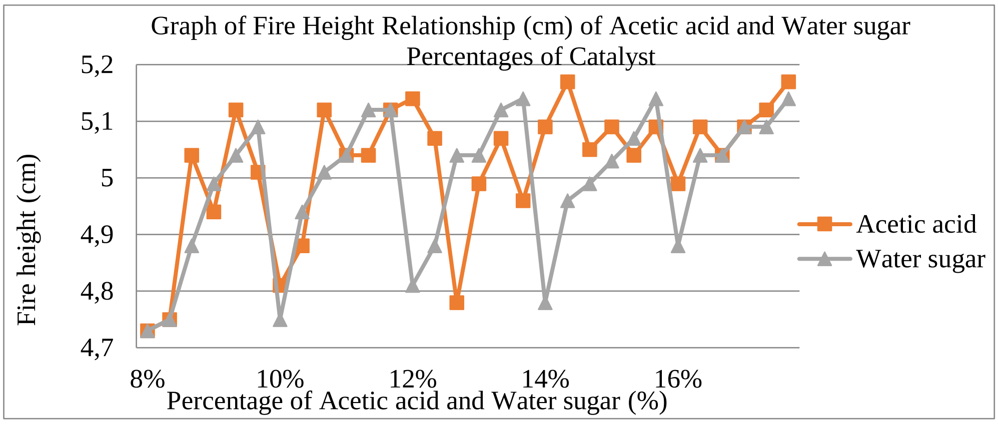

Figure 6. Graph of the effect of high flame (cm) with of the percentage of acetic acid and sugar water catalysts

It can be seen from Figure 6 that the relationship between flame height and variations in the use of acetic acid and sugar water catalyst percentages is 8%, 10%, 12%, 14%, and 16%. It can be seen that the highest flame height was produced at the percentage of 16% acetic acid catalyst and sugar

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water, namely 5.17 cm and 5.14 cm. and the lowest flame height at the percentage of acetic acid 8% is 4.73 cm and sugar water is 4.73 cm.

From Figure 6 it can be seen that the greater the percentage of addition of acetic acid catalyst and sugar water, the higher the flame height will be and vice versa. This is caused by the volume of hydrogen. The large volume of hydrogen allows for a higher flame than the smaller volume of hydrogen. Conditions like this cause a large volume of hydrogen causing a higher flame.

Graph of the Relationship of Hydrogen Volume with Percent of the Acetic Acid and Sugar Water Catalysts

From table 3.1, you can graph the relationship between the volume of hydrogen and the percentage of acetic acid and sugar water added.

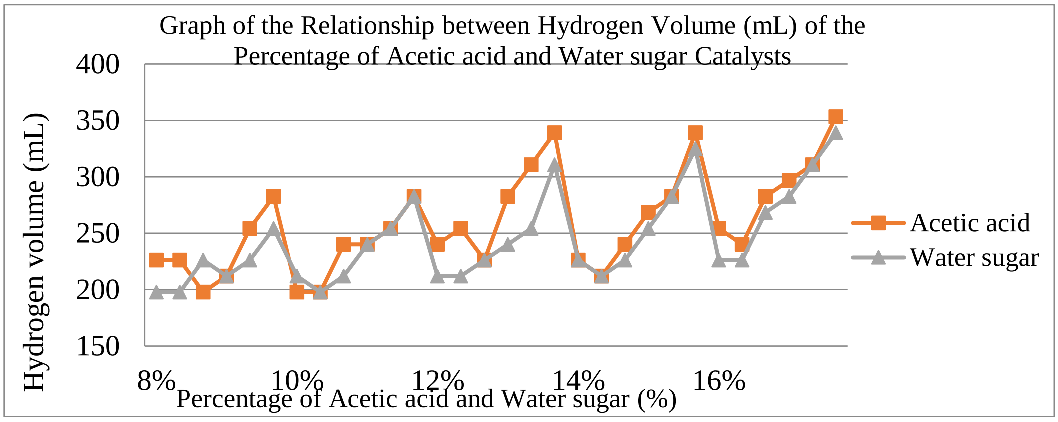

Figure 7. The relationship between the volume of hydrogen and the percentage of acetic acid and sugar water catalysts

Can be seen in Figure 7 The relationship between the volume of hydrogen with of the percentage of acetic acid catalyst and sugar water 8%, 10%, 12%, 14%, and 16%. At a percentage of 16%, the volume of hydroge acetic acid is 353 mL and sugar water is 339 mL. and the lowest hydrogen volume at the percentage of 8% is 212 mL and 198 mL. This is because the more catalyst, the greater the volume of hydrogen produced through electrolysis and if the mass of catalyst added is the same, the volume of hydrogen produced will be greater.

Graph of the Relationship of Flame Temperature with the Percentage of the Acetic Acid and Sugar Water Catalysts

From table 3.1 it can be described the relationship between the flame temperature and of the percentage of acetic acid catalyst and sugar water.

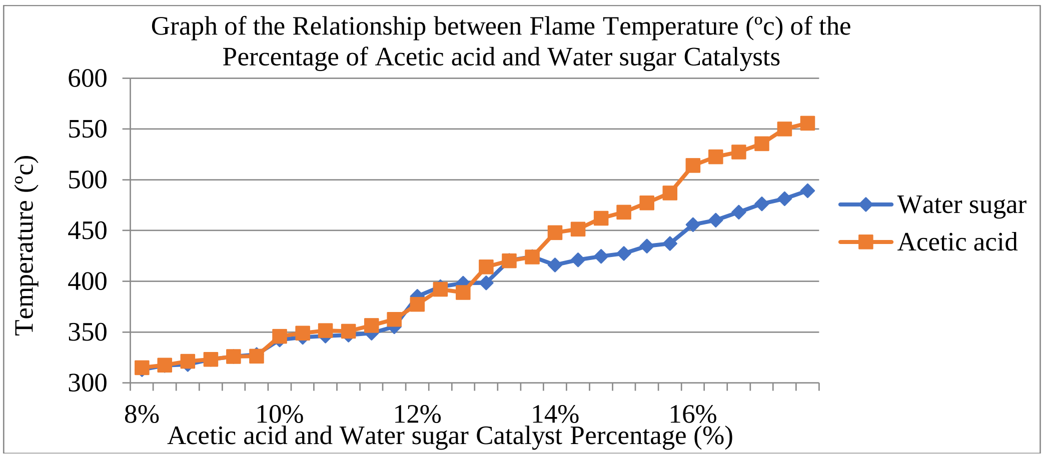

Figure 8. Graph of the relationship between the temperature of the flame with of the catalyst percentage of acetit acid and sugar water

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From Figure 8, it can be seen that the highest temperature produced with a catalyst percentage of 16% acetic acid was 556 ^{0}C and sugar water was 489 ^{0}C, the lowest temperature with a percentage of 8% acetic acid was 315 ^{0}C and sugar water was 313 ^{0}C. This condition is caused by the volume of hydrogen. The large volume of hydrogen allows the flame to burn longer than the smaller volume of hydrogen. Therefore, a large volume of hydrogen is the highest flame temperature.

Flame image processing uses Image-J software to obtain flame brightness and flame color temperature (RGB) values. The best sample of data is selected.

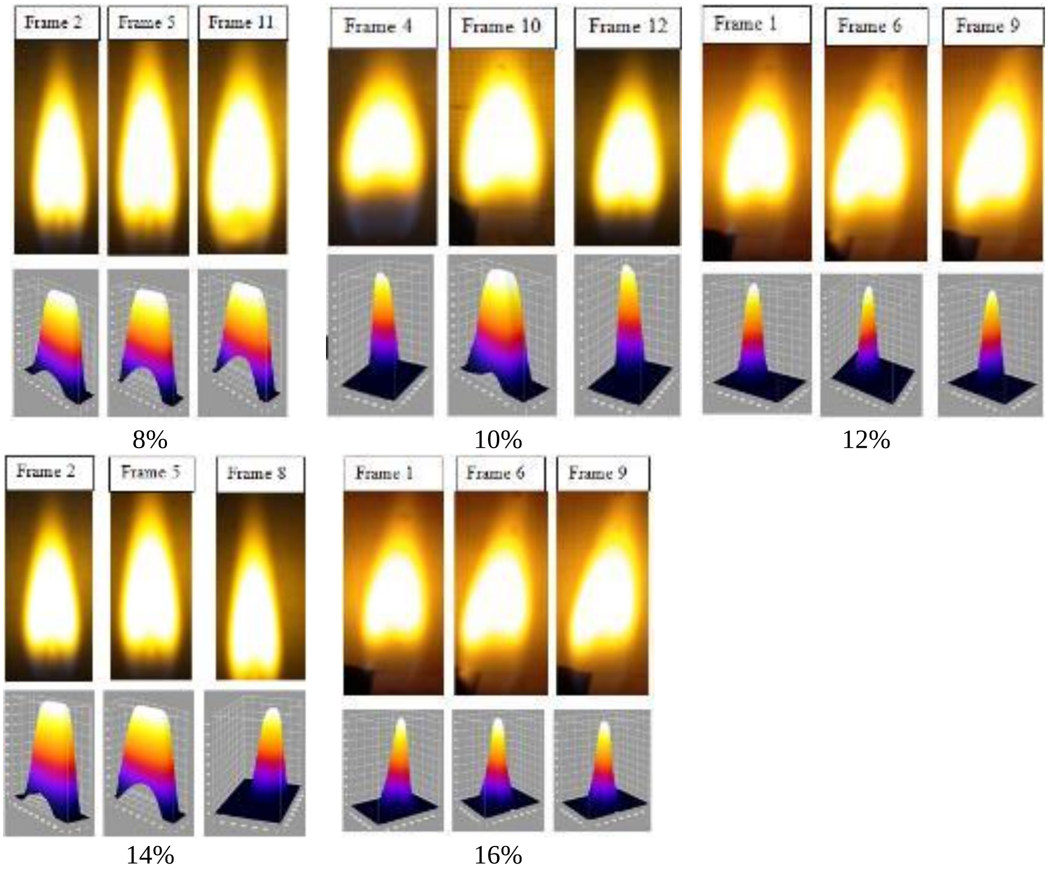
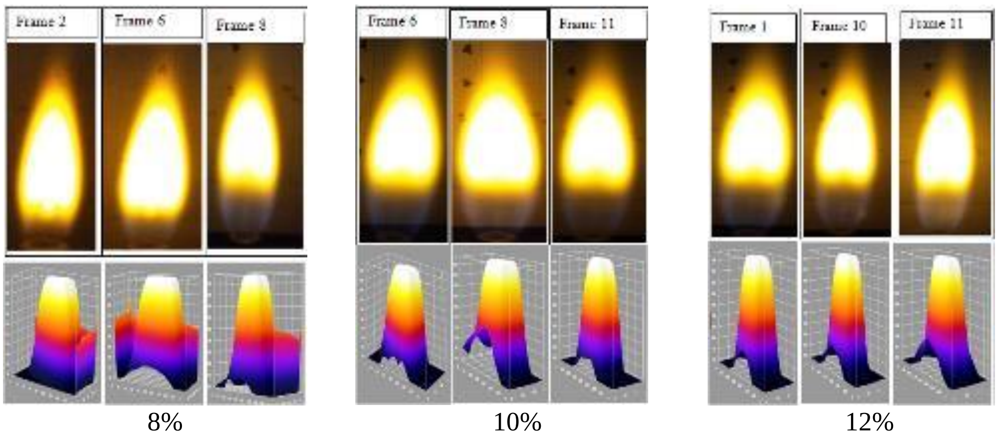


Figure 9. Processing using image-J acetic acid flame (CH_3COOH)



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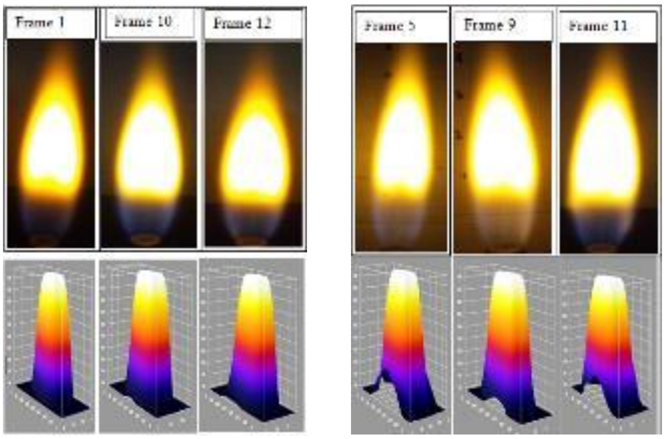

14% 16%

Figure 10. Processing using image-J sugar water flame ($C_{12}H_{22}O_{11}$)

From the image above, it can be seen that the flame results using the image-J application show that the shape, size and brightness of the flame resulting from each measurement is different with of the catalyst, 8%, 10%, 12%, 14% and 16% using distilled water as a solvent. From the data in the research table it can be seen that the hydrogen production data on the acetic acid and 16% sugar water catalyst mass produces hydrogen volumes of 353 mL and 339 mL within 60 seconds while the smallest volume is hydrogen production at 8% is 212 mL and 198 mL for 60 seconds. In fact, the higher the percentage of acetic acid catalyst and sugar water, the faster the electron transfer reaction to the electrode, so that electrolysis releases more water molecules, so the volume of hydrogen increases.

The highest flame temperature was obtained at a percentage of 16% with acetic acid 556 ^{0}C and sugar water 489 ^{0}C and the lowest flame temperature was obtained at a percentage of 8% with acetic acid 315 ^{0}C and sugar water 313 ^{0}C. Therefore this is due to the volume of hydrogen. At a larger volume of hydrogen, the flame will burn longer than with a smaller volume of hydrogen. A longer flame gives the thermocouple a greater opportunity to equalize the measured temperature. This condition causes the large HHO mass to increase the flame temperature even higher and vice versa.

For the highest level of flame brightness at a percentage of 16% with an acetic acid catalyst of 19 RGB and sugar water of 17 RGB, the lowest level of flame brightness is at a percentage of 8% with an acetic acid catalyst of 3 RGB and sugar water of 2 RGB. This is caused by the volume of hydrogen. At large volumes of hydrogen, the flame area increases and at small volumes of hydrogen, the brightness decreases.

At a percentage of 16% with an acetic acid catalyst it produces a flame width of 2.62 cm and sugar water of 2.57 cm and the lowest flame width at a percentage of 8% with an acetic acid catalyst of 2.15 cm and sugar water of 2.15 cm. and the highest flame height with a percentage of 16% with an acetic acid catalyst of 5.17 cm and sugar water of 5.14 cm with the lowest flame height with a percentage of 8% with an acetic acid catalyst of 4.73 cm and sugar water of 4.73 cm.

CONCLUSION

Based on the research that has been carried out, it can be concluded as follows:

1. The higher the percentage of vinegar catalyst and sugar water added produces a larger volume of hydrogen.
2. The addition of a higher percentage of vinegar and sugar water produces a greater flame temperature, changes in flame height and width and brightness (luminuity)

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