Development Hydrogen Gas Generator for Duel Fuel Engine Using Capacitor Water Fuel Cell Method

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Report submitted in partial fulfillment of the requirements for the award of the Diploma of Mechanical Engineering

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I hereby declare that I have checked this project report and in my opinion this project is satisfactory in terms of scope and quality for the award of Diploma in Mechanical Engineering.

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Date : 30 DECEMBER 2011

STUDENT DECLARATION

I hereby declare that the work in this report is my own except for quotations and summaries which have been duly acknowledged. The report has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature :

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ABSTRACT

This report shows the design and fabrication of the fuel-saving plate-electrode device on gasoline fuel engine. The objective of the report is to develop the procedures to design and fabricate the fuel-saving plate-electrode base device on gasoline fuel engine. Design generation is showed and solid three dimensional structures modeling of the test rig was developed with the solid work software. Material selection and the reason behind the selection are shown based on criteria predetermined. Based on the selection, plastic and steel are selected. This project is difficult to make because it is hard to find the references and information of similar project. As the conclusion, this project has achieved its goal through the successful of the product making.

ABSTRAK

Laporan ini menunjukkan rekaan dan pembuatan alat penjimat minyak menggunakan kepingan besi sebagai elektrod untuk enjin yang mengunakan gasoline sebagai bahan bakar. Objektif laporan ini adalah untuk menhasilkan prosedur-prosedur dalam pembuatan alat penjimat minyak menggunakan kepingan besi sebagai elektrod untuk enjin yang mengunakan gasoline sebagai bahan bakar. Generasi rekaan ditunjukkan dan struktur model tiga dimensi alat penjimat minyak dibangunkan melalui perisian solid work. Pemilihan bahan dan sebab-sebab pemilihan ditunjukkan berdasarkan bahan yang telah dipilih. Plastik dan besi telah dipilih untuk pembangunan projek ini. Penghasilan projek ini sukar kerana rujukan dan maklumat tentang projek ini sukar ditemui dan terhad. Sebagai kesimpulan,misi projek ini telah tercapai melalui penghasilan alat penjimat minyak yang telah dilakukan.

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CHAPTER 1

INTRODUCTION

1.1 PROJECT INTRODUTION

This project involves in designing and fabricating the fuel saving device. The basic system used to generate the device was the electrolysis. Basically, the working session could be divided into three stages, which were the concept review and development, designing, and fabrication. The device was invented by using the fasteners like plate aluminum and cork (rubber cover) that were used to build the structure of electrode for the electrolysis system. Then, the pair of electrodes were hanged inside of a plastic container that act as the container of the electrolyte for the electrolysis process. Apart from plastic containers, aluminum plate size and plate spacing aluminum important role in the electrolysis. Electrical connection was also required for generating the device in order to run the electrolysis. Lastly, a small plastic container was used in order to accumulate the gas that was produced by the electrolysis process before being flowed into the intake manifold.

1.2 PROBLEM STATEMENT

Nowadays, most people find it is difficult when the fuel for their vehicle runs out before the allocated time. If this problem continues, consequently it will rise up their spending or budget for the fuel for example budget for the fuel for a week. It also can affect to the individual's working quality and efficiency. For example, getting scolded by the boss because of getting late to work caused by the running out of the fuel. Moreover, people stated that in the past, the fuel was hard to runs out within a period of time, although the spending remains the same as present. Meaning that the price is still the same, but the volume is decrease due to the global economy rate.

1.3 PROJECT OBJCTIVE

The objectives of this project are:

- To design and fabricate a fuel saving device systemized with the electrolysis system by using the plate electrode base.
- To investigate the usage of the device whether can decrease the usage of gasoline fuel or not.

1.4 PROJECT SCOPE

The specific scope of this project is to design and fabricate a fuel saving device. Its purpose is to minimize the fuel usage on a vehicle by supplying the hydrogen gas produced by the device which is done through the electrolysis process, then channeled into the intake manifold to be used for the combustion of the engine.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

There are many forms of fuel saving device that are available in the market. Some are invented in the form of gadget, and some are in the form of additional substances for the fuel that used for the internal combustion of engine. Back of the time, there was a Canadian inventor, Charles Nelson Pogue, who had invented the 200 mpg carburetor, used as a fuel saving gadget for vehicles. But, the invention was claimed difficult to justify because the invention did not undergo any testing or demonstration that proved the carburetor loud save up the fuel usage. Nowadays, people had invented the fuel saving device in many ways especially in the form of fuel additives. Materials such as tin, magnesium and platinum compound are used for the additives. Generally, these usages of additives purposely to improve the energy density of the fuel by virtue of the material added. But some of the other additives also can cause harmful for the internal plastic parts in the fuel system such acetone. For my project, the device is invented in the form of gadget. The body of the device is mainly about plastic. The electrode is built by using the fasteners that made of steel that have the characteristic of the electrical conductivity. And the system of my device is also based on the electrolysis system in order to generate the device for producing the hydrogen gas that later used for the combustion.

2.2 TYPE OF FUEL SAVING DEVICE

Figure 2.1: Voltage Stabilizer.

The product name is voltage stabilizer. The function of this product is for fuel saving for vehicle that using petrol. This product is easy to use because the connection from terminal to car socket (cigarette-lighter socket).

Advantages

- Very accurate output voltage regulation.
- Wide choice of kVA rating, voltage and configuration.
- Easily applicable to outdoor application.
- High tolerance to system faults and overload.
- High tolerance to power factor and frequency deviations.
- Good line isolation.
- Relatively inexpensive.

Disadvantages

- Mechanical drive components, brushes and contactors require regular maintenance And/or replacement
- Frequent overloads can damage brushes.
- Speed of voltage correction correct may not be fast enough for electronic loads.

Figure 2.2: Gas Saving Gadget.

Figure 2.3: Prozone.

Figure 2.4: Tezkar Fuel Saver.

Figure 2.5: Hydro-Octane Booster.

This product has two ways which is outlet and inlet. The source of oil tank was connected to the inlet of this product and the pipe from this product was connected to the carburetor.

Advantages

• Relatively concentrated and you can travel many hundred km with one full tank of petrol.
• It is highly available.
• It is fairly cheap.
• It is not difficult to make - it just has to be distilled and no waste is produced.
• It is easy to carry around.
• It is fairly safe to store.

Disadvantages

• The supply of petrol is decreasing and we will one day run out of it.
• Because of the high demand and decreasing supply, the price of petrol is increasing.
• It greatly affects the environment as carbon is produced when petrol is burned.
• Petrol can be much better used to create other products like plastics and chemicals.
• Wars and international disputes have formed from petrol.

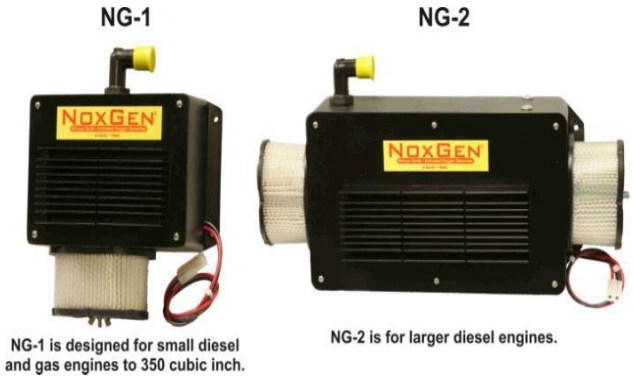

Figure 2.6: Nox Gen Fuel Saving Device.

Figure 2.7: Force Flow Turbine Fuel.

Figure 2.8: Fuel EX Fuel saver.

Figure 2.9: Air Compressor Fuel Saver.

ECO-Power Compressor is simple technology designed to improve fuel economy. Developed based on the scientific principle of magnetic .This amazing revolutionary device enhances the molecular structure of the fuel resulting in a better and more complete combustion. As the fuel passes through the highly focused charges, the molecular bonds and spins are enhanced, re-arranged and aligned. These molecule structural changes result in a more complete combustion.

Product Name : HKS Secondary Fuel Saving Accelerator/HKS Micro Air Compress Fuel Saver/Hks power compressor with meter for all car, high quality.

Item Code : 43200848

Category : Air-Compressors

Port : Ningbo

Type : Turbo

Advantages

Saves fuel up to 5% to 35%.

• Easy to fix (no modification on original engine)
• Cheaper price
• Compatible to all cars
• Maximizes energy
• Saves fuel up to 5% to 35%
• Improves spark plug life.
• Improves torque
• Increases car engine power 15% to 35%
• Environment friendly
• Smother running engine, by promoting a more complete combustion.
• The Combustion of the air and fuel mixture is more complete compare with the engine without micro compressor.
• No need any supported accessories (can function well independently).
• All the components inside the micro compressor function 100% mechanically.
• Won't make any noise to your engine.
• Won't cause any side effect to your engine.
• Small size component (compatible with all kind of engine).
• Light, not bulky & easy for handing.
• Product Weight: 1kg.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

For the diagram in **Figure 3.1** below, the project is started with the literature review and research about the title. This consists of the review of the concept of the fuel saving device, type of the fuel saving device, and the features of the fuel saving devices used in various fields. These tasks have been done through the research based on internet, books, and other sources. After gathering all the relevant information's, the project undergoes the designation process. In this step, the knowledge gathered are used to make several sketches or designs that may be fit for this project. After that, design consideration have been made in order to chose the best design so later on it can be built-up. The selected design's sketch is then transferred into the solid modeling generated by the solid work program. The materials and the measurements needed for the device were listed down and calculated in order to give an ergonomic shape of the device. After listing up the materials needed, acquisition step take place. There are only few materials that are needed to be bought such as wires, tubes and other additional accessories for the production of the product. The next step is the fabrication process. The design and the drawing are used as the references in order to build the device.

The fabrication process that involved in this project are drilling, assembling and fastening. After each of these processes is finished, the product undergoes the inspection session so that the product obeys the design and drawing that have been made earlier.

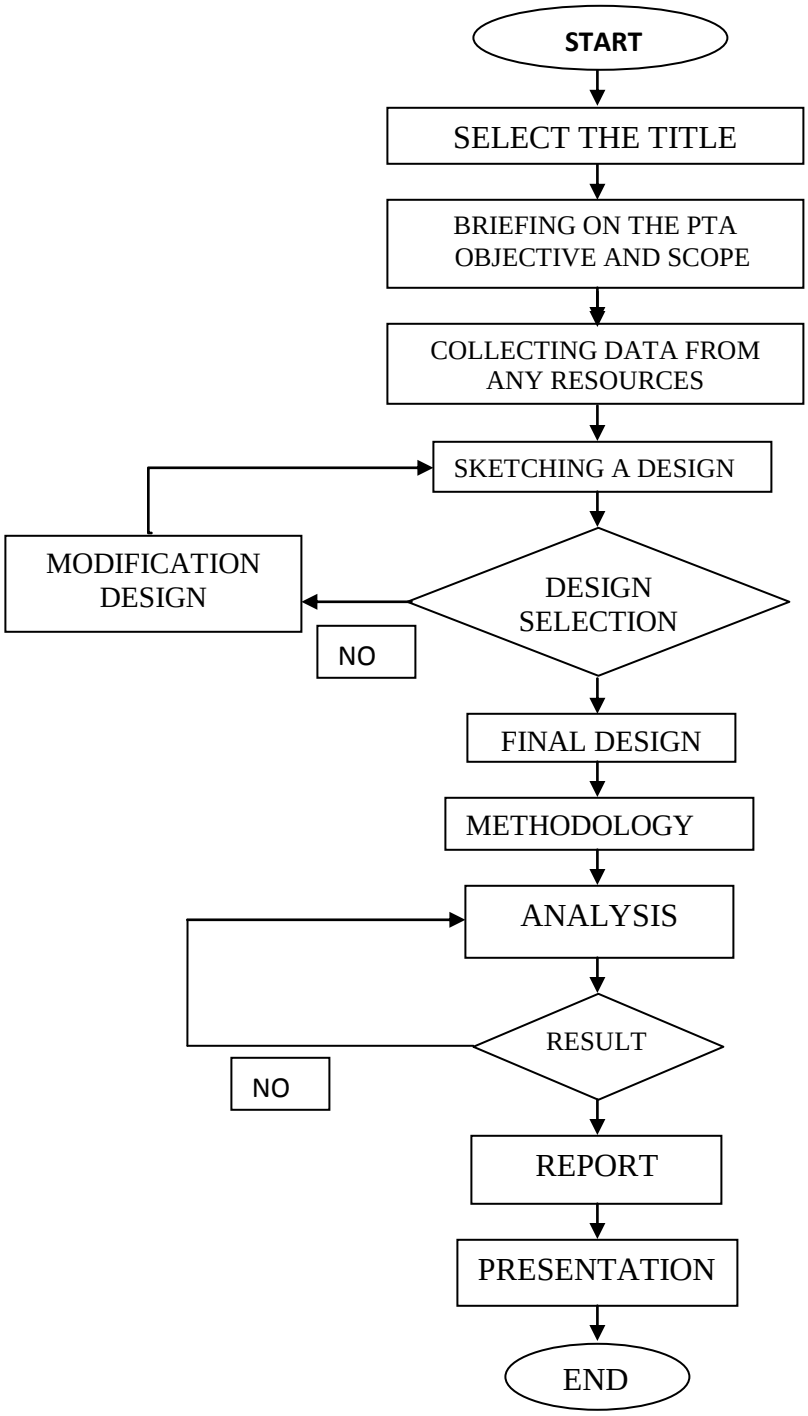

Figure 3.1: Flow Chart

The product is then being tested in order to get the result as stated in the project objective. During the testing session, if any problem occurs such as malfunction and others, the device will step back to the previous process where all the mistakes and errors will be fixed.

After fixing up the errors, the testing session will be done again in order to get the expected result. If the testing goes well, then it will proceed to the last stage, the discussion. In the discussions data, the draft report and all the related things are gathered and handed over to the supervisor to be checked in order to ensure that there is no mistake done for both the project and report.

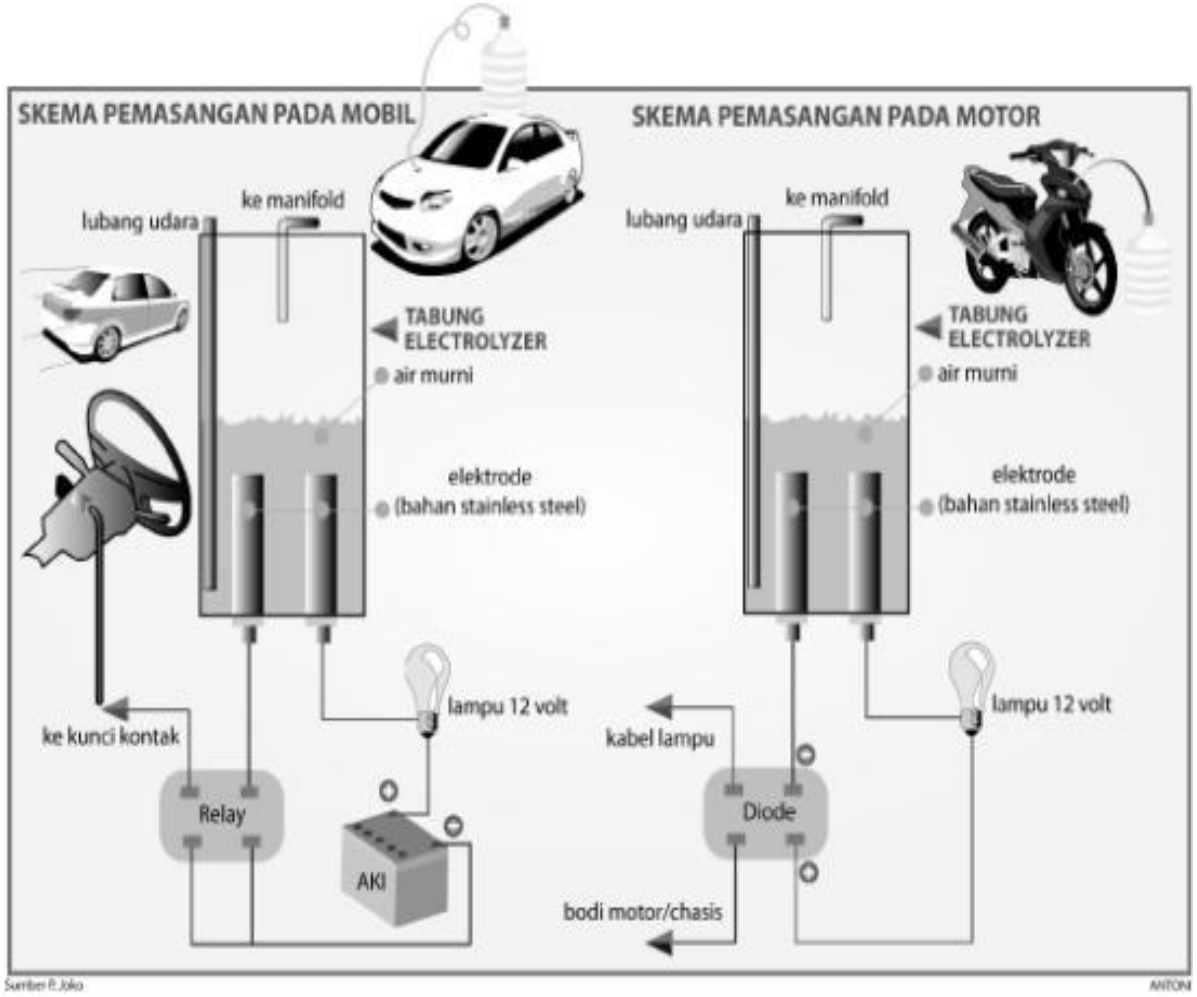

Figure 3.2 Example of electrolysis

The **figure 3.2** show analysis of both types of vehicle that using gasoline fuel. Which carry out electrolysis process to produce bubble to be distributed into intake manifold of vehicle.

3.2 DESIGN

The design of the device must comply with several aspects. The design consideration must be done carefully so the design can be fabricated and functioned well. The aspects that must be considered in designing the device are:

3.2.1 Ergonomic factors:

The fuel saving device must be user friendly such as easy to use and convenience.

3.2.2 Safety:

The fuel saving device must have the characteristic of electrical insulator since it is generated by the electricity source.

3.2.3 Size of the plate electrode:

The larger the surface of the plate electrode, the higher the rate of electrolysis. So, the gas production is also high.

3.3 DRAWING

The drawing is divided into two categories which are :

3.3.1 Sketching:

All ideas for the device fabrication are sketched first so that the idea selection can be made.

3.3.2 Solid modeling:

The selected designs or sketched concepts are transferred to solid modeling using Solid work software.

3.4 SKETCHING DRAWING SELECTION

From the existed ideas, only three sketches that has been chosen to be considered as the final ideas which are:

3.4.1 First Design

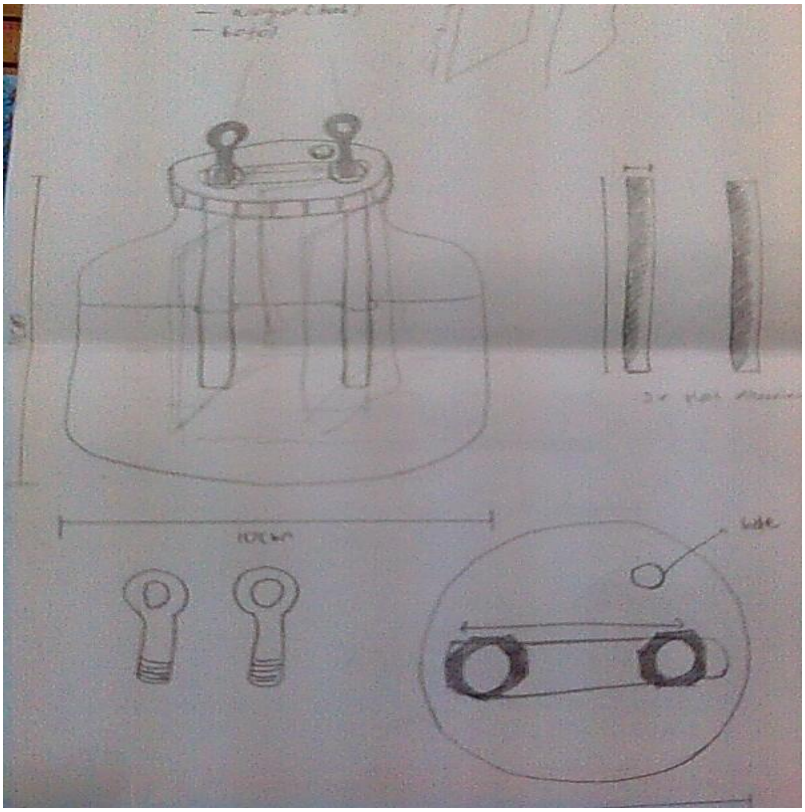

Figure 3.3: Concept A

Advantage

- Can be built up easily
- Easy to use
- Portable

Disadvantage

- Gas production is low due to the size of the plate
- No safety measure applied to protect the engine since the water can be directly sucked the into engine.

3.4.2 Second Design

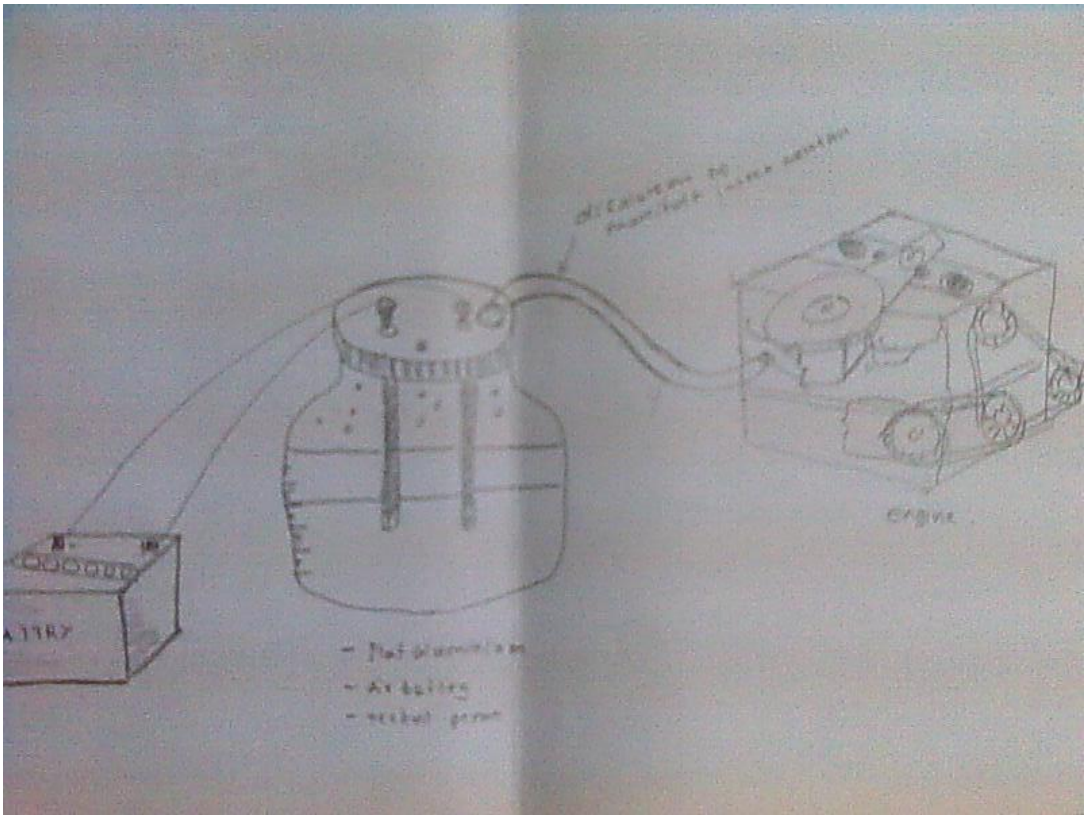

Figure 3.4: Concept B

Advantage

- Easy to build
- Easy to use
- Gas production is high than before due to the larger area of the electrode plate.

Disadvantage

- No safety measure applied since the water can directly being sucked into the engine.

3.4.3 Third Design

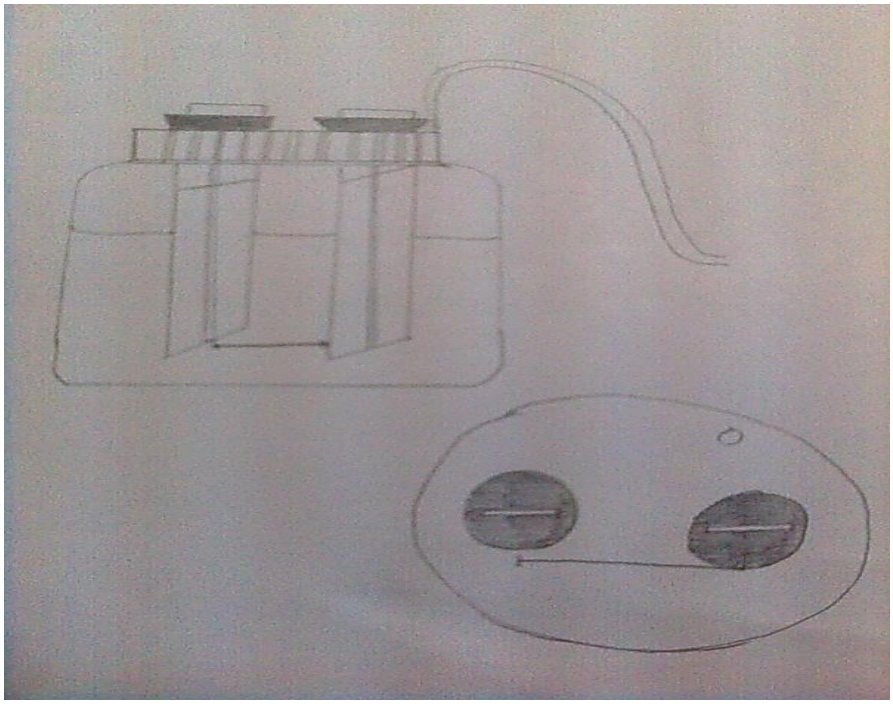

Figure 3.5: Concept C

Advantage

- Easy to use
- Portable
- Easy to build
- Gas production is higher due to the size of the plate.
- Safety measure applied
- Light and easy to shapes.

Disadvantage

- Need more space to install

3.5 CONCEPT GENERATION AND EVALUATION

Four concepts for the fuel saving device are developed and evaluated against the datum of the device using the Pugh concept selection. The comparison between each concepts are shown in **Table 3.1**.

Selection Criteria	**Concept**			
	X(Datum)	**A**	**B**	**C**
Easy to manufacturing	0	+	+	+
Easy to use	0	+	+	+
Portability	0	+	+	+
Function	0	0	0	0
Efficiency	0	-	+	+
Safety	0	-	-	+
Σ+	6	3	4	5
Σ0	0	1	1	1
Σ-	0	2	1	0
Net score	0	1	3	5
Ranking	4	3	2	1

"0": Same as "-": Worse than "+": Better than

Table 3.1: Pugh's Selection Method

According to the Table 3.1, Concept C is chosen because it is simple yet convenience. It is because the device is portable, easy to use, easy to manufacture, and also can function effectively. Besides that, the Concept C is equipped with a small container which helps in collecting the gas effectively and then channeled into the manifold without the water because the container also acts as the filter. Thus, it is a safety feature that is used for the device to prevent the engine from damage.

3.5.1 FINALIZE DESIGN

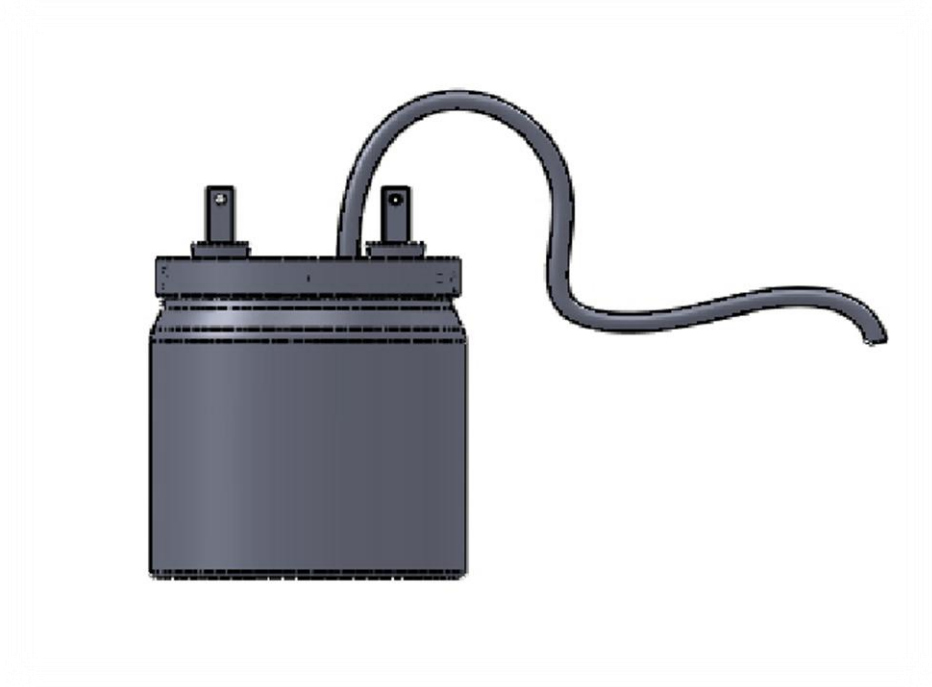

Figure 3.6 Final Design

I choose the third design as my final design because according to the concept screening example Pugh selection method it the was suitable design for my project to comply with the scope and objective.

3.6 FUNCTION

The main function of the device is to decrease the fuel usage on a vehicle. This can be done by the device that operates the electrolysis system which then produces hydrogen gas. Then, it will be channeled into the intake manifold and get along with the gasoline and sued for the combustion of the engine. Thus, this can reduce the amount of gasoline that enters into the combustion chamber by supplying along it with the hydrogen gas produce by the device. Meaning that amount of fuel that inserted into the engine after attaching the device is lower than before we attaching the device.

3.7 JOINING METHOD

Joining method that is used in this project is fasteners. This joining method is used when build-up the electrode for the electrolysis system.

3.8 FASTENERS

Generally, fastener is a hardware tool that mechanically joins two or more objects together.

3.8.1 Cork.

Figure 3.7

Among its valued properties are its lightness, impermeability to liquids, and resistance to wear, rot and temperature extremes and its renowned compressibility. Being elastic, cork is also more tolerant than other materials of changes to temperature and pressure.

3.8.2 Plate aluminum

Figure 3.8

Physically, chemically and mechanically aluminum is a metal like steel, brass, copper, zinc, lead or titanium. It can be melted, cast, formed and machined much like these metals and it conducts electric current. In fact often the same equipment and fabrication methods are used as for steel.

3.8.2.1 Light Weight

Aluminum is a very light metal with a specific weight of 2.7 g/cm3, about a third that of steel. For example, the use of aluminum in vehicles reduces dead-weight and energy consumption while increasing load capacity. Its strength can be adapted to the application required by modifying the composition of its alloys.

3.8.2.2 Corrosion Resistance

Aluminum naturally generates a protective oxide coating and is highly corrosion resistant. Different types of surface treatment such as anodizing, painting or lacquering can further improve this property. It is particularly useful for applications where protection and conservation are required.

3.8.2.3 Electrical and Thermal Conductivity

Aluminum is an excellent heat and electricity conductor and in relation to its weight is almost twice as good a conductor as copper. This has made aluminum the most commonly used material in major power transmission lines.

3.8.2.4 Reflectivity

Aluminum is a good reflector of visible light as well as heat, and that together with its low weight, makes it an ideal material for reflectors in, for example, light fittings or rescue blankets.

3.8.2.5 Ductility

Aluminum is ductile and has a low melting point and density. In a molten condition it can be processed in a number of ways. Its ductility allows products of aluminum to be basically formed close to the end of the product's design.

3.8.2.6 Impermeable and Odorless

Aluminum foil, even when it is rolled to only 0.007 mm thickness, is still completely impermeable and lets neither light aroma nor taste substances out. Moreover, the metal itself is non-toxic and releases no aroma or taste substance which makes it ideal for packaging sensitive products such as food or pharmaceuticals.

3.8.2.7 Recyclability

Aluminum is 100 percent recyclable with no downgrading of its qualities. The re-melting of aluminum requires little energy: only about 5 percent of the energy required to produce the primary metal initially is needed in the recycling process.

3.8.3 Baking Powder (sodium bicarbonate)

Figure 3.9 Baking Powder

Baking soda isa dry chemical leavening agent used to increaseis the volume.Spra d bakingsoda acts by carbon dioxide into a mixture Oran acid base reaction,
causing bubbles in the mixture mixed. Most of the commercial baking powder made from commercial baking powder is made of (usually baking soda, also known as sodium bicarbonate) alkalinity, one or more of the acid salt, and baking soda a common starch is a source of carbon dioxide, and the acid-base reaction can be generically represented as:

$$NaHCO3 + H + \rightarrow Na + + CO2 + H2O$$

3.9 ELECTROLYSIS OF WATER

Is the decomposition of water to produce oxygen and hydrogen gas by letting electrical current passed through the water.

3.9.1 PRINCIPLE

Electrical source is connected to the two electrodes, the positive and negative terminals which are then place in the electrolyte. When current passes through the electrolyte which is the water for example, the electrolyte then breaks into hydrogen and hydroxide ion that are then will be attracted to the both terminal depend not he opposition of the polarities and then undergoes chemical reaction.

- Reduction at cathode or negative terminal : $2H^+(aq) + 2e^- \rightarrow H_2(g)$
- Oxidation at anode or positive terminal : $2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$

Thus, in this project, we used the hydrogen gas produced by the fuel saving device as the addition in the combustion chamber in order to reduce the fuel usage that are inserted for the combustion.

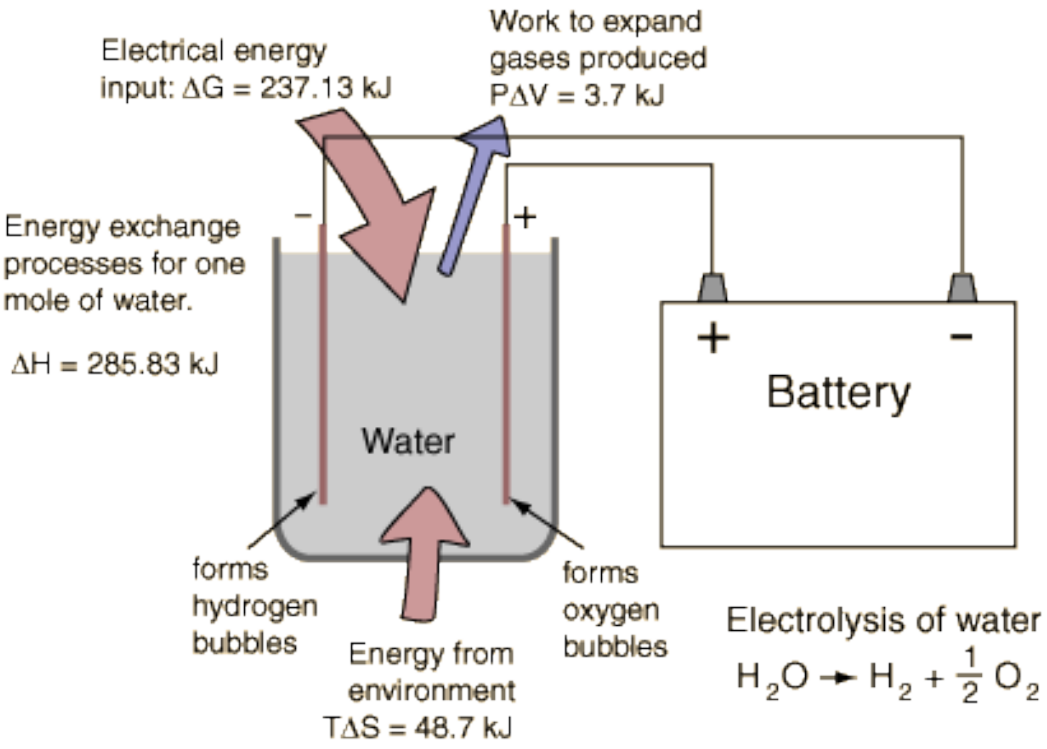

Figure 3.10 Example of process hydrogen

Figure 3.10 show that me example of process to produce hydrogen. Battery is being used as a source of electricity to connect to the terminal (+) and (-) of aluminum plate. Then aluminum plate was inserted to the container fill with mixture of battery water and sodium bicarbonate. After that, electric current was connected to the terminal (+) and (-) to produce hydrogen bubble.

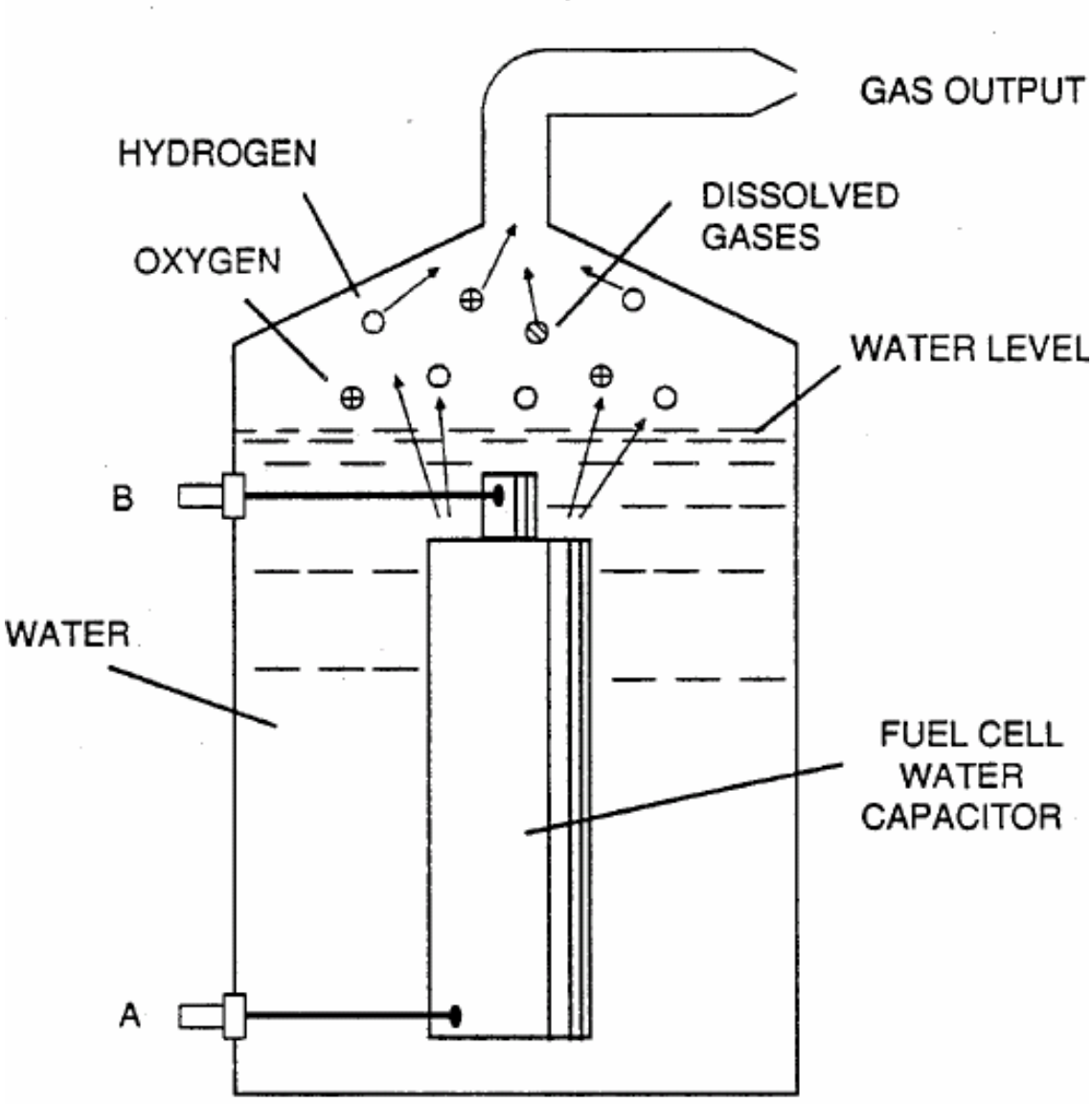

Figure 3.11 Example of process hydrogen

3.9.2 HYDROGEN AND OXYGEN

Table 3.2: Hydrogen and Oxygen Characteristic

Hydrogen (H2)	Oxygen (O2)
o Element with the atomic number of one. o Represented by the symbol of "H". o Lightest and most abundant chemical elements. o Highly flammable. o Burn in air at very wide range of volume concentration.	o Element with the atomic number of eight o Represented by the symbol of "O". o Can cause combustion when it is highly concentrated. o Act as oxidant.

3.10 FUEL

Material that are usable in generating energy to produce work. In other words, fuel are a substance that produce energy mostly generated by usable heat. Common type of fuels are used nowadays are hydrocarbons.

3.10.1 GASOLINE

A petroleum derived liquid mixture used for internal combustion engine. Obtained from the fractional distillation, it is then enhanced with the isooctane and benzene to increase the octane rate.

3.11 EDDY CURRENT TYPE ABSORBER

Is an electromagnetic load device. The engine is being tested spins the disc in the dynamometer. Electrical current passes through coils surrounding the disc, and induce a magnetic resistance to the motion of the disc. Varying the current varies the load of the engine.

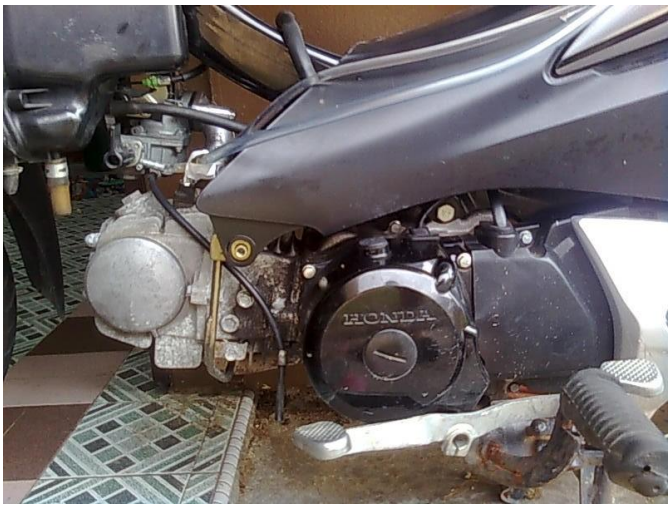

Figure 3.12: Engine

3.11.1 Specifications of engine 4-stroke

ITEM	SPECIFICATION
Engine	4-Stroke. OHC. Air-cooled
Displacement	97.1 cc
Bore X stroke	50 mm x 49.5 mm
Compression Ratio	9.1:1
Max. Output / RPP	5.36 kw/8,000 rpm (or 7.3PS/8,000 rpm)
Max. Torque / RPM	7.34 N-m/5,500 rpm (or 0.75kg-m/5,500 rpm)
Engine Oil Capacity	0.9 Liter
Transmission	4-Speed, Rotary Type
Starter	Electric Starter / Manual Starter
Dimension (LxWxH)	1898 mm x 705 mm x 1057 mm
Dry Weight	96.6 kg.
Fuel Tank Capacity	3.7 liters
Wheel Base	1208 mm
Seat Height	751 mm
Min. ground clearance	130 mm
Front Suspension	Telescopic Fork
Rear Suspension	Twin

3.12 FABRICATION PROCESS

This process is about to fabricate the device using the materials selected and make it based on the design by following the dimension stated. Many methods can be used to fabricate the product like fastening, drilling, fastening, and also many other method. Fabrication process is difference to the manufacturing process. Fabrication involves in making a product only while manufacturing involves in producing the products in a large batch.

3.13 PROCESS INVOLVED

In order to make the design comes to reality, fabrication process needs to be done first. The fabrication process starts from dimensioning the materials unit until it is finish as a desired product. The process that involved in this project is:

3.13.1 Measuring: Materials are measured to desired dimension or locations as shown in **Figure 3.12**

Figure 3.13 measuring process

3.13.2 Marking: All measured materials needed to be marked in order to give precise dimension.

3.13.3 Cutting: cut the material as shown in **figure 3.14**

Figure 3.14 Cutting process

3.13.4 Drilling: Marked holes are then drilled to make holes for the bolts as shown in **Figure 3.15**

Figure 3.15 Drilling process

3.13.5 Joining: Materials joined by using plate aluminum, bottle, cork and engine.

Figure 3.16 Joining plate and cork

Figure 3.17 Joining plate, bottle and cork

Figure 3.18 Full Joining for running

3.14 PROCESS ELECTROLYSIS

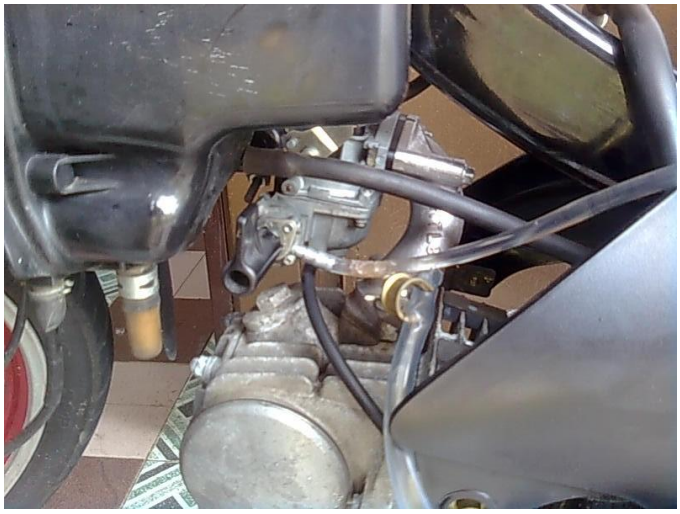

Figure 3.19 connection tubes fuel and hydrogen gas to carburetor.

- Both of connection has been connected correctly to fuel and hydrogen.

Figure 3.20 Fuels to Carburetor

- Fuel was connected to the carburetor using neutral wire amount of fuel used is 350ml

Figure 3.21 connection electric

- Connection of electricity to the aluminum plate.

Figure 3.22 Engine Running

- Electrolysis is carried out, the time was taken from observation to the amount of fuel.

Figure 3.23 Electrolysis Run

- Reaction when electrolysis was run shows the changes to the color of battery water.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

Chapter 4 is the discussion on the result for modification of this project and several problems occur to the project. This chapter also will mainly about the problems encountered during the whole project was been carried out.

4.2 FINAL PRODUCT: The final product design and final product in several views are shown in the figure 4.1, figure 4.2 and figure4.3.

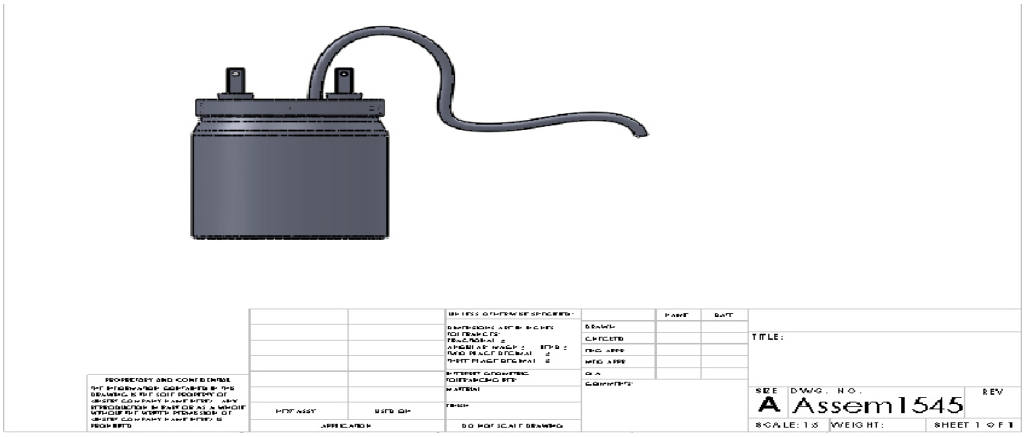

Figure 4.1: Drawing final design

Figure 4.2: Final product

Figure 4.3: product connection

4.3 RESULT DATA

This is result regarding analysis of development hydrogen gas generator for duel fuel engine using capacitor water fuel cell method.

Table 4.1: Result of Analysis

Concept	**Distance of Plate aluminum (cm)**	**Amount of Sodium bicarbonate (spoons)**	**Duration of mass**	**Fuel Consumption (L/h)**
1	0	0	2hour 16min	0.1544
2	4	2	2hour 20min	0.15
		4	2hour 50min	0.1235
3	**2.5**	2	3hour 5min	0.1135
		4	**3hour 20min**	**0.105**
4	1.5	2	2hour 15min	0.1544
		4	2hour 30min	0.14

4.4 GRAPH ANALISYS ELECTROLISYS HIDROUGEN RESULT

Based on the graph fuel consumption VS distance of aluminum plate above, we can see that the effect of using gas generator. This product was tested using two manipulated variables which is distance of aluminum plate and amount of sodium bicarbonate. Normally, without using hydrogen fuel gas generator, the fuel consumption is 0.1544 L/h.

Initially the analysis was performed by using aluminum plate with distance 1.5cm and two spoon of sodium bicarbonate. The results show that, the fuel consumption decreased to the 0.15L/h. Then, by using 4 spoons of sodium bicarbonate with same distance of plate the fuel consumption decreased to 0.125L/h.

The analysis was continued with 2.5 cm aluminum plate and 2 spoons of sodium bicarbonate and the result shows the fuel consumption from 0.15L/h become 0.1135L/h. by using the same distance of aluminum plate the analysis was continued by added 4 spoons of sodium bicarbonate and the fuel consumption state that 0.105L/h compare to the using of 4 spoons of sodium bicarbonate with distance of aluminum plate 1.5cm the fuel consumption decreased to 0.1235L/h.

The final test was continued with 4 cm aluminum plate and 2 spoons of sodium bicarbonate and the result shows the fuel consumption increased to the 0.1544 L/h compared to the distance of plate 2.5cm and 2 spoons of sodium bicarbonate the fuel consumption showed was 0.1135L/h. By using of 4 spoons of sodium bicarbonate we found that the different of fuel consumption is 0.14L/h.

From the data we can conclude that the suitable distance of aluminum plate that can use for the product is 2.5cm with 4 spoons with a saving of 0.105L/h and the fuel consumption reduce is 30%.

4.4.1: Graph Result

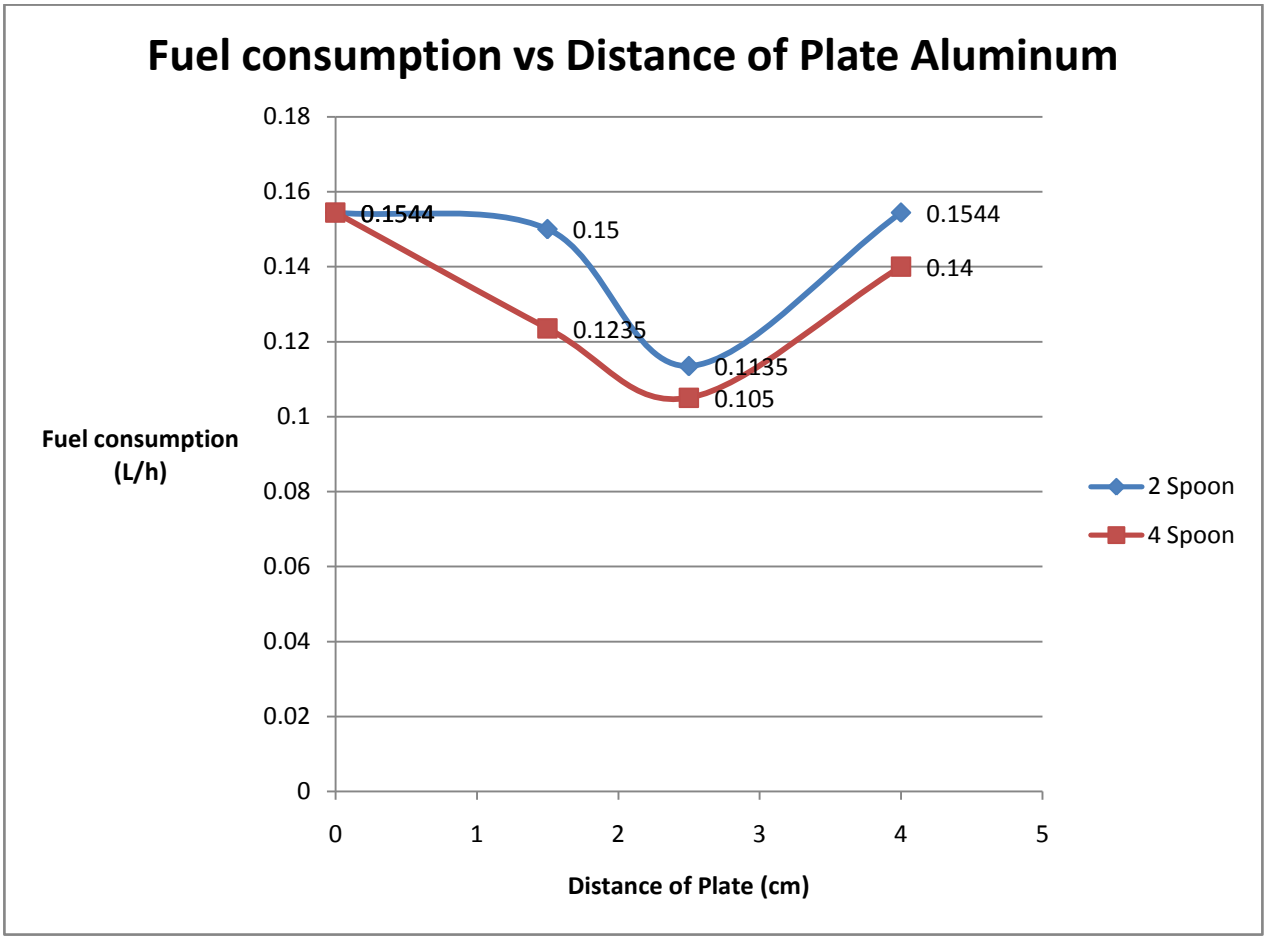

Figure 4.4: Fuel Consumption vs. distance of plate aluminum

4.4.2: Graph Result

From the graph Duration of mass Vs. Distance of aluminum plate above we can found which distance is most suitable for generation of gas in fuel cell. Normally without using gas generator engine can run in 130 minutes.

After using gas generator with the distance of aluminum plate 1.5 cm and 2 spoons of sodium bicarbonate, the duration of engine run is 135 minutes. Then by change the amount of sodium bicarbonate to 4 spoons the engine will run in 150 minutes.

Analysis was continued by using 2.5 cm of aluminum plate with 2 spoons of sodium bicarbonate the duration of engine run is 185 minutes. Then with the same distance of plate and 4 spoons of sodium bicarbonate, the duration of engine run increased to 200 minutes compared to 1.5 cm (4 spoons sodium bicarbonate is 150 minutes.

Finally the analysis was continued by using 4 cm of aluminum plate and 2 spoons of sodium bicarbonate, the result showed that the duration of time engine run decreased to 140 minutes compare to the distance of plate 2.5 cm with 2 spoons of sodium bicarbonate the duration of engine run is 185 minutes. While using 4 spoons of sodium bicarbonate with same distance the duration of time decreased to 170 minutes, compare to using 2.5 cm the duration of time engine run is 200 minutes.

Based on the data result we can concluded the most suitable distance of plate that can be use is 2.5 cm because the duration of time engine run is 200 minutes. The differences of time state that the normal engine run without gas generator and using gas generator with 2.5 cm of aluminum plate (4 spoons sodium bicarbonate) is 64 minutes.

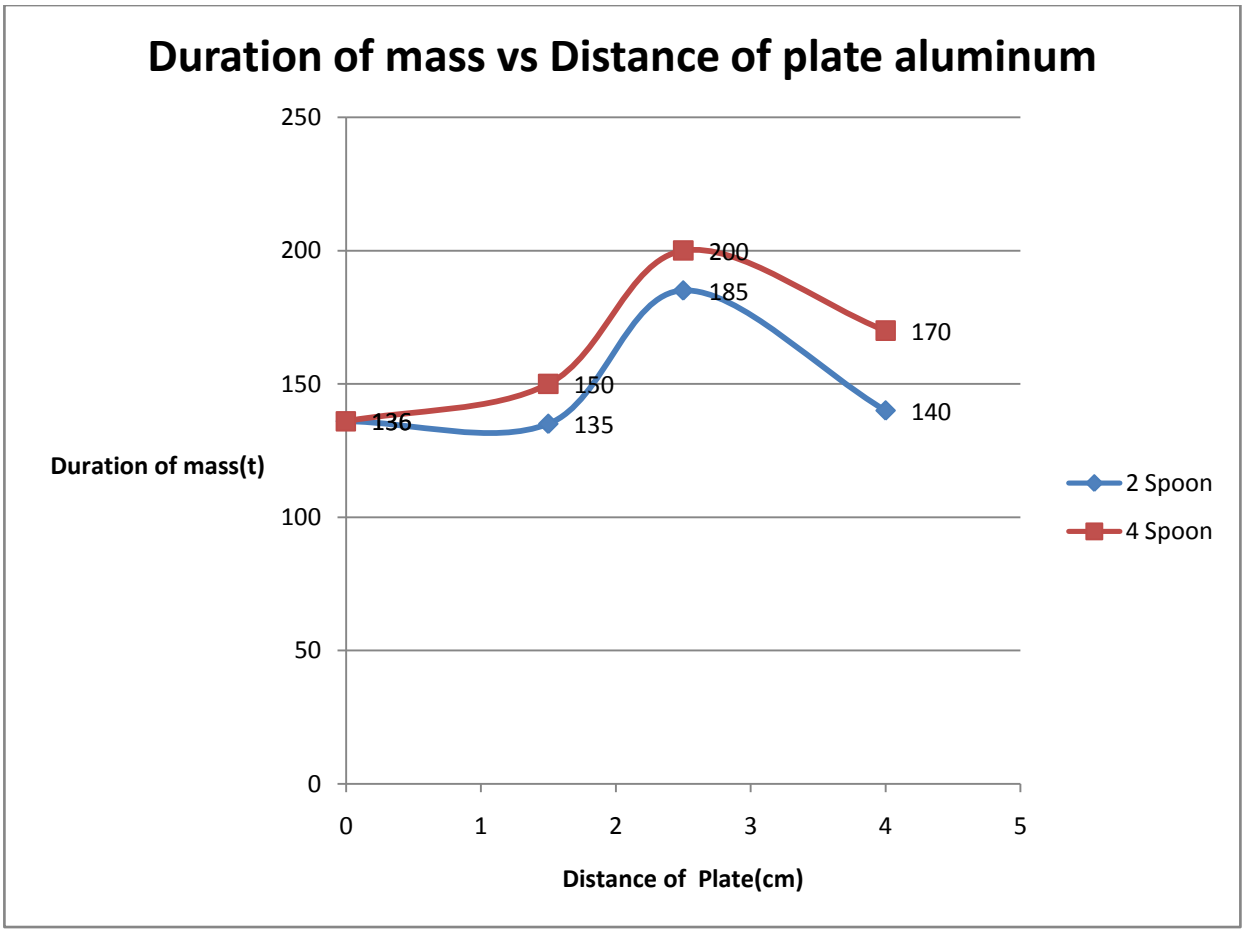

Figure 4.5: Duration o mass vs. Distance of plate aluminum

4.5 DISCUSSION

4.5.1 The Advantages of Project Analysis hydrogen fuel cell

After using electrolysis hydrogen, the engine can run for long time compared before using electrolysis hydrogen. Based on the figure, the fuel consumption can be reduced 30%. Distance between two plate aluminum must be precise. It cannot be to far or to close between them because it can effete the number of bubble produce by aluminum plate. The more sodium bicarbonate is added into solvent, the more number of bubbles are produce.

$$\frac{0.1544 - 0.105}{0.1544} \quad X\ 100 = 31.99\%$$

Very good performance because engine more pick-up and more silent engine smooth. Do not need to change the engine oil many times because there is no engine oil contaminating carbon. Viscosity of engine oil and oil filter does not change is not blocked. The impact of this technology is to reduce air pollution and improved mileage. Did you know that only 30% of the gasoline you buy used, while the remaining cast as carbon, heat and pollution. Hydrogen is the smallest molecules, breaking down large droplets to droplets finer and combines. This is allow complete combustion of hydrogen.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

Chapter 5 is the conclusion and recommendation of this project. In this chapter, it will include the objective of this project is fulfilled and some weakness that need to be improve.

5.2 CONCLUSION

The objective of this project was successfully achieved. The project a scope is covered very well with the creation of this hydrogen gas generator, we hope that it can bring much convenience and satisfaction to users.

The advantages of hydrogen energy, among others, free of pollution (emissions produced only water), not noisy, operate at higher efficiency than the engine when the internal combustion motor fuel is converted into electricity. Whereas energy losses where hydrogen is currently more expensive than the source other energy, the current infrastructure has not been made to accommodate hydrogen fuel, hydrogen extraction process requires fossil fuels causing pollution, and hydrogen is difficult in the storage and distribution. Potential of hydrogen as energy fuels that supports the creation clean environment and also reduce import dependence sources of energy. Before energy plays

a major role and be an alternative lot facilities and systems that must be prepared, such as facilities for producing hydrogen, storage and transfer. Consumers will need a material an economical fuel, technology and knowledge in the use of these fuels be safe. It should be noted that the fuel cell (hydrogen fuel) is itself a very friendly environment, but in producing fuels still have a lot of be noted. Overall very possible energy savings.

Although the environment friendly utilization is still only on the side, rather than manufacture of hydrogen fuel. In the coming decade with a sky-high oil prices and the awareness energy efficiency, the technology of hydrogen (fuel cell) will be very important. With hydrogen we will achieve the vision in the creation of safety, hygiene, abundant source of energy and produce future energy source!

5.3 RECOMMENDATION

During fabricating process, I realize something that I need to improve which is the electrolysis arrangement that can be more systematic. Other than that, I also can use bigger and long lasting container. I also can decorate a circuit with more safety connection of the electricity. Lastly improve the method of joining gas generator also can be done.

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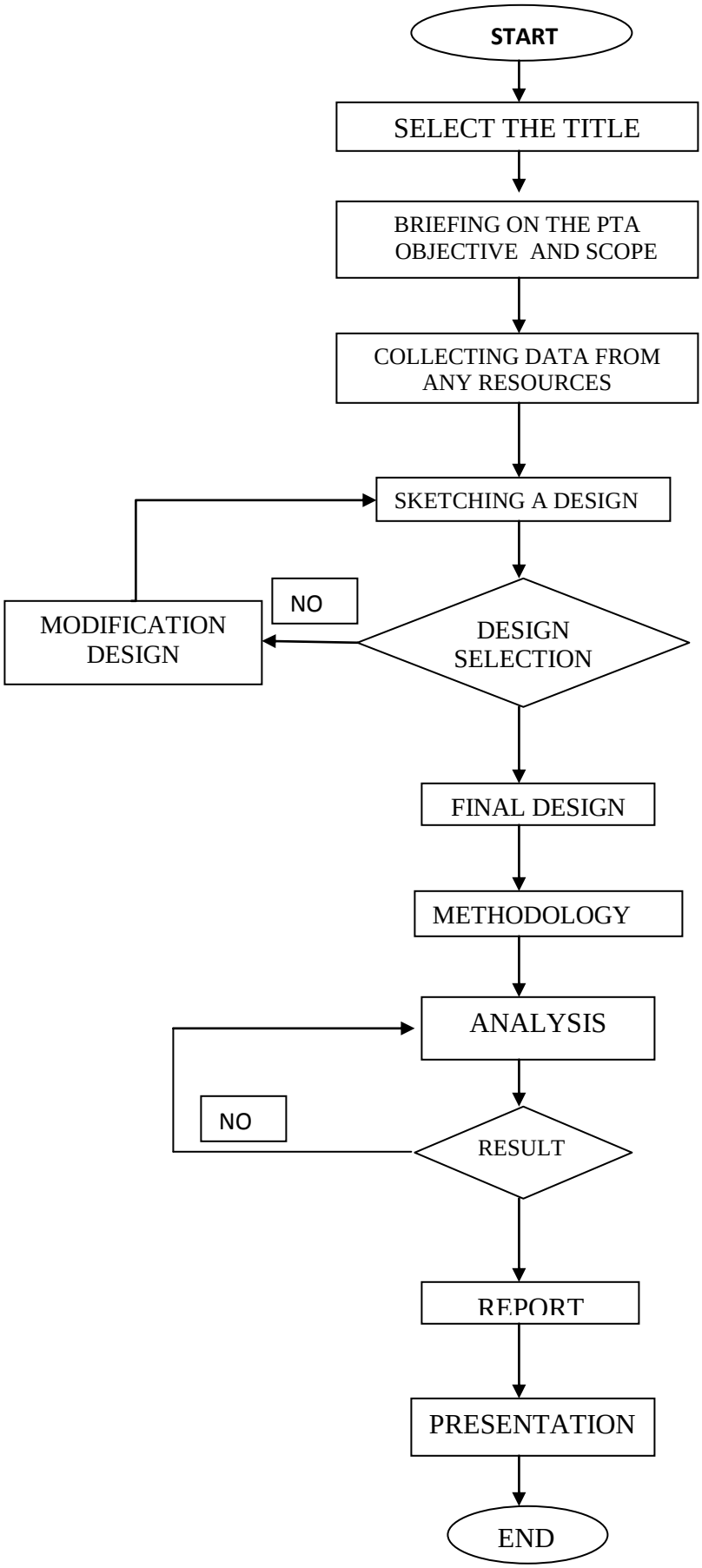
Appendix A

Task		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14
Literature Review & Market Survey	Plan														
	Actual														
Identify Scope, Objectives and Problem statements	Plan														
	Actual														
Concept Design	Plan														
	Actual														
Finalize Design	Plan														
	Actual														
Analyze Structure	Plan														
	Actual														
Mid Presentation	Plan														
	Actual														
Fabrication	Plan														
	Actual														
Testing & Improvement	Plan														
	Actual														
Final Report Preparation	Plan														
	Actual														
Final Presentation Preparation	Plan														
	Actual														

Plan	
Actual	

Appendix B


START
SELECT THE TITLE
BRIEFING ON THE PTA OBJECTIVE AND SCOPE
COLLECTING DATA FROM ANY RESOURCES
SKETCHING A DESIGN
DESIGN SELECTION
NO
MODIFICATION DESIGN
FINAL DESIGN
METHODOLOGY
ANALYSIS
RESULT
NO
REPORT
PRESENTATION
END

Appendix C