FABRICATION OF FUEL SAVING DEVICE HELICAL SPRING BASED ON GASOLINE FUEL CAR

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

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SUPERVISOR’S DECLARATION

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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STUDENT'S 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 concurently submitted for award of other degree.

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I acknowledge my sincere indebtedness and gratitude to my parents for their love, dream and sacrifice throughout my life.

ABSTRACT

This project is about designing and fabricating fuel saving device based on gasoline fuel car using hydrogen as a additional fuel to saving saving the uses of gasoline fuel which is cannot be recycle and pollute the atmosphere. The main objective of this thesis is suitable due to resent trends in modernization, the standard living has multiplied, there is a heavy demand for the fuels, which is the basis for many industries, factories and automobiles. The device is suitable for gasoline car. Electrolysis process is used to get the hydrogen chenneled to the intake manifold. The electrolysis process using water as the electrolyte. The testing were performed on gasoline car engine to get saving efficiency data. Finaly, gasoline fuel reducing (volume) versus time (minute) data recorded to be analyse.

ABSTRAK

Tesis ini membentangkan proses merekabentuk dan mencipta alat bantuan penjimatan minyak kereta berasaskan hidrogen sebagai sumber tambahan bahan api bagi mengurangkan peggunaaan minyak petrol pada masa kini yang mana tidak boleh dikitar semula dan tidak mesra alam. Objektif utama tesis ini adalah sesuai dengan permintaan tinggi terhadap minyak yang mana ianya keperluan utama kepada kebanyakan industri. Alat yang dihasilkan sesuai digunakan pada kereta yang menggunakan petrol sebagai bahan api. Proses elektrolisis digunakan bagi mendapatkan hidrogen untuk disalurkan pada maniful masuk enjin kereta. Air tulen digunakan untuk tujuan elektrolisis tersebut. Proses penilaian kebolehjimatan alat dijalankan keatas enjin kereta yang menggunakan petrol bagi mendapatkan data kecekapan kebolehjimatan. Akhirnya, data pengurangan minyak(volume) dengan masa diambil bagi menganalisis kadar kebolehjiamatan.

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CHAPTER 1

INTRODUCTION

1.1 Project Synopsis

The project involves design and fabricating the fuel saving device- helical spring based on gasoline fuel car. Basically, the entire fuel saving device could be divided into 4 stages, which are concept review and development, designing, fabricating and testing.

The device used the helical spring as the electrode. The testing were performed in engine performance laboratory to investigate the efficiency of the product.

1.2 Problem Statement

The recent trends in modernization, the standard of living has multiplied. Due to this there is a heavy demand for the fuels, which is the basis for many industries, factories and automobiles. These fuels suffer from demerits like they are limited, expensive and pollute the atmosphere.

1.3 The Objective Of The Research

To design and fabricate the fuel saving device helical spring based on gasoline fuel car.

Project Scope

The main scope of the project is to design and fabricate the fuel saving device-helical spring base on gasoline fuel car. The purpose of the project is to minimize the fuel usage by supplying the hydrogen gas produce by the device which is done through the electrolysis process, then channeled into the intake manifold to be used for combustion of the engine.

1.4 Planning Project

According to Gantt chart from Table 1 (appendix 1), the project briefing started followed by collecting literature review. These include a research project title and gathering some raw data from internet, book, and other source. The planning process is from week 1 until week 4.

After that, this project was continued with design and measurement process at week 3 and week 4. Then, started for sketching 4 type of fuel saving device concept and then identifies the best concept based on concept generation and evaluation. Next, design the fuel saving device that was chosen using solidwork software with actual dimension.

The fabrication process was started at week 8 after the pre-presentation. This week also report writing started. The manufacturing process is determined from the literature review.

Evaluation stage has been implementing after fabrication stage. The experiments were performed at engine performance laboratory to investigate the efficiency of the product.

The final stage is writing the final report and prepare for the final presentation. The report writing guided by University Malaysia Pahang Thesis Writing Guide and project supervisor. The entire task scheduled to take about fourteen weeks overall.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discuss entire related to the fuel saving device which is using hydrogen as combustion fuel produce by electrolysis process.

2.2 Water As Combustion Fuel

To understand how these water-fuel systems works, it helps to begin by realizing that ordinary water is actually a “battery” containing vast amounts of energy. Water is H2O-two parts of hydrogen combined with one part oxygen. Every cubic foot of water contains about 1376cubic feet of hydrogen gas and 680 cubic feet of oxygen. The amount of energy in the water molecule is thus vast, and has absolutely nothing to do with the amount of energy it takes to break down that molecule.

2.3 Instant Hydrogen Gas

The first process uses water, salt and an extremely inexpensive metal alloy. The gas that results from this process is pure hydrogen, a fuel that without the need for external oxygen –and gives of no pollution whatsoever. It is the metal alloy to break down the water molecules that is of interest to us here. The salt acts as the electrolyte here. When a piece of metal is dropped into a electrolyte mixture, hydrogen instantaneously begins to form at the amazing rate. Hydrogen gas produced here travels straight to the carburetor. The combustion of hydrogen results in the rebonding of previously separated hydrogen and oxygen molecules, making the engines exhaust water vapor steam and nothing else meaning that no pollution at all.

2.4 Why hydrogen?

Neither the use of hydrogen as an energy vector nor the vision of a hydrogen economy is new. Until the 1960s, hydrogen was used in many countries in the form of town gas for street lighting as well as for home energy supply (cooking, heating, lighting), and the idea of a hydrogen-based energy system was already formulated in the aftermath of the oil crises in the 1970s. Moreover, hydrogen is an important chemical feedstock, for instance for the hydrogenation of crude oil or the synthesis of ammonia. The breakthroughs in fuel cell technology in the late 1990s are the main reason behind the revival of interest in hydrogen. While hydrogen can be utilized in different applications (mobile, stationary and portable), the transport sector is going to play the crucial role for the possible introduction of hydrogen, as outlined in the previous paragraphs. This is also where fuel cells can make the most of their high conversion efficiencies compared to the internal combustion engine. Hydrogen offers a range of benefits as a clean energy carrier (if produced by ‘‘clean’’ sources), which are receiving ever greater attention as policy priorities. Creating a large market for hydrogen as an energy vector offers effective solutions to both emissions' control and the security of energy supply. Hydrogen is emission-free at the point of final use and thus avoids the transport-induced emissions of both CO2 and air pollutants. Being a secondary energy carrier that can be produced from any (locally available) primary energy source (unlike other alternative fuels, except electricity), hydrogen can contribute to a diversification of automotive fuel sources and supplies and offers the long term possibility of being solely produced from renewable energies. Hydrogen could further be used as a storage medium for electricity from intermittent renewable energies such as wind power. Assuming that CCS is eventually realized on a large scale, clean power generation from fossil fuels would be possible via the production of hydrogen. Moreover, there is also the possibility to co-produce electricity and hydrogen in IGCC plants. However, it is hard to justify the use of hydrogen solely from a climate policy perspective. It must be stressed that hydrogen is not an energy source in itself but a secondary energy carrier in the same way as electricity. Similar to electricity, as far as the security of supply or greenhouse gas emissions are concerned, any advantage from using hydrogen as a fuel depends on how the hydrogen is produced. If produced from coal, it augments the security of supply, but causes much higher CO2 emissions (unless the CO2 is captured and stored, a critical prerequisite for this pathway). If produced using non-fossil fuels (nuclear or renewable), it adds to the security of supply and reduces CO2 emissions, but only in so far as the non-fossil fuel source is additional to what would otherwise be used in electricity generation. This means that any assessment of the virtues of switching to hydrogen as a transportation fuel involves a number of assumptions about long term future energy policy developments. Local air emissions, responsible for particulate matter, ozone and acid rain, as well as noise could be significantly reduced by the introduction of hydrogen fuel cell vehicles. Emissions of NOx, SO2, and particulates can be reduced by 70– 80% compared to a case without hydrogen. Especially in densely populated areas this is one major benefit of hydrogen, which is often underestimated. As there are a growing number of megacities worldwide, the importance of improving urban air quality is also increasing. A calculation shows that the CO2, local emissions, and noise benefits of a fuel cell vehicle can reduce the average external cost of a vehicle by 1000–1500 US$ compared to a conventional vehicle.

2.5 The role of fuel cells

In fuel cells, electricity and water are usually produced from hydrogen and oxygen in an electrochemical reaction which also releases heat. In contrast to conventional electricity generation, which takes place in a three-stage conversion process (chemical energy – thermal energy – mechanical energy – electricity), in a fuel cell, chemical energy is directly converted into electrical energy. A fascinating point is the potential theoretical efficiency of fuel cells. A lot of different fuel cell types exist which do not require hydrogen as fuel. Therefore fuel cells could enter the market independently of hydrogen production or infrastructure build-up. This is especially valid for portable applications and stationary applications. Stationary (high temperature) fuel cells – and hence distributed heat and power generation – are not necessarily a market for hydrogen because they can use, e.g. natural gas from the gas mains directly; conversion to hydrogen would only reduce their overall efficiency. The situation is different for mobile applications, where the dominant fuel cell type is the Proton Exchange Membrane (PEM) fuel cell, which only functions with pure hydrogen. On the other hand, it makes no sense to introduce hydrogen in the transport sector without fuel cells in the long run because of the high electricity to heat ratio and the high overall conversion efficiency of fuel cells powered by hydrogen: today, the efficiency of the fuel cell system for passenger cars is around 40% (in the future maybe 50%) compared to 25–30% for the gasoline/diesel powered internal combustion engine under real driving conditions. Fuel cell systems have a higher efficiency at partial load than full load which also suggests their suitability for application in motor vehicles, which are usually operated at partial load, e.g. during urban driving. In addition, the fuel cells exhaust produces zero emissions when fuelled by hydrogen. Road transport noise in urban areas would also be significantly reduced. Furthermore, fuel cell vehicles could possibly even act as distributed electricity generators when parked at homes and offices and connected to a supplemental fuel supply. From this perspective, the use of hydrogen in internal combustion engines can only be an interim solution. Today, the powertrain costs of fuel cell vehicles are still far from being cost-competitive. They have the largest influence on the economic efficiency of hydrogen use in the transport sector and the greatest challenge is to drastically reduce fuel cell costs from currently more than

$2000/kW to less than 100 $/kW for passenger cars. On the other hand, fuel cell drive systems offer totally new design opportunities for vehicles: because they have fewer mechanical and hydraulic subsystems compared with combustion engines, they provide greater design flexibility, potentially fewer vehicle platforms and hence more efficient manufacturing approaches which may lead to additional cost reductions. Nevertheless, this cost reduction potential has to be realized first and is in a continuous interplay with the requirements for efficiency and lifetime. This is the major source of uncertainty for the market success of fuel cell vehicles. Additional technical challenges like hydrogen storage and safety issues have to be solved as well.

To achieve a relevant market success, it is essential to meet the fuel cell targets set for costs, lifetime and reliability. These technology developments obviously always take longer than planned by industry. However, preparation for the structural changes in industry is just as important as the technical optimization of fuel cells. Qualified service technicians and skilled workers must be available to ensure that the introduction of fuel cell technology is managed as smoothly as possible.

The success of hydrogen in the transport sector will crucially depend on the development and commercialization of competitive fuel cell vehicles. 1.5. Hydrogen storage Hydrogen storage is regarded as one of the most critical issues, which must be solved before a technically and economically viable hydrogen fuel system can be established. In fact, without effective storage systems, a hydrogen economy will be difficult to achieve.

Considerable progress has been achieved over the past few years concerning hydrogen-propelled vehicles. Most of the development efforts concentrated on the propulsion system and its vehicle integration. At present, there is a general agreement in the automotive industry that the on-board storage of hydrogen is one of the critical bottleneck technologies for future car fleets. Still, no approach exists as yet which is able to comply with the technical requirements for a range greater than 500 km while meeting all the performance parameters regardless of costs. The physical limits for the storage density of compressed and liquid hydrogen have more or less been reached, while there is still potential in the development of solid materials for hydrogen storage, such as systems involving metal hydrides.

2.6 Hydrogen production

Hydrogen occurs naturally in the form of chemical compounds, most frequently in water and hydrocarbons. Hydrogen can be produced from fossil fuels, nuclear and renewable energy sources by a number of processes such as water electrolysis, natural gas reforming, gasification of coal and biomass, water splitting by high temperature heat, photo electrolysis and biological processes. Global hydrogen production today amounts to around 700 billion Nm3 (enough to fuel more than 600 million fuel cell cars) and is based almost exclusively on fossil fuels: roughly half on natural gas and close to one third on crude oil fractions in refineries. Most of this hydrogen is produced on-site for captive uses. The largest use of hydrogen is as a reactant in the chemical and petroleum industries: ammonia production has a share of around 50%, followed by crude oil processing with slightly less than 40%.

Natural gas reforming, coal gasification and water electrolysis are proven technologies for hydrogen production today and are applied on an industrial scale all over the world. Steam reforming of natural gas is the most used process in the chemical and petro-chemical industries; it is currently the cheapest production method and has the lowest CO2 emissions of all fossil production routes. Electrolysis is more expensive and only applied if high-purity hydrogen is required. With an assumed increase in natural gas prices, coal gasification becomes the most economical option from around 2030 onwards. Biomass gasification for hydrogen production, still at an early stage today, is expected to become the cheapest renewable hydrogen supply option in the coming decades although biomass has restricted potential and competes with other biofuels as well as heat and power generation. Biomass gasification is applied in small decentralized plants during the early phase of infrastructure rollout and in centralised plants in later periods. Steam reformers and electrolysers can also be scaled down and implemented on-site at fuelling stations (although still more expensive), while coal gasification or nuclear energy are for large-scale, central production only and therefore restricted to later phases with high hydrogen demand.

In the medium to long term, hydrogen may be produced by natural gas reforming or coal gasification in centralised plants with CCS. CCS is essential in order to avoid an overall increase in CO2 emissions through fossil hydrogen production, primarily from coal. The (additional) costs of CO2 capture in connection with hydrogen production from natural gas or coal are mainly the costs for CO2 drying and compression since CO2 and hydrogen are already separated as part of the hydrogen production process (even if the CO2 is not captured). Taking the costs for CO2 transport and storage into account, total hydrogen production costs increase by about 3–5% in the case of natural gas reforming and 10–15% in the case of coal gasification.

Hydrogen also occurs as a by-product of the chemical industry (for instance chlorine-alkali electrolysis) and is already being used thermally. This represents another (cheap) option (where available), because it can be substituted by natural gas although investments in purification might be necessary. This option is relevant for supplying hydrogen during the initial start-up phase in areas where user centres are nearby.

Nuclear power plants dedicated to hydrogen production are an option for later phases with high hydrogen demand. Thermo-chemical cycles based on nuclear energy or solar energy are a long term option for hydrogen production with new nuclear technology (for instance the sulphur–iodine cycle) or in countries with favourable climatic conditions. However, nuclear hydrogen production is likely to face the same public acceptance concerns as nuclear power generation. The production of hydrogen from photo-electrolysis (photolysis) and from biological production processes is still at the level of basic research.

Generally, the hydrogen production mix is very sensitive to the country-specific context and strongly influenced by the assumed feedstock prices; resource availability and policy support also play a role, in particular for hydrogen from renewable and nuclear energy. The fossil hydrogen production option dominates the first two decades while infrastructure is being developed and also later periods if only economic criteria are applied: initially on the basis of natural gas, subsequently with increasing gas prices more and more on the basis of coal. Renewable hydrogen is mainly an economic option in countries with a large renewable resource base and/ or a lack of fossil resources, for remote and sparsely populated areas (such as islands) or for storing surplus electricity from intermittent renewable energies. Otherwise renewable hydrogen needs to be incentivised or mandated. It is evident that hydrogen needs to be produced in the long term from processes that avoid or minimize CO2 emissions. Renewable hydrogen (made via electrolysis from wind or solar-generated electricity or via biomass gasification) is surely the ultimate vision (particularly from the viewpoint of mitigating climate change), but not the precondition for introducing hydrogen as an energy vector. Until this goal is reached, hydrogen from fossil fuels will prevail, but the capture and storage of the produced CO2 then becomes an indispensable condition if hydrogen is to contribute to an overall CO2 reduction in the transport sector. The expected dominance of fossil hydrogen during the introduction phase (the period until around 2030) is reflected in the various hydrogen roadmaps as is the later role of renewable energies. With the exception of biomass, the specific costs of hydrogen production from renewable energies are not considered to be competitive with most other options during this period.

Hydrogen production costs depend to a very large extent on the assumed feedstock prices. The typical range until 2030 is between 8 and 12 ct/kW h (2.6–4 $/kg). In the long term until 2050, with an expected increase in feedstock prices (fossil fuels) and CO2 prices, hydrogen production costs will increase as well. 1.6.2. Hydrogen distribution Different options are available for hydrogen transport and distribution: delivery of compressed gaseous and liquid hydrogen by trucks and of gaseous hydrogen by pipelines.

2.7 Electrolysis

This is another method of converting water to fuel. It is called Electrolysis. This method breaks water down into Brown’s gas that is also perfect fuel for gasoline engines. Brown's gas is a better fuel than pure hydrogen: The environment is experiencing tremendous problems at the moment, and one of the most serious of these is that we are losing our oxygen. The oxygen content of the air is becoming low that it threatens our very existence in some areas. The normal oxygen content of air is 21% by volume. But in some places it is only a very small fraction of that. If it reaches 5% people will begin to die. Eventually if something is not done this low oxygen situation will affect each and every one of us. Browns gas created through an electrolytic process, actually may contribute oxygen to the air supply, rather than leaving it the same (as with fuel cells and pure hydrogen) or consuming it with fossil fuels. It is for this reason that we feel it will be the future technology of choice for running our vehicles.

2.8 Working of combustion system using hydrogen

The existing engines in our automobiles could work with these systems with very little and no need for external support infrastructure. Certain head and exhaust system modifications have to be made to expect trouble-free extended use. Most automakers use cast iron exhaust manifolds and steel valves. The combined effect of heat and moisture cause extremely rapid corrosion of the system. Part of the fix is to install stainless steel valves and an exhaust system constructed entirely out of stainless steel. Since hydrogen doesn't contain lead as some gasoline does if you're not using a late model. No lead engine, the heads will have to be reworked to include valves seats not needing the lubrication lead provide. Where the steel gasoline tank used to be, a plastic water tank is fitted, along with a electric float sensor that will be attached to the vehicles existing fuel gauge. If you were to start your engine with no modifications other than the carburetor to accept hydrogen fuel, it will run fine, but the exhaust system will rapidly corrode in almost no time and if you leave the engine turned off for an "extended period", the stock valves and guides will rust up and seize. Stainless steel valves don't cost much, and are as trouble free as the stainless steel exhaust system. For the cast iron combustion chambers and valve ports, there is a high temperature ceramic coating call "heanium" that can be performed to guard against the same corrosion that affects the valves, guides and exhaust system. Also Intake manifold; moisture down there too will cause corrosion.

When using hydrogen as an internal combustion engine fuel, extra precautions must be taken to make extended operation a reality. Seawater contains three fourths of a pound of salt in every gallon; a material that will coat the electrodes very easily. The reason for electrode deposit built up is that tap water is never 100% pure. It contains mineral contaminants that are drawn to the action chamber electrode during the electrically activated molecular separation process that results in the hydrogen contained in water to be released from the oxygen molecules they are bonded to; making a fuel that can power an internal combustion engine. So, we cannot use seawater as the means of producing hydrogen in ic engines.

2.9 Comparing the technologies

We will look at all three types of hydrogen fuel solutions fuel cells, pure hydrogen and browns gas-and see how they work relative to oxygen production or consumption.

1. Fuel cells: This method uses oxygen from the atmosphere to complete the burning of the hydrogen in the fuel cell. What comes out of the tail pipe is oxygen and water vapor, but the oxygen originally came from the atmosphere, not from the fuel and so the use of fuel cells neither takes away nor contributes to the oxygen content of the air.
2. Hydrogen: This fuel is complete in itself. It doesn't need oxygen from the atmosphere to which is an improvement over fossil fuels in saving the oxygen in our air supply. Infact, when hydrogen burns perfectly, nothing at all comes out of the tail pipe. If salt and metal alloy are to create hydrogen, then there will be residues of that in the exhaust, but hydrogen fuel does contribute oxygen to the atmosphere.
3. Brown's gas: The most perfect fuel of all for running our vehicles. Like pure hydrogen made from water, i.e., hydrogen and oxygen, but it burns in the combustion engine so that, depending on the setup, it may actually release oxygen into the atmosphere. In that case, comes out of the tail pipe is oxygen and water vapor, just with fuel cells; but the oxygen from the water that's being used

to create the browns gas fuel. So burning browns gas can add oxygen to the air and thus increase the oxygen content of the atmosphere.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter includes about all the process to fabricate the fuel saving device from the beginning to the end of the project. There are three dimensional drawing using Solid Work Software and fabrication process.

3.2 Overall Research Methodology

Overall this project is following the flow chart from take the title from supervisor, then the second task from taking the title is finding the related literature review for the project given. Then, sketch some design of fuel saving device to be choose the best design using concept screening method. After that, draw the final design selected using Computer Aided Design Software is used. Fabrication is beginning with measuring size of the water tank. After fabrication is finish, device is test to the car engine to get the result. Finally report documentation is writing to describe all the process since the beginning to the end of the project.

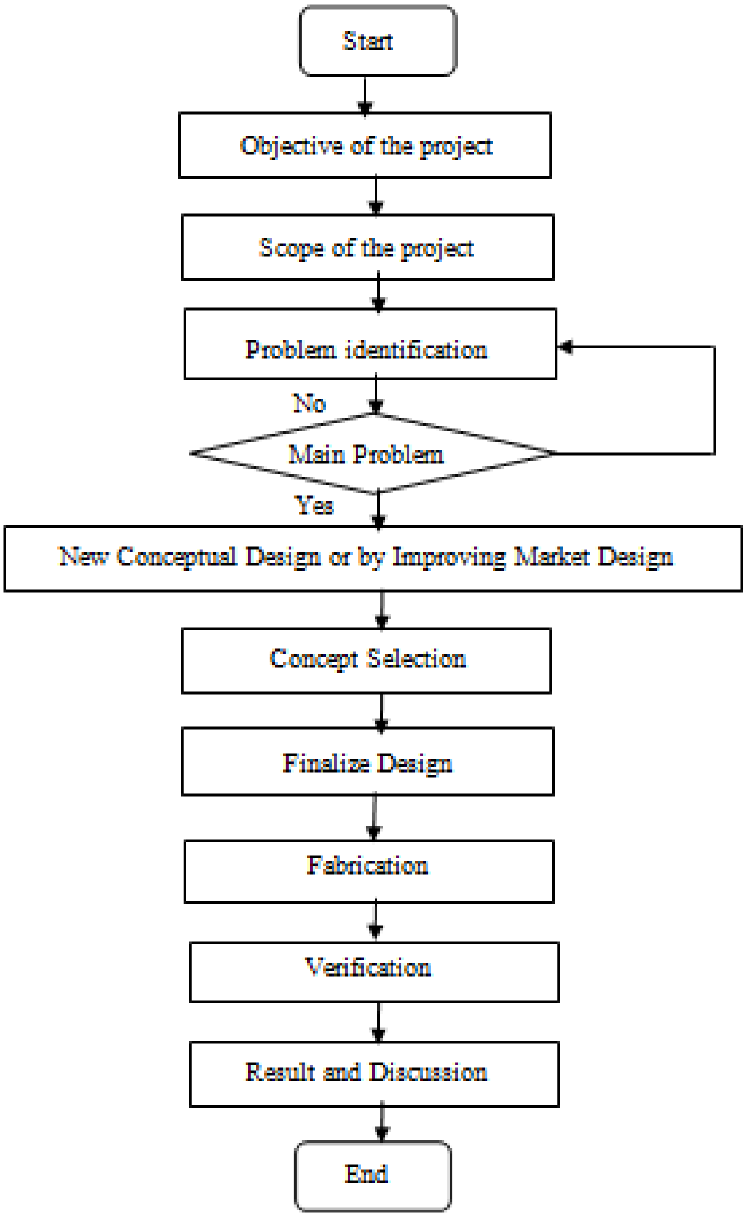

Figure 3.1: Flow Chart

3.3 Design Selection

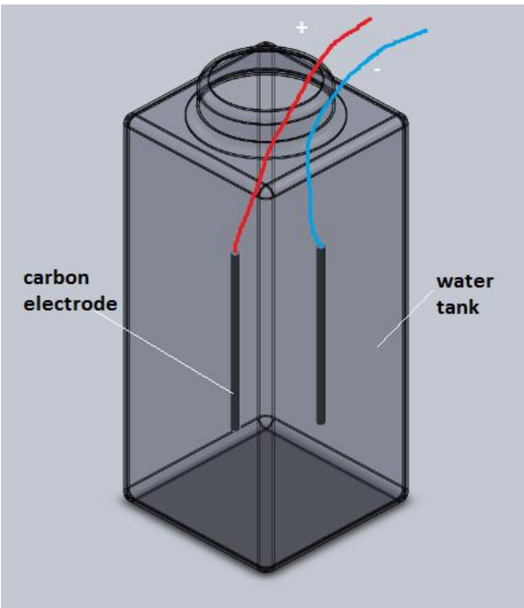

Figure 3.2: Design A

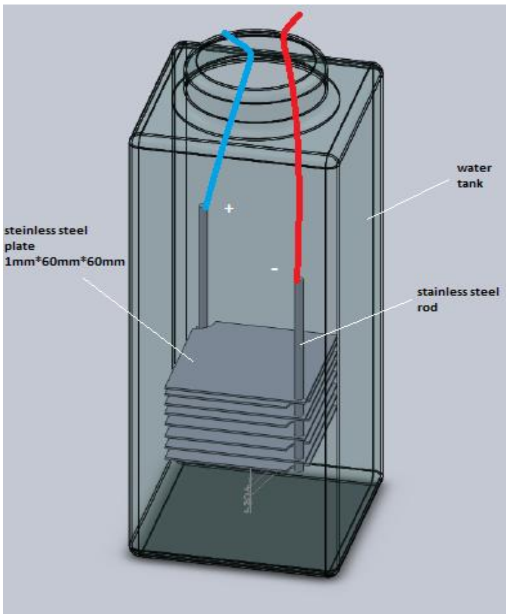

Figure 3.3: Design B

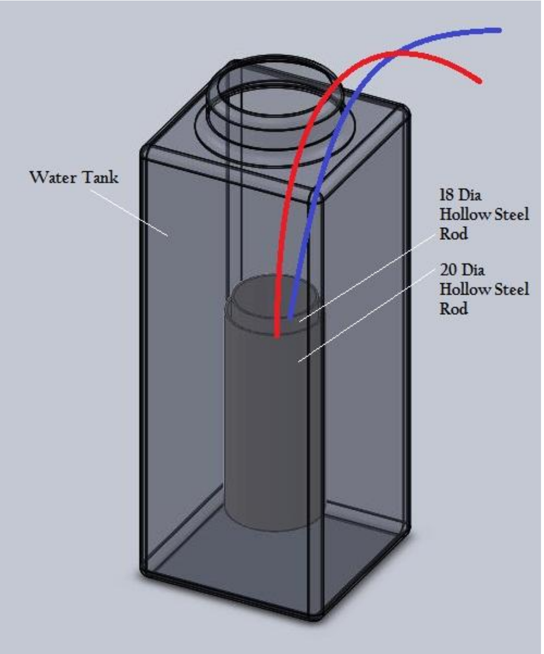

Figure 3.4: Design C

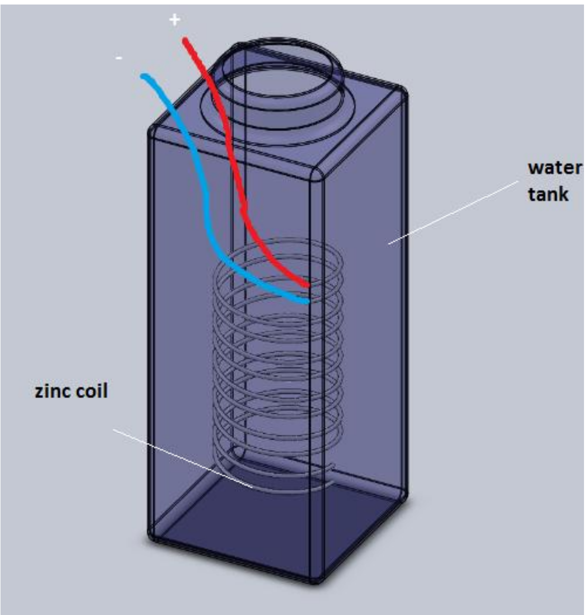

Figure 3.5: Design D

Table 3.1: Concept generation and evaluation

Selection Criteria	Concept			
	A	**B**	**C (Datum)**	**D**
Durability	0	+	0	+
Easy of Manufacture	+	-	0	+
Material Needs	+	-	0	0
Portability	0	0	0	0
Efficiency	-	0	0	+
Function	0	0	0	0
Safety	0	0	0	0
∑+	2	1	0	3
∑0	5	4	7	4
∑-	1	2	0	0
Net Score	1	-1	0	3
Ranking	2	4	3	1

From the table ranking, concept D was choose as the project design.

3.4 Fabrication

There are several fabrication methods that have been applied in the fabrication of the fuel saving device.

3.4.1 Measuring

Measure the entire related to the fuel saving device using the measuring tape such water tank and coil.

Figure 3.6: Measuring Tape

3.4.2 Drilling

Drill the entire related to the fuel saving device using the portable drilling machine such as hole on the water tank to supply hydrogen to the engine.

Figure 4.7: Portable Drilling Machine

3.4.3 Cutting

Cut the entire related to the fuel saving device using the bench saw machine such as the coil holder.

Figure 3.8: Bench Saw

3.5 Experimental Setup and Procedure

The tests were performed at the Engines Laboratory of Pahang Malaysia University. The laboratory consists of test benches involving an eddy current-type dynamometer and fuel metering device. Figure 3.9 illustrates the basic experimental setup.

Besides the engine itself, flywheel, starting motor, alternator, fuel pump, fuel tank, and exhaust assemblies were mounted to the proper places. The engine was coupled with its original shaft to the dynamometer. The control panel of the dynamometer was placed at a safe but easily accessible distance from the setup. The hydrogen produced by electrolyser was supplied to the intake manifold of the engine. The valve installed on the gas tank was used to prevent hydrogen gas backward to the tank. The experiments were carried out on a four-cylinder, four strokes, SI engine with carburetor as the fuel induction mechanism.

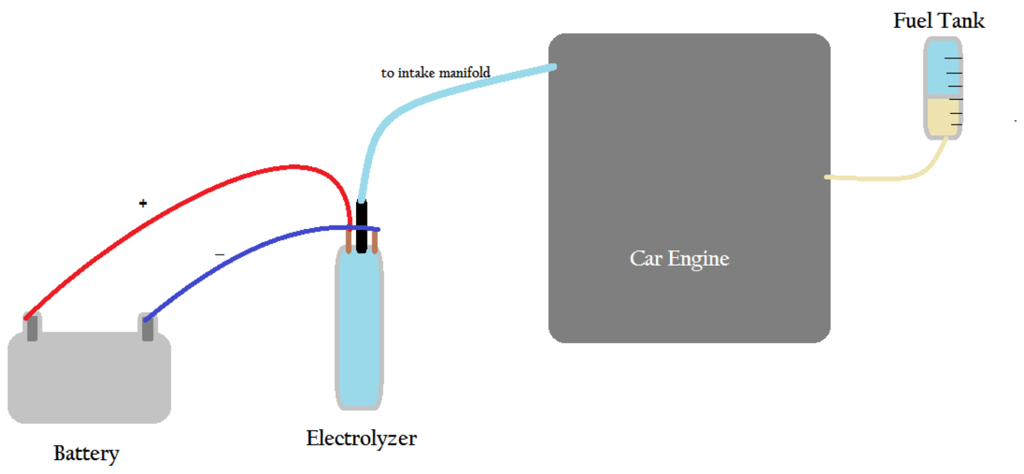

Figure 3.9: Illustrate of basic experimental setup

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This chapter is aim the result of the project. It includes the final design, product and analysis of the product. The result also was helped to making further improvement fuel saving device performance.

4.2 Design

After the final concept was selected, the final concept is transfer to solid modeling and engineering drawing using Solidwork software. Figure 4.1 show the actual design of the fuel saving device.

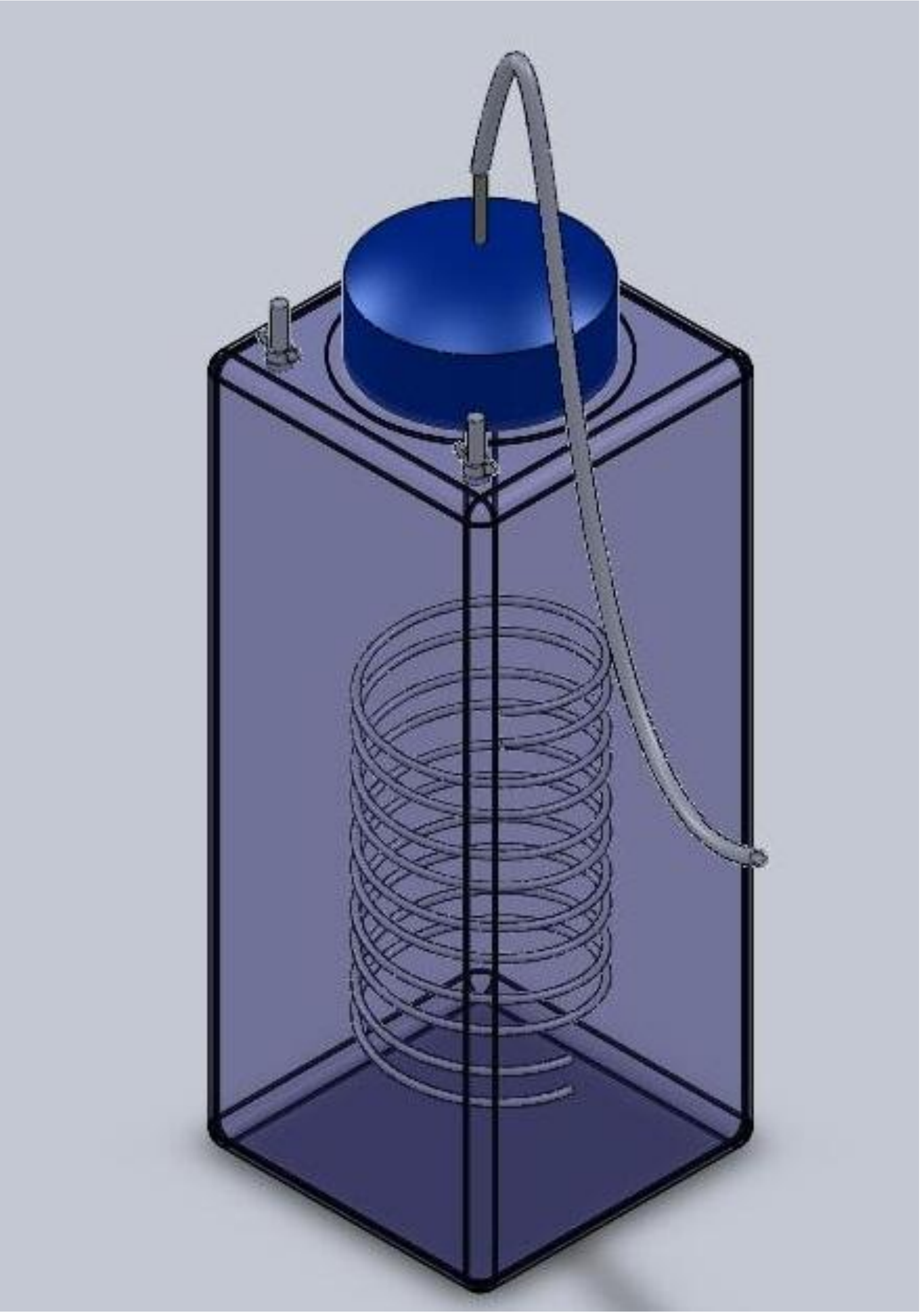

Figure 4.1: Final Design

4.3 Product

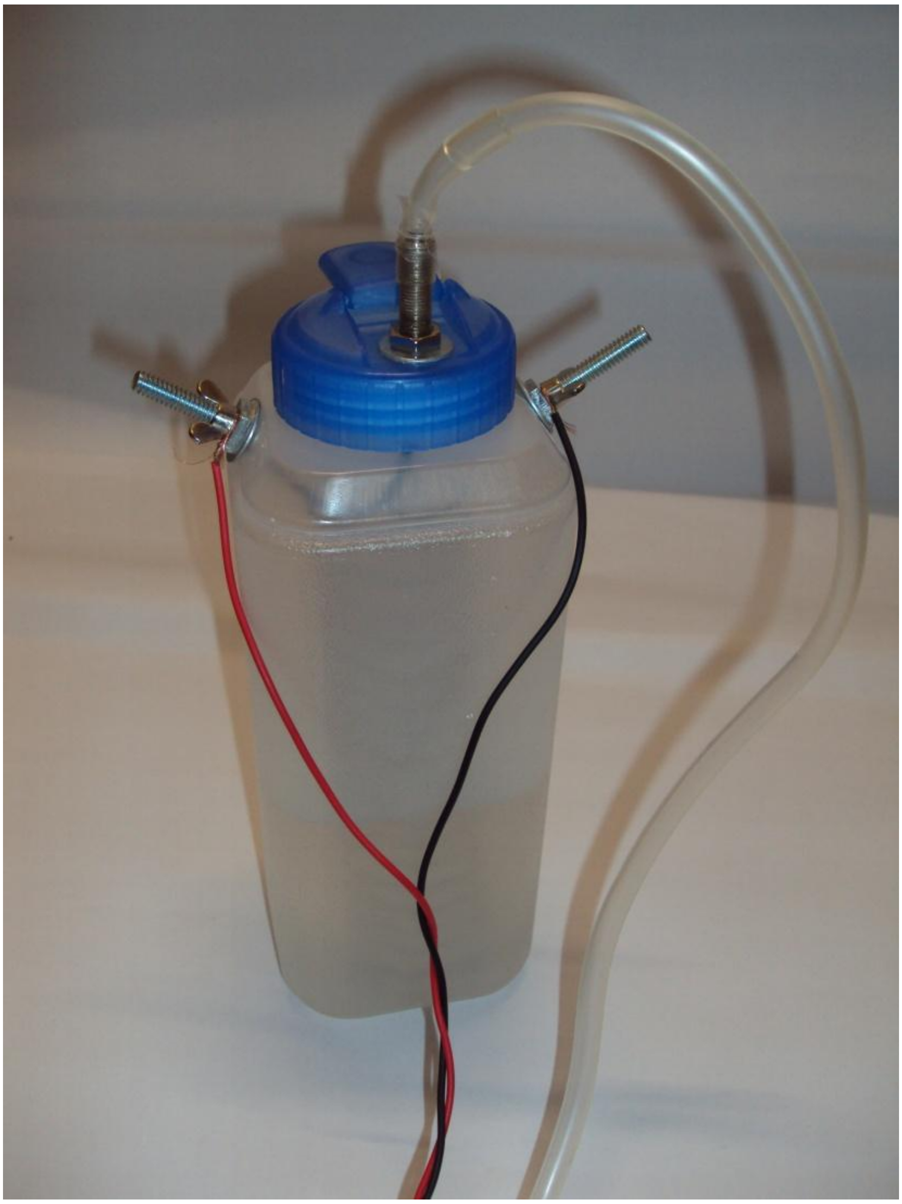

Figure 4.2: Product

4.4 Analysis

The tests were performed at the Engines Laboratory of Pahang Malaysia University. The laboratory consists of test benches involving an eddy current-type dynamometer and fuel metering device. Figure 3.9 illustrates the basic experimental setup.

Besides the engine itself, flywheel, starting motor, alternator, fuel pump, fuel tank, and exhaust assemblies were mounted to the proper places. The engine was coupled with its original shaft to the dynamometer. The control panel of the dynamometer was placed at a safe but easily accessible distance from the setup. The hydrogen produced by electrolyser was supplied to the intake manifold of the engine. The valve installed on the gas tank was used to prevent hydrogen gas backward to the tank. The experiments were carried out on a four-cylinder, four strokes, SI engine with carburetor as the fuel induction mechanism.

During the test, fuel reduce against time was recorded as shown in table below:

Table 4.1: Fuel Reduction

Time(min)	**Fuel Reduce(Volume, *l*)**		
	Without Hydrogen	**With Hydrogen (1 mm dia coil)**	**With Hydrogen (2 mm dia coil)**
1	0.5	0.5	0.5
2	0.425	0.45	0.45
3	0.31	0.4	0.425
4	0.23	0.33	0.38
5	0.14	0.3	0.31
6	0.06	0.27	0.3

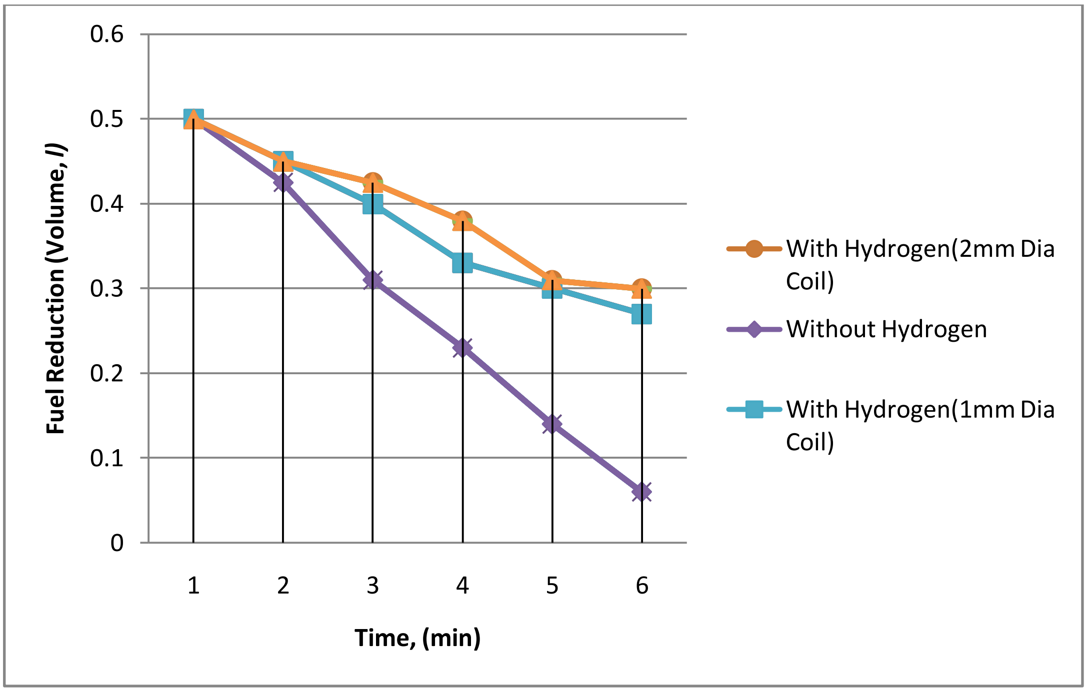

Figure 4.3: Fuel Reduction Graph

4.5 Discussion

Base on graph above, yellow line show the reducing gasoline fuel running without hydrogen gas which is the fastest reduce. Red line show the reducing gasoline fuel running with hydrogen gas using 1mm diameter coil which is the slower than yellow line. Blue line show the reducing gasoline fuel running with hydrogen gas using 2mm diameter coil which is the much slower than red line. We conclude that larger diameter or larger surface contact between water with coil slower the rate of reducing of fuel usage. Using larger surface contact between water with coil can produces more hydrogen.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter is mainly discussed about conclusion and problems encountered during the whole project have been carrying out. Recommendation are should be take for further improvement of the fuel saving device.

5.2 Conclusion

The main objective to design and fabricate the fuel saving device-helical spring based on gasoline fuel car is successful.

According to the fuel redution data in **Table 4.1**, there is about 4.5% of reduction using 1mm diameter coil while 5% of reduction using 1mm diameter coil. From that, we know that the device is able to minimize the gasoline fuel usage but the amount of minimizing the gasoline fuel usage is too small.

5.3 Recommendation

Since the amount of minimizing the gasoline fuel usage is small because the amount of hydrogen supplied is small. For the further improvement, device should be built on a larger scale to produces more hydrogen gas.

REFERENCE

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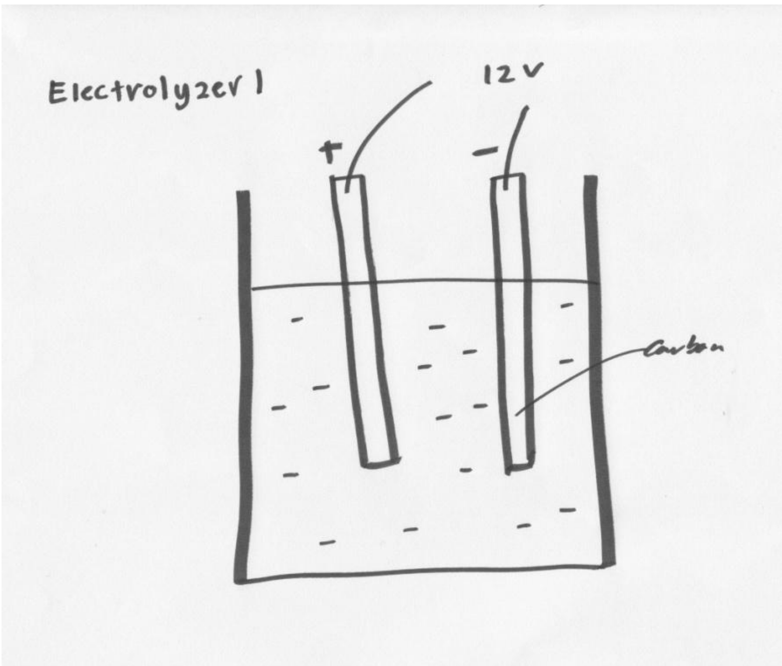
APPENDIX 1

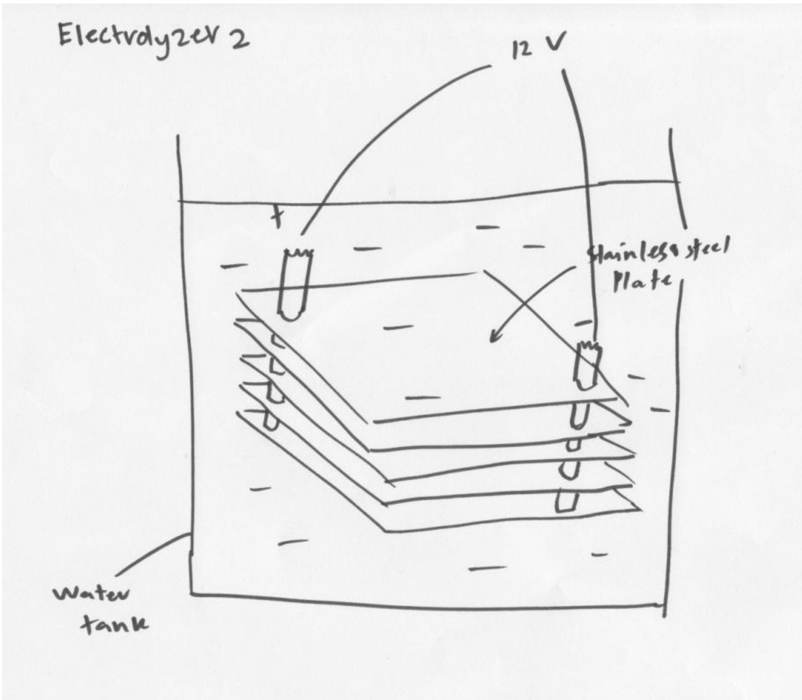
Table 1: Gantt Chart

Project Activities	Week 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Title Selection	■													
Background, Objective, Scope, Problem Statement		■	■	■										
Design on Selection of Final Concept				■	■	■								
Pre-presentation							■							
Fabrication and testing								■	■	■	■			
Final Report									■	■	■	■	■	
Final Presentation														■

APPENDIX 2



Preliminary scetch 1



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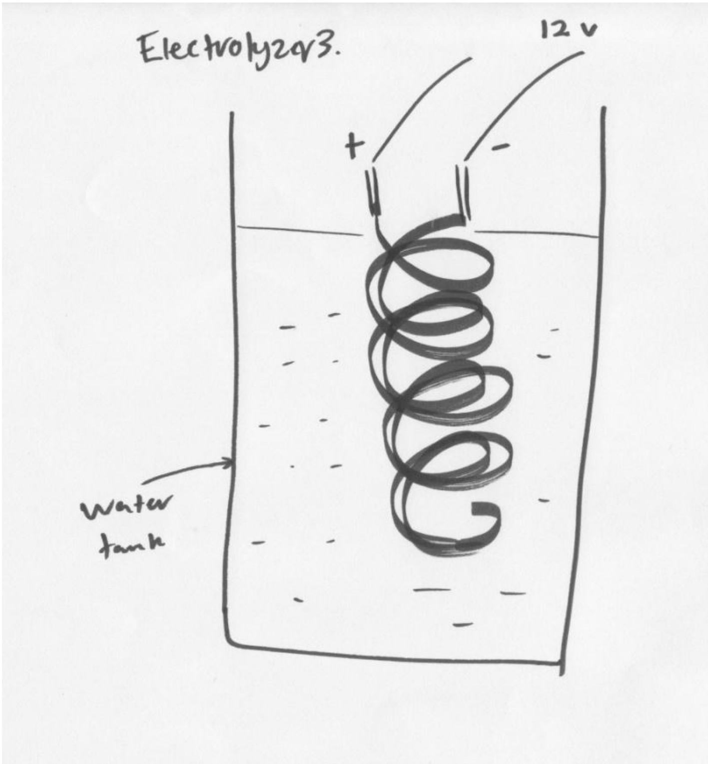

Preliminary scetch 3