DEVELOPMENT OF A PORTABLE DC WATER KETTLE

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UNIVERSITI MALAYSIA PAHANG

DEVELOPMENT OF A PORTABLE DC WATER KETTLE

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Thesis submitted in partial fulfilment of the requirements

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ABSTRACT

Nowadays, biker like to spend their time with the nature such as visiting waterfall or camping in a jungle where the electric power is not available. This situation have made new technology to be developed such as powerbank and portable lamp. One of the new tachnology that have been developed is electrical portable water kettle. This device help people to boil the water without using fire as the heater. In this thesis, the portable DC water kettle suitable for motorcycle is designed, developed and tested. This device use 12v, 5a battery as it power supply which is directly connect to the source. The reason for choosing this type of battery is because it commonly use by the motorcycle in Malaysia. The kanthal 26 AWG is used as it heating element while the mechanical thermostate will sense the boiled water. The device has been tasted with different length of heating element which are 15cm, 30cm and 50cm correnspondingto resistance value 2.6ohm, 5.0ohm and 8.3ohm respectively. The kanthal is connected to the thermostate by using copper wire. This device can boil 500ml of water at one times. The device also equiped with auto-off sensor to cut the power supply when the water reach at it boiling point. Experiment conducted shows that the most optimal condition is achieved when the device uses kanthal 26 AWG, with resistance is at 5.0ohm. With 500ml water in the container, the device took about 25minutes to reach boiling point while maintaining the motorcycle's batery at healthy condition.

ABSTRAK

Pada zaman ini, manusia suke berjalan jalan sekeliling dunia. Manusia suka menghabiskan masa dengan mendekatkan diri dengan alam semula jadi seperti melawat kawasan air terjun dan berkhemah di dalam hutan. Di sebabkan hal yang demikian, banyak teknologi telah dicipta seperti “powerbank” dan lampu mudah alih. Salah satu teknologi yang telah dicipta adalah cerek mudah alih. Alat ini membantu orang ramai memasak air tanpa menggunakan api sebagai bahan pemanas. Di dalam thesis ini, ia akan menerangkan tentang cerek elektrik yang menggunakan DC sebagai sumber. Alat ini menggunaan bateri 12v, 5a sebagai bekalan kuasa yang disambung secara terus dengan sumber kuasa. Alat ini menggunakan makanikal thermostat sebagai sensor pemanas. Ia juga menggunakan kantal 26 AWG sebagai elemen pemanas. Masa untuk mendidihkan air adalah 24-25 minit. Peranti ini juga mempunyai penunjuk voltan yang memaparkan maklumat kepada pengguna sama ada bateri masih dalam keadaan baik untuk menggunakan alat ini atau tidak. Peranti ini mempunyai suis tutup sendiri untuk memutuskan punca kuasa apabila air mencecah takat didih. Teknologi keselamatan tambahan kepada pengguna.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

Human nowadays, love to travel either by plane, ship, car or motorcycle. This phenomena have make a lot of new invention such as power bank. One of the new technology that have been innovate is a portable dc water kettle. This technology allow people to have a boiling water while they travel by car or motorcycle. This will solve the problem mostly to parent who have a baby in their family which is when they want to make a milk for their baby. As we know that to make milk, we need a boiling water. This technology have been improve as the demands from the people have increase in time.

1.2 OBJECTIVE

The main aim of this thesis is to design and develop a portable dc water kettle. The objective of this thesis is:

1. To develop a portable dc water kettle for a motocycle powered by 12V,5Ah motorcycle battery

1.3 PROJECT SCOPE

In this project there are several things that need to be covered. The scope consist of several elements which are:

I. To develop a portable dc water kettle with capacity of 500ml
II. Using 12v, 5a motocycle baterry as power supply
III. Baterry indicator to monitor battery condition

1.4 PROBLEM STATEMENT

In this current technology, most of portable water kettle use alternating current (AC) as their power supply. This technology limit the uses of portable water kettle as mostly ac power supply only available at house or building.

Besides that, other problem with current portable water kettle need high wattage to operate as they use ac power supply which is 230-240v. This will have more losses due to high power transfer.

Lastly, the other problem that occur in this current technology is there is no portable water kettle specially made for motorcycles user.

1.5 THESIS ORGANIZATION

In this thesis, it will be covering five chapters which consist of introduction, literature review, methodology, result & discussion and lastly conclusion.

Chapter 1 describing the overview of the project. Including the project background, the problem statement, objective and project scope.

Chapter 2 in this chapter, literature review that had been use is being presented litera-ture review are taken from relevant research that had been made that are related with the project. There will be some critics and review.

Chapter 3 explaining about the whole methodology used in order to carry out the project. The hardware and software used in the project.

Chapter 4 result and analysis of the project is presented.

Chapter 5 conclusion about the whole project.

CHAPTER 2

LITURATURE REVIEW

2.1 INTRODUCTION

In this chapter, all the literature reviews that had been conducted is being presented. Conducting literature review before proceeding to project is important because it will cater the researcher with plenty of information regarding the project. Researcher can do comparison with existing research and make some improvement. This chapter also will be explaining about the basic operation of kettle, type of kettle in current market.

2.2 KETTLE

A portable kettle is a device that are use to boil water. The different between traditional kettle with portable kettle is the power supply [1]. The traditional kettle use fire to boil the water and the portable kettle use electricity to boil the water [1]. The basic operation of portable kettle are, the power supply is connected to the device and the supply will heat the heating element inside the kettle [2] .

2.2.1 Traditional Kettle

Traditional kettle is an old technology. This technology have been invented before humankind create electricty. The basic concept of this kettle is, use the fire to boil the water inside it [3]. There are many type of traditional kettle in the current market. This kettle also cheap when compare to electric kettle as it not involve any electronic part. The traditional kettle also easy to clean as there is no electronic component inside it. Thus it make user easier to clean the kettle without worries that the water would damage the electronic compartment [4].

Figure 2.1 : Traditional Water Kettle

2.2.2 Electric Kettle

Electric kettle use electricity as their power supply. This device is a new technology compare to traditional kettle. This device contain heating element at the bottom because it can reduce the time to boil the water compared to heating element install in other places.

Figure 2.2.2 : Electric Water Kettle

This device also have auto-off switch as a safety protection to user. It cut off the supply as the device reach it boiling point. The sensor for this auto-off switch is thermostat. This sensor detect the change of temperature of the water.

2.3 HEATING ELEMENT

A typical heating element is usually a coil, ribbon, of strip of wire that gives off heat much like a lamp filament. When an electric current flows through it, it glows red hot and converts the electrical energy passing through it into heat, which it radiates out in all directions [5].

Heating elements are typically either nickel-based or iron-based. The nickel-based ones are usually nichrome, an alloy that consists of about 80 percent nickel and 20 percent chromium. There are various good reasons why nichrome is the most popular material for heating elements. It has a high melting point which is about 1400°c or 2550°f. It doesn't oxidize, doesn't expand too much when it heats up and has a reasonable resistance [5]. There are several type of heating element such as 240v ac heating element and 12v dc heating element

2.3.1 240V AC Heating Element

240v ac heating element is made special for 240v ac power supply. This heating element take the 240v as it power supply. This heating element usually use in house portable kettle as the house power supply from utility is 230-240v ac. There are many design of 240v ac element such as spiral shape and plane shape.

Figure 2.3.1 : 240 AC heating element

2.3.2 12V DC Heating Element

12v dc heating element is made special for 12v dc power supply which usually battery. This heating element take 12v dc as it power supply. This heating element usually use in portable dc kettle. This heating element have many design such as spiral shape.

Figure 2.3.2 : 12V DC Heating Element

2.4 BATTERY

A battery is an electrochemical cell (or enclosed and protected material) that can be charged electrically to provide a static potential for power or released electrical charge when needed [6].

A battery generally consists of an anode, a cathode, and an electrolyte. Common types of commercial batteries and some of their characteristics and advantages. Battery types include the lead acid, and alkaline batteries [6].

2.4.1 Lead Acid Battery

Lead acid batteries used in the rv and marine industries usually consist of two 6-volt batteries in series, or a single 12-volt battery. These batteries are constructed of several single cells connected in series each cell produces approximately 2.1 volts. A six-volt battery has three single cells, which when fully charged produce an output voltage of 6.3 volts. A twelve-volt battery has six single cells in series producing a fully charged output voltage of 12.6 volts.

A battery cell consists of two lead plates a positive plate covered with a paste of lead dioxide and a negative made of sponge lead, with an insulating material in between. The plates are enclosed in a plastic battery case and then submersed in an electrolyte consisting of water and sulfuric acid. Each cell is capable of storing 2.1 volts [7]. There are several type of lead-acid battery such as 12v lead acid battery and 24v lead acid battery.

Figure 2.4.1.1 : Lead Acid Battery

Figure 2.4.1.2 : Lead Acid Battery

2.4.2 Alkaline Battery

The alkaline was introduced in 1992 as an alternative to disposable batteries. The battery was promoted as a low-cost power source for consumer goods. Attempts were made to open markets for wireless communications, medical and defense. But the big breakthrough never came. Today, the alkaline occupies only a small market and its use is limited to portable entertainment

devices and flashlights. The lack of market appeal is regrettable when considering the environmental benefit of having to discard fewer batteries. It is said that the manufacturing cost of the alkaline is only marginally higher than the primary cell. There many types of alkaline battery in current market based on the voltage it supply such as 1.5v and 9v.

Figure 2.4.2 : Alkaline Battery

2.5 THERMOSTAT

A thermostat simply switches the heating system on and off as necessary. It works by sensing the air temperature, switching on the heating when the air temperature falls below the thermostat setting, and switching it off once this set temperature has been reached. Turning a room thermostat to a higher setting will not make the room heat up any faster. How quickly the room heats up depends on the design of the heating system, for example, the size of boiler and radiators. There are many different type of thermostat in the current market such as mechanical thermostat and electrical thermostat.

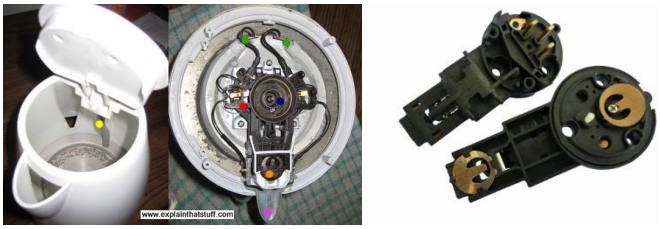

Figure 2.5 : Thermostat

2.5.1 Mechanical Thermostat

This thermostat work by using mechanical. This thermostate does not use any electrical component. It mostly build up by spring and metal

2.5.1.1 Bimetal Thermostat

Purely mechanical control has been localised steam or hot-water radiator bi-metallic thermostats which regulated the individual flow.

Figure 2.5.1.1 : Bimetal Thermostat

2.5.1.2 Wax Pellet Thermostat

This thermostat usually be use in automotive. It have be use to control the water flow in the radiator. As the engine become hotter, the thermostat will allow the water to flow around the radiator.

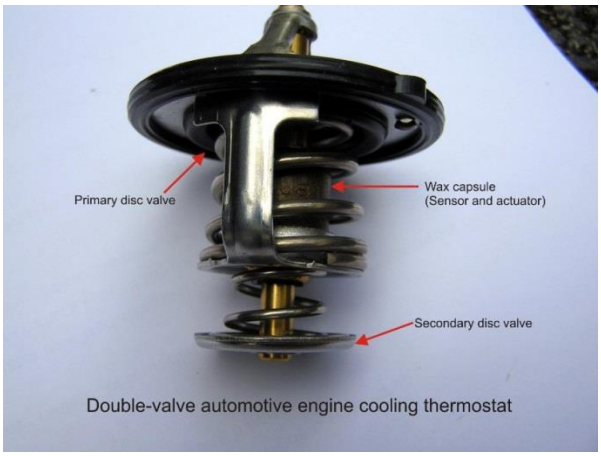

Figure 2.5.1.2 : Wax Pellet Thermostat

2.6 VOLTAGE INDICATOR

Voltage indicator is a device use to measure the voltage of a circuit. Is SI unit is voltage (V). There are may type of voltage indicator in the current market such as digital voltage indicator and analog voltage indicator.

2.6.1 Analog Voltage Indicator

Analog voltmeters use a wide variety of means to measure voltage, with d'Arsonval moving-coil galvanometers being most common. These devices use a coil of fine wire suspended within a magnetic field. The coil rotates and moves a pointer or other indicator proportional to the applied current level.

Figure 2.6.1 : Analog Voltage Indicator

2.6.2 Digital Voltage Indicator

A digital voltmeter (DVM) measures an unknown input voltage by converting the voltage to a digital value and then displays the voltage in numeric form. DVMs are usually designed around a special type of analog-to-digital converter called an integrating converter.

Figure 2.6.2 : Digital Voltage Indicator

2.7 EXAMPLE OF PORTABLE DC WATER KETTLE IN MARKET

From the catalogue in [8] current existing pump in market is put into category and their specification.

NORMAL PORTABLE DC WATER KETTLE

- Operate in 12v
- Does not have container
- Does not have voltage indicator

Figure 2.7 : Portable DC water kettle

CHAPTER 3

METODOLOGY

1.1 INTRODUCTION

This chapter clarifies the methodology related in this project to ensure the successfulness of the research objectives. This chapter will also describe the methods that had been use to design and develop a portable dc water kettle.

Section 3.2 describe the gantt chart in this project, section 3.3 explain the resources for project, section 3.4 is about portable dc water kettle development, section 3.5 indicates the hardware implementation,(section 3.5.1). section 3.5.4 explain the analyse data, collect data (section 3.6.),

before all the task is done, a full gantt chart is plan for showing the progress timeline for this project involve two semesters to complete. The element involve in gantt chart include writing the thesis of project, hardware design, collect the data result, analyze data result, presentation for the project and submission report. The timeline to complete each task is separate into 14 weeks for both semesters.

1.2 GANTT CHART

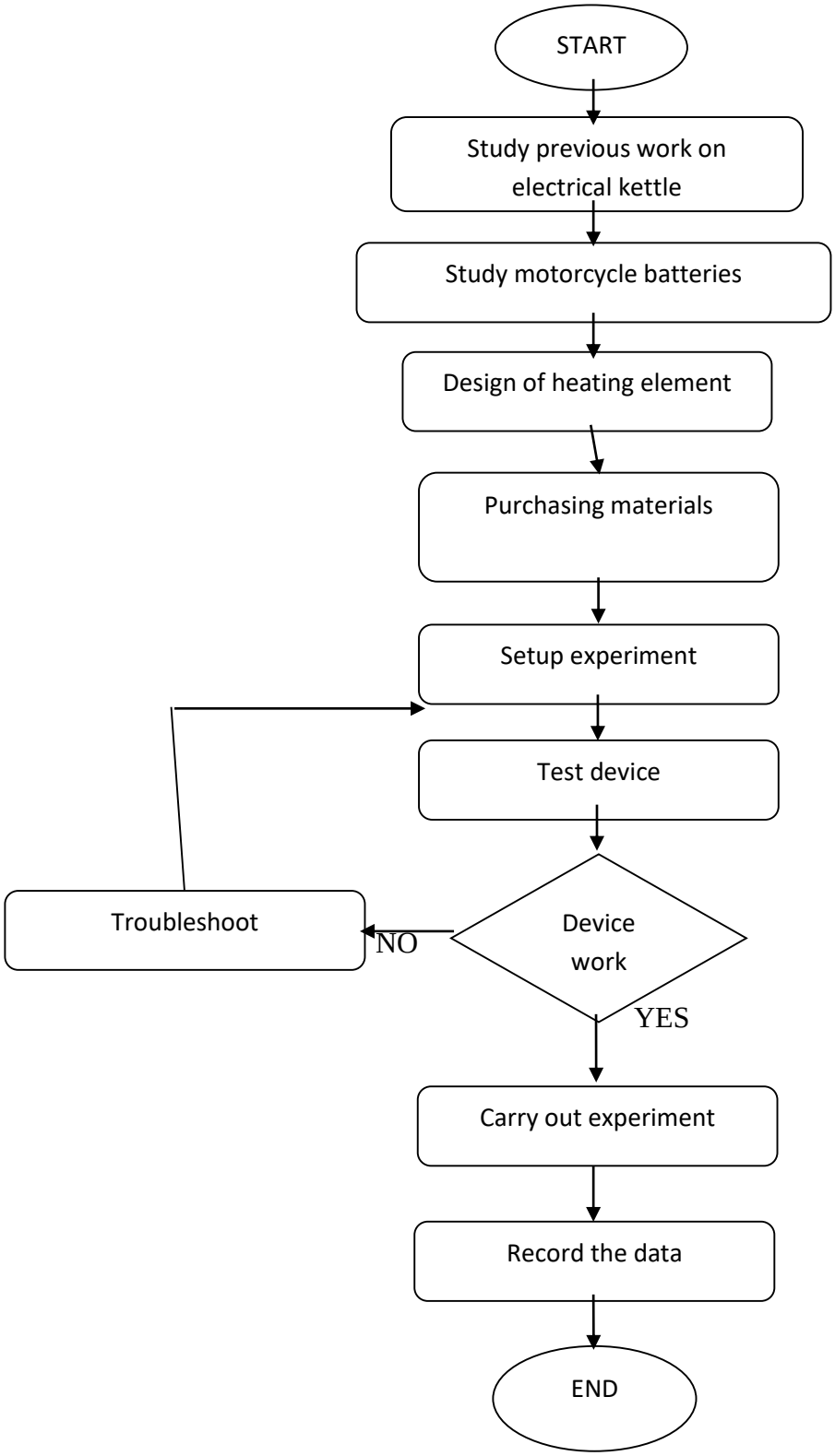

Figure 3.2 : Flow Chart

At first, the previous research or device of electric water kettle is study. There are several type and design of electric water kettle in current market. Next, the motorcycle battery is study. In research, there are diffent type of motorcycle battery based on rating of the battery for example, there are 12V, 3Ah and 12V, 5Ah battery. After study about electric water kettle and motorcycle battery, the heating element for this project is design. One of the design is choose. Next, the materials for develop this device is purchase. After that, the materials is assemble and test. If the device is not working, troubleshoot is conduct until the device is functional. After the device has be working, the experiment is carry out. Finally, based on working device, all data have been collect.

1.3 HARDWARE DEVELOPMENT

First of all, before the project is implementing, all the items needed is listed include the quantity of item that need to be used and also cost for each of the item. Listed item used to develop the project need to be specific include the reason for used the item. The total cost for all the item listed is calculate to make sure it is in range of budget.

Table 3.3 indicates the listed item that need to find for develop portable dc water kettle exclude the material that can get from workshop. The items use is to developed prototype. To complete the prototype, the equipment is needed.

Table 3.3 : List of Materials Uses

NO	EQUIPMENT	BUDGET
1	Variable resistor	Rm 6.50
2	Steam thermostat	Rm 16.70
3	Heating element	Rm 25.00
4	Copper wire	Rm 10.00

5	Voltage Indicator	Rm 42.90
6	Push button	Rm 0.40
7	Container	Rm 8.00

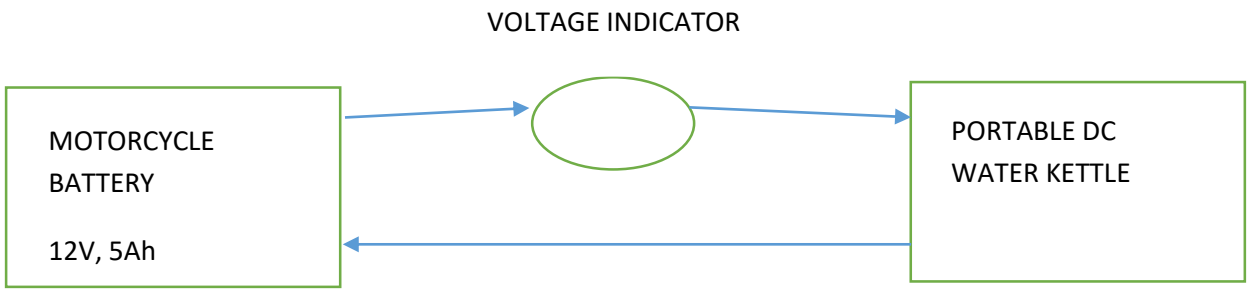

Figure3.3 : Block diagram of portable DC water kettle

1.3.1 Battery

In this project, battery is use as the dc source. The type of battery used is 12V lead acid battery and mainly used to supply the power required by the heating element.

Figure 3.3.1 : 12V 5Ah battery

1.3.2 Voltage Indicator

In this project, the voltage indicator have be buy from other company. The reason is, the voltage indicator are cheaper to buy compare to develop it.

Figure 3.3.2 : voltage indicator

In this project, the supply from battery connected directly to the device. The device will display the voltage to the user. The user will switch on the device if the voltage reading show the reading is in good condition.

Figure 3.3.2.1 : Connection of Voltage Indicator

1.3.3 Portable DC Water Kettle Development

Portable dc water kettle is developed based on the imitation and some improvements from the previous works in the journals from the literature review. Hardware development is the most crucial part need to be considered in this project.

1.3.3.1 Thermostat

In this project the mechanical thermostat is used due to cheap price and suitable for this project. It also easy to find in the market.

Figure 3.3.3.1 : mechanical Thermostat

From the voltage indicator, it is connect to the thermostat. The user will switch on the device.

Figure 3.3.3.1.1 : Connection of Thermostat

1.3.3.2 Heating Element

In this project, the heating element that have be choose is kanthal heating elemet. It was choose because it suitable with the power supply which is 12V dc. The heating element also easy to find in the current market.

Figure 3.3.3.2 : 26 AWG kanthal

After the thermostate is connect to the voltage indicator, heating element is connect to the thermostat.

Figure 3.3.3.2.1 : Connection of Heating Element

1.3.3.3 Container

In this project, the shape of container is rectangular shape. The reason of this shape have been selected was because, it easy to install the thermostat to the body of the container. Besides that, it also cheap and easy to find in the current market.

Figure 3.3.3.3 : 500ml container

CHAPTER 4

RESULT AND ANALYSIS

4.1 RESULT

After completing hardware configuration for psm 2, the results are tabulated as shown in table 1, table 2, table 3, table 4 and table 5, it is done to see the system configuration. The battery condition are record in figure 1

Table 1 : Table of Battery Condition

	ENGINE CONDITION	BATTERY CONDITION
14.4-14.8	**on**	**very good**
13.4-14.4	**on**	**good**
13.2-13.4	**on**	**not bad**
13.2 below	**on**	**check**
11.9-12.8	**off**	**good**
11.6-11.9	**off**	**check**
11.6 below	**off**	**bad**

Figure 15 : Picture of working battery indicator

The time taken for water to be boil out using fast and slow mode also have been recorded. The table below indicate the time taken and mode and current reading when the device is turn on.

Table 2 : Table of time taken to boil water

MODE	TIME TAKEN TO BOIL WATER (MINUTES)	CURRENT READING (A)
fast mode	**20-30**	**3.16**

Kanthal 26 data

Table 3 : Data for Kanthal 26 AWG

		RESISTANCE LENGTH (METER)	RESISTANT VALUE (Ohm)	CURRENT VALUE (AMPERE)	WATTAGE (WATT)	TIME TAKEN (MINUTE)
KANTHAL 26 AWG	VERTICAL	0.15	2.6	4.62	55.44	65
		0.30	5.0	3.15	37.8	24
		0.5	8.3	1.45	17.4	43

Table 4 : Data for Kanthal 26 AWG

		RESISTANCE LENGTH (METER)	RESISTANT VALUE (Ohm)	CURRENT VALUE (AMPERE)	WATTAGE (WATT)	TIME TAKEN (MINUTE)
KANTHAL 26 AWG	HORIZONTAL	0.15	2.6	4.62	55.44	48
		0.30	5.0	3.15	37.8	30
		0.5	8.3	1.45	17.4	38

The time taken to boil the water is shorter when the coil is in vertical design when compare to the horizontal design.

Kanthal 28 data

Table 5 : Data for Kanthal 28 AWG

		RESISTANCE LENGTH (METER)	RESISTANT VALUE (Ohm)	CURRENT VALUE (AMPERE)	WATTAGE (WATT)
KANTHAL 28 AWG	VERTICAL	0.15	1.1	10.91	130.92
		0.30	1.2	10.00	120.00
		0.5	1.3	9.23	110.76

By using kanthal 28 AWG the current reading is exceed the target current rating which is 5 ampere maximum. Thus, the experiment for boiling the water are not taken.

4.2 ANALYSIS

Based on table 1, the most suitable battery condition to use the portable DC water kettle in engine running condition is 13.4V and above. Meanwhile, in engine off condition, the most suitable battery condition to use this device is 11.9 and above.

From the table 3 and 4, it can be found that as the length of heating element increase, the value of resistant increase. Besides that, the value of power also increase as the length is decrease. It is because, the value of current in short length of heating element is increase proportionally to the resistant value. From the both table, it also shown that the design of vertical heating element boil the water faster compare to horizontal design. It is beacause, the area that heating element contact with the water is greater in vertical design compare to horizontal design. Thus, it decrease the time taken to boil the water.

Based on table 5, the analysis that can be found is the kanthal 28 AWG is not suitable to use for portable DC water kettle. It is because, the current rate is use is greater than 5A which is more than motorcycle battery rating. The battery cannot supply the current it required.

4.3 DISCUSSION

After observation have be recorded, the device is recommand to be use when the engine running. The reason of this statement is, the device use a lot of battery current. It will decrease the capacity of the battery. Beside that, under observation, the time taken to boil the water is shorter when the engine is running compare to engine not running.

Other than that, the most suitable size for the heating element is 26 kanthal which the heating element length is 0.30 meter as it output power is 37.8 watt. It also most suitable as the length is suitable with the size of the container.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

This chapter will describe the conclusion and the recommendation based on this project.

5.1 CONCLUSION

As conclusion, the objective of this project is achieve which is to develop a portable DC water kettle for motorcycle powered by 12V, 5Ah motorcycle battery. The other additional gadget have succesfully install in this product which is battery indicator. This device also save to use by user as it not effect the battery health because it use minimum current rate and low wattage. In this project, it can be found that the kanthal 26 AWG is most suitble to be use in this project. This device also can boil water in 24 minute without effect the heatlh of motorcycle battery.

5.2 RECOMMENDATION

Although this project is successfully developed and met the objective, however it is found that this system can be further improved by decrease the time taken to boil the water as this project take about 25 minute to boil 500ml water. To decrease the time to boil the water, its need to increase the power and current rate. Thus, it need to change the battery rating as more current can be flow through the heating element and decrease the time taken to make the coil heated.

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