REQUIREMENT FOR BATTERY INTEGRATION IN THE CONSTRUCTION OF A 5KVA PURE SINE WAVE INVERTER.

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A PROJECT WORK SUBMITTED TO THE DEPARTMENT OF PHYSICS, FACULTY OF PHYSICAL SCIENCES, UNIVERSITY OF BENIN, BENIN CITY. I N PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF SCIENCE B.Sc (HONS) DEGREE IN PHYSICS.

SEPTEMBER, 2023

CERTIFICATION

This is to certify that this project work titled REQUIREMENT FOR BATTERY INTEGRATION IN THE CONSTRUCTION OF A 5KVA PURE SINE WAVE INVERTER was carried by OMOKHE GODSWILL OSAIVBIE in the Department of Physics. Faculty of Physical Sciences. University of Benin, Benin City.

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PROFESSOR O.D. OSAHON

HEAD OF DEPARTMENT DATE

EXTERNAL EXAMINER DATE

DEDICATION

This Project report is firstly dedicated to God Almighty, who saw me through the period of my study, for keeping me alive till this moment and for his grace and goodness.

I also dedicate this report to my lovely family the Mr and Mrs Omokhe for their immense contribution into my academic life, for the love and continuous support and encouragements, to me for the time and effort I put into my academics, and finally to my project supervisor PROFESSOR S.O AZI for tutoring me with love and understanding.

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TABLE OF CONTENT

LIST OF FIGURES

ABSTRACT

Inverters are electronic devices that convert direct current (DC) into alternating current (AC) and are used in a wide range of applications, including power generation systems, renewable energy systems, and portable electronic devices. The choice of battery for an inverter is an important decision that can impact the performance and efficiency of the inverter.

In this project, the aim was to specify the factors that should be considered when choosing a battery for an inverter. To achieve this goal, a literature review on inverters, batteries, and deep cycle batteries, and analyzed the available information on the performance, lifespan, and cost of different types of batteries, was conducted.

Based on the review and analysis, a 65AH 24V inverter was chosen to power the inverter as it had little requirements for maintenance and met the require specifications

CHAPTER ONE

1.0 INTRODUCTION

Electricity plays a fundamental role in our daily lives, powering our homes, businesses, and electronic devices. It drives essential services such as healthcare and communication, enriching our quality of life and fueling progress across various sectors. Many of power devices found including those found in our homes, workplace, can work with inverters. An inverter is an electrical device that converts direct current (DC) to alternating current (AC). According to the United States Department of Energy (DOE), renewable energy systems with battery storage offer a versatile and sustainable energy solution for both grid-connected and off-grid applications. The integration of batteries with solar panel systems enables efficient energy management, ensuring electricity availability when needed most (DOE).

In order to provide a consistent and dependable source of electricity, batteries and inverters are essential parts of solar panel installations. Effective energy storage options, such as batteries, are essential for maximizing the potential of solar energy as a sustainable alternative. Solar panels use sunshine to create electricity, however the output might fluctuate depending on the weather. This electricity is transformed into a useful form by inverters. Batteries can maintain a steady power supply even during times of poor solar output or at night by storing excess energy during peak production and releasing it when needed (Wikipedia, n.d).

1.1 TYPES OF INVETERS

1.2 The following are the basic types of inverters;

1. Square wave inverter: The most fundamental and traditional form of inverter is the square wave inverter. They generate a straightforward square-shaped output waveform that alternates quickly between positive and negative voltage levels (Electrical Technology, 2018).

Square wave inverters are easy to use and inexpensive, but because of their high harmonic content and potential for causing noise and inefficiency in some appliances, they are not recommended for the majority of modern electronic gadgets.

2. Modified Sine Wave Inverter: Modified sine wave inverters are an improvement over square wave inverter. They attempt to approximate a sine wave by adding steps and smooth transitions to the output waveform (Electrical Technology, 2018). These inverters are more compatible with various electronic devices compared to square wave inverters, but some sensitive equipment may still experience performance issues or hum in audio applications.

3. Pure Sine Wave Inverter: Pure sine wave inverters are the most advanced and sophisticated type. They produce a smooth and continuous sine wave output, which closely resembles the waveform of the utility grid power (Electrical Technology, 2018). These inverters are the most versatile and compatible with all electronic devices, including sensitive equipment like computers, medical devices, and audio systems. Pure sine wave inverters ensure optimal performance, efficiency, and safety for a wide range of applications, making them the preferred choice for most residential, commercial, and industrial setups.

One of the key drives of the need for inverters is the growing dependence on renewable energy sources such as solar panels and wind turbines. These sources provide DC power, which must be converted into AC before it can be utilized in most homes and businesses. Inverters play an important part in this process, converting DC electricity to AC and allowing the use of renewable energy sources in AC-powered systems. As an alternative to solar panels and wind turbines, batterics are used to provide DC used to run the inverter system.

1.2 BATTERY

Batteries are energy storage devices that transform chemical energy into electrical energy. They are utilized in a variety of applications such as portable electronic gadgets, electric cars, and renewable energy systems (Supply, 2014; Dahn, 2012). Primary and secondary batteries are the two basic types of batteries.

Primary Batteries: also known as non-rechargeable batteries, primary batteries are designed for single-use and cannot be recharged. They are generally less expensive and have a longer shelf life. Once their energy is depleted, they need to be disposed of properly. Examples include alkaline batteries, zinc-carbon batteries, and lithium primary batteries (Supply, 2014; Dahn, 2012).

Secondary Batteries: Also referred to as rechargeable batteries, secondary batteries have several recharge cycles. They cost more up front, but because they can be reused, they may end up being more affordable over time. Examples include lithium-ion, lead-acid, nickel-cadmium (NiCd), and nickel-metal hydride (NiMH) batteries (Supply, 2014; Dahn, 2012).

1.2.1 HISTORY OF BATTERIES

The idea of a battery has been around for a long time; the first recorded use of a galvanic cell is credited to the ancient Greeks in the fifth century BC (Supply, 2011). The Daniel cell and Grove cell were created in 1836 and 1839, respectively, but it wasn't until the 19th century that the first useful batteries were created (Supply, 2011). Since then, batteries have undergone a great deal of research and advancement, and they are presently utilized in a wide range of applications.

1.2.2 BATTERY OPERATION

Batteries employ a chemical reaction to produce power. The anode and the cathode, which are separated by an electrolyte, are the two electrodes where the chemical reaction occurs. An electric current is produced when ions flow from the anode to the cathode through the electrolyte as a result of the chemical reaction that occurs while the battery is in use. The kind of battery you have affects the current's direction. Figure 1 shows the components of a battery(cell), (BYJU, 2022).

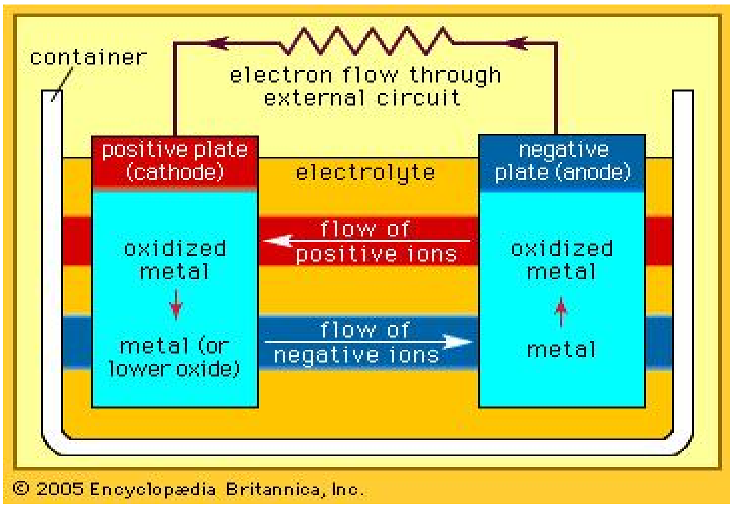

Figure 1.1: components of a battery(cell)(encyclopedia Britannica, 2005)

1.3 AIM AND OBJECTIVES

The aim of this project is to specify the optimum battery required for a 5kVA pure sine wave power inverter battery.

The objectives are to;

1. do a proper literature review for the specification of an optimum battery.
2. study battery with deep cycle.
3. procure and test the desired deep cycle battery.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

To store electricity and provide backup power, inverter batteries, a type of storage battery, are frequently used with inverters. They have been the focus of a great deal of research studies and have gotten a lot of attention in the literature. In this literature review, with a focus on their performance, longevity, and maintenance needs, we will summarize and describe the key findings and insights from earlier studies on inverter batteries. As a result of these findings, we will also point out any gaps or potential areas for future study. Utilizing inverter batteries has many advantages, one of which is its ability to store large amounts of electricity for extended periods of time. hey are therefore ideal for use as a backup power source in the event of power outages or other major power supply disturbances. A popular option for a variety of applications, inverter batteries are also inexpensive and easily accessible. The type and quality of the battery, as well as the charging and discharging processes, must all be carefully examined in order to obtain the best performance and lifespan.

Numerous studies have been done to look into the variables that may affect the functionality and longevity of inverter batteries. Studies have shown that the quality and type of the battery, as well as the surrounding temperature, can all significantly affect the battery's performance and lifespan. Furthermore, the performance and lifespan of these batteries can be impacted by charging and discharging habits, as well as by electrical or mechanical trauma. Numerous gaps and opportunities for additional research on Inverter batteries have been identified by prior studies. For instance, further research is required to fully comprehend how different charging and discharging schedules affect battery performance and lifespan. Furthermore, greater study on the use of inverter batteries in various applications and conditions, as well as the development of new technologies and methodologies for improving the performance and lifespan of these batteries, is required.

2.1 PREVIOUS WORK REVIEWS

Several of the elements examined in the selection of an inverter battery as done by some notable researchers will be reviewed in this section.

Nanostructured electrodes for high-performance batteries (Gurkaynak et al,2007).

The following were considered:

Capacity: The amount of energy a battery can store and produce is determined by its

capacity, which is often measured in ampere-hours (Ah). A battery with a higher capacity can frequently run a load for a longer period of time before needing to be recharged. In their investigation, Gurkaynak et al. (2007) looked at the use of nanostructured electrodes in high-performance batteries. They realized that they could significantly increase the battery's capacity by increasing the electrodes' surface area. Due to the fact that a battery with a higher capacity could supply electricity to a load for an extended period of time, this could be helpful when designing batteries for use in inverters.

Voltage: A battery's voltage is important because it needs to match the demands of the load it is powering. The inverter or the load could be harmed if the wrong battery voltage is used. In their study, Gurkaynak et al. (2007) stressed the significance of matching the battery voltage to the voltage requirements of the load. To prevent harming the inverter or the load, they suggested using a battery with the appropriate voltage for the application.

Self-discharge rate: When a battery is not in use, it loses charge at a certain pace. Lower self-discharge rate batteries can maintain their charge for longer and might be a better option for use in an inverter. The significance of the self-discharge rate in influencing battery performance was highlighted by Gurkaynak et al. (2007) in their study. They emphasized that batteries with a lower rate of self-discharge will be able to maintain their charge for longer durations, which could be helpful when utilized with an inverter.

Compatibility with the inverter: The battery must be compatible with the inverter in order for the system to function properly. A number of factors may be taken into account, including the voltage and current ratings of the battery and the inverter as well as any other unique requirements or suggestions for the battery made by the inverter's manufacturer.

Type of battery: Different battery types, including lead-acid, lithium-ion, and nickel-metal hydride, have unique qualities that make them suitable for use in an inverter system. For applications where weight is a concern, lithium-ion batteries, for instance, are frequently lighter and have a higher energy density than lead-acid batteries. In contrast, lead-acid batteries are sometimes more affordable and have a longer lifespan than lithium-ion batteries, making them a more economical choice in some applications.

Size and weight: The size and weight of the battery may be critical concerns in an inverter system, especially if the system must be portable or has limited space.

Durability: When selecting a battery for an inverter, take into account the battery's capacity to withstand harsh environmental conditions. In challenging conditions like freezing temperatures or rough terrain, durable batteries may be less likely to malfunction or degrade (Gurkaynak et al., 2007).3212211Q

The effects of depth of discharge and charging discharging rate on the performance of lithium-ion batteries (Kim et al, 2014).

Depth of discharge (DOD): The amount of a battery's capacity that must be utilized before it can be recharged is referred to as the depth of discharge (DOD). Higher DOD bateries typically have shorter lifespans than lower DOD batteries, in a study, Kim et al. (2014) looked into how the performance of lithium-ion batteries was impacted by the depth of discharge and rate of charging and discharging. They found that the battery's life duration decreased as the depth of drain increased. This demonstrates that choosing a battery with a lower DOD may be desirable when using it in an inverter to lengthen its lifespan. A battery's lifespan can be extended with appropriate maintenance, such as routinely checking the electrolyte level and keeping the battery clean (Kim et al., 2014). In their study, Kim et al, (2014) found that proper maintenance including periodically checking the electrolyte level and keeping the battery clean was essential for preserving a battery's performance and lifespan. This means that in order to ensure optimal performance and lengthen the lifespan of the battery when choosing one for an inverter, it may be better to use a low-maintenance, simple-to-care-for battery.

Rate-dependent impact of charge/discharge rate on battery performance (Kamat & David, 2006).

Charge/discharge rate: A battery's performance in an inverter may be affected by the rate at which it is charged or discharged. Shorter battery life may be the result of faster charge/discharge rates. In a study from 2006, Kamat and David assessed the rate-dependent impact of charge/discharge rate on battery performance. They found that using a battery with a slower charge discharge rate may be favorable for use in an inverter because faster charge/discharge rates decreased battery lifespan.

Recharge time: When a battery is used to power essential loads that cannot be interrupted for an extended period of time, the amount of time it takes to recharge the battery is a major concern.

Discharge rate: How quickly a battery releases its stored energy can affect how well it performs in an inverter system. While slower discharge rate batteries may be more appropriate for applications where a steady power supply is needed over a longer length of time, faster discharge rate batteries may be better suited for situations where a large amount of power must be delivered quickly.

The effect of temperature on the performance of lead-acid batteries (Cao et al., 2012).

Temperature: A battery's temperature can significantly affect how well it performs. In a study, Cao et al. (2012) assessed how temperature affected the performance of lead-acid batteries. They found that while higher temperatures boosted battery performance, excessively high temperatures hindered it by reducing battery capacity or hastening its degradation. This suggests that it would be vital to consider the battery's operating temperature range when choosing a battery for an inverter to ensure that it will perform admirably in the particular application.

State of charge (SOC): The amount of energy a battery has stored is indicated by itsstate of charge (SOC). Generally speaking, batteries with higher SOC perform better than those with lower SOC. In their analysis, Cao et al. (2012) found that a battery's SOC had an impact on its performance. They found that batteries with a higher SOC outperformed those with a lower SOC in terms of performance. This demonstrates that it might be preferable to select a battery with a higher SOC for usage in an inverter.

Influence of high temperature on the performance and safety of lithium-ion (Zhang el al, 2020).

Life expectancy: When selecting a battery for use in an inverter, it's crucial to take into account how many charge-discharge cycles the battery can withstand before needing to be replaced. in general, choosing a battery with a longer life expectancy will end up being more cost-effective (Zhang et al., 2020). In a review, Zhang et al. (2020) assessed the impact of high temperatures on the functionality and security of lithium-ion batteries. They claimed that a battery's life expectancy is an important factor to take into account when selecting a battery for use in an inverter since a battery with a longer life expectancy will ultimately be more cost-effective.

Cyclic stability: refers to a battery's capacity and performance being able to be maintained across a significant number of charge-discharge cycles. When used in an inverter, batteries with good cyclic stability may be a superior option because they are less likely to deteriorate over time. The significance of cyclic stability in battery performance was highlighted by Zhang et al. (2020) in their review. They found that batteries with high cyclic stability had a lower propensity to deteriorate over time and would be a better option for use in inverters. When selecting a battery to be used in an inverter, battery safety is an important consideration. Batteries that could explode or catch fire, endangering both the user and the environment, (Zhang and associates). Significance of battery safety in their review, especially in the context of lithium-ion batteries. They advise carefully analyzing a battery's safety before installing it in an inverter because overheating and the potential for explosion or fire are potential safety hazards with these types of batteries.

Environmental impact: There may be an environmental impact associated with the manufacture and disposal of batteries. When choosing a battery for an inverter, consider the battery's environmental impact, taking into account the materials used in production, the energy utilized, and the method of disposal. In their review, Zhang et al. (2020) stressed the importance of considering batteries' effects on the environment. They said that the production and disposal of batteries can have an effect on the environment, and they advised choosing a battery for an inverter by taking into account its construction materials, energy requirements for production, and disposal options. Various research used statistical analysis to assess the data and derive conclusions on the relationship between various parameters. In order for an inverter system to function properly and dependably, it is essential to choose the right battery. A battery's performance in an inverter system can be influenced by a variety of variables, some of which may be interconnected. Temperature, charge level, upkeep requirements, lifespan, cyclic stability, safety, environmental effects, recharge time, discharge rate, and compatibility with selecting a battery for an inverter, it's crucial to take the inverter, battery type, size, weight, and durability into account. It is possible to choose a battery that is suitable for use in an inverter system and will provide stable performance over time by carefully considering these criteria and the unique requirements of the application. It is equally important to consider the battery's price, the total cost of ownership, and the manufacturer's or brand's reputation. You may select a battery for an inverter system that is both efficient and affordable by taking into account these factors.

CHAPTER THREE

METHODOLOGY

3.0 INTRODUCTION

This chapter will look at all the factors that must be taken into account when selecting the battery needed to build an inverter, in this case a 5kVA inverter.

Let's start by thinking about how the inverter works. Connect the DC power supply to the inverter's input and the AC load to the inverter's output to operate it. The DC electricity will then be changed to AC power by the inverter, which will subsequently supply it to the load. The sort and size of the AC load, the ambient temperature, and the quality of the DC power source are all variables that may have an impact on the effectiveness and efficiency of an inverter. The inverter may also be subject to certain operational specifications and constraints, including a range of the minimum and maximum input voltages, a maximum power rating, and a frequency range for the generated AC voltage. Our primary concern is the DC source's quality.

3.1 BATTERY SELECTION FACTORS

Factors including backup hours, number of cycles, internal resistance, temperature impacts, and orientation must be taken into account when choosing the type of inverter battery to be utilized (Wavetra, 2022). Additional elements are listed here.

1. Battery type: The kind of battery you choose will depend on your unique needs as well as what your inverter needs. Batteries used with inverters frequently include nickel-cadmium, nickel-metal hydride, and lead-acid batteries.

2. A battery's capacity is typically expressed in watt- or amp-hours (Ah/Wh). A battery with a higher capacity can store more energy and run the inverter for longer.

3. Voltage: The voltage of a battery is normally measured in volts (V). The voltage level should match the voltage rating of the inverter.

4. Depth of discharge (DOD): The depth of discharge (DOD) refers to the amount of energy discharged from a battery as a proportion of its capacity. In general, a battery with a lower DOD lasts longer.

5. Cost: The price of the battery should be taken into account while choosing the right one for your inverter.

6. The term "life cycle" refers to how many times a battery can be discharged and recharged before it reaches the end of its usable life. In general, a battery with a longer life cycle will end up being more affordable.

7. Maintenance requirements: Compared to other batteries, some batteries could need more frequent maintenance, like adding water or electrolyte. Think about the battery's maintenance requirements when choosing.

8. Temperature range: If you plan to use the battery in extremely hot or cold conditions, its usable temperature range will be important.

9. Charge rate: The rate at which a battery may be charged is referred to as the charge rate. Although a battery that charges faster quickly could be more practical to use, it might also last less time.

10. Discharge rate: The pace at which a battery can be discharged is known as the discharge rate. Despite having a lower life period, a battery with a faster discharge rate can power larger wattage loads.

11. Self-discharge rate: The rate at which a battery discharges on its own over time is known as the self-discharge rate. A battery that self-discharges less slowly will be able to maintain a charge for longer when not in use.

12. Take into account the manufacturer's warranty while choosing a battery. You might experience additional peace of mind and protect your investment with an extended warranty.

13. An indicator of a battery's resistance to electrical current flow is its internal resistance. Because it may affect the battery's performance and lifespan, it is an important factor to take into account when choosing a battery for use with an inverter. A battery can generally deliver more current and last longer than one with a higher internal resistance. On the other hand, internal resistance can vary based on things like battery age, temperature, and charge level. The right battery must have the right internal resistance for your application and operating circumstances. The manufacturer's technical data sheet is often where you can get the internal resistance specification for a battery (Buchmann, 2021).

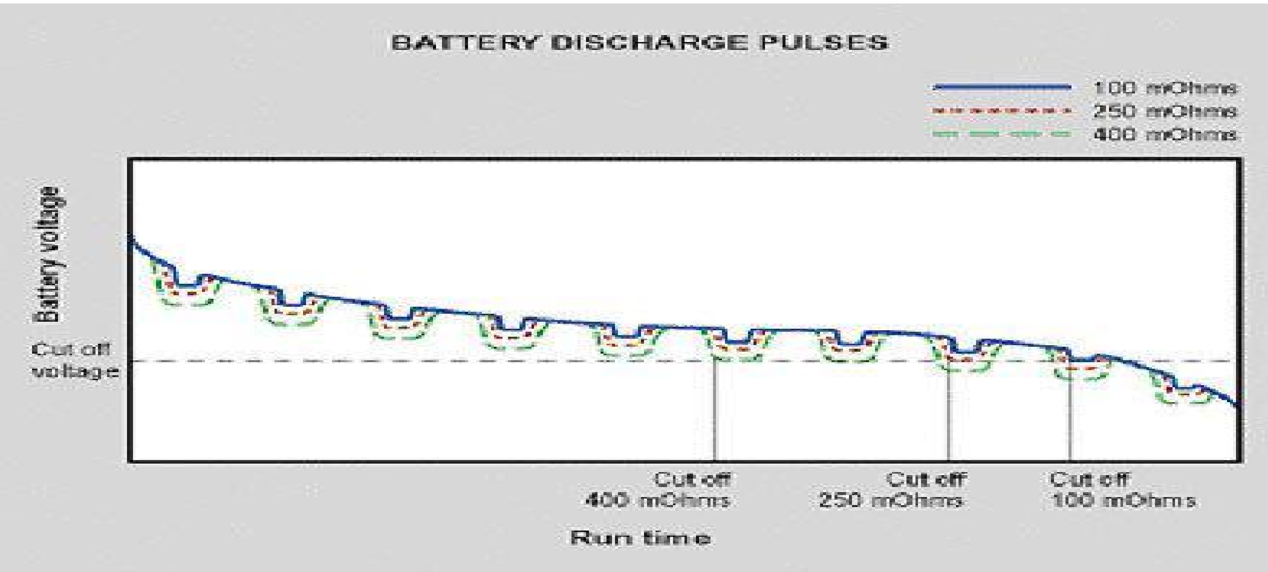

Figure 3.1: Discharge Curve on a Pulsed Load with Diverse Resistance (Buchmann, 2021).

Figure 3.1 illustrates how internal resistance and run time are related. The backup time of inverter batteries should be taken into account when choosing them. You must take into account the battery capacity figure that will allow you to run your desired load for the desired backup hours. Equation 1 describes the link between battery capacity, total wattage, and backup hours (Leonics, 2013).

$$\mathbf{C}=\frac{Whd}{V}\text{ - - - - - - }\mathbf{(1)}$$

Where:

C= battery capacity (AH)

W= total watts of load

h= backup time (hours)

h =days of autonomy

V= nominal battery voltage

For an effective and efficient inverter system, a deep-cycle battery was used to power the inverter.

3.2 THE DEEP CYCLE BATTERY

Deep cycle batteries are made to be depleted to extremely low levels often around 50% of their capacity and then fully recharged. Deep-cycle battery capacity is often expressed in ampere-hours (Ah). How long a deep cycle battery can run a load before needing to be recharged depends on its capacity. The capacity of a battery is also impacted by the rate of discharge. For instance, a high-capacity battery may have less capacity if it runs out quickly. A deep-cycle battery needs to be charged and discharged properly in order to maintain its performance and lifespan. It is essential to use a deep-cycle battery charger and to maintain the battery according to the manufacturer's instructions.

3.2.1 TYPES OF DEEP CYCLE BATTERY

Deep-cycle batteries come in a variety of forms, including lithium-ion and lead-acid. The many deep-cycle battery types are listed below in brief, along with some examples of each. deep-cycle lead-acid batteries;

1. Lead-acid deep cycle batteries:

Flooded: Water must be constantly added to the cells of these batteries to maintain the proper electrolyte level. Examples are the Trojan T105, Crown CR430, and US Battery US2200. Lead-acid sealed batteries (SLA): These sealed batteries don't need to be maintained on a regular basis, although they are usually more expensive than flooded batteries. Examples are the Mighty Max ML35-12, Optima D31M, and VMAX MR127.

Absorbed glass mat (AGM) batteries are more expensive than flooded batteries but are also sealed and maintenance-free. The Deka Intimidator 8A8D, Renogy Deep Cycle AGM Battery, and battle Born LiFePO4 Deep Cycle Battery are a few examples.

2. Lithium-ion deep cycle batteries: they are lighter and more compact than lead-acid batteries and have a higher energy density. They cost more money, though. A few examples include the Battle Born LiFePO4 Deep Cycle Battery, Renogy 12V 100Ah Lithium Iron Phosphate Battery, and Victron Energy Lithium Ion Battery.

Deep cycle batteries of other types:

3. **Nickel-metal hydride batteries**: However less prevalent, have a higher energy density than lead-acid batteries. Sanyo Eneloop Pro High-Capacity NiMH AA Rechargeable Batteries and ENERGIZER NIMH AA Rechargeable Batteries are two examples.

4. Nickel-cadmium: Despite having a high cycle life, these batteries are less popular than others because of environmental concerns. Panasonic Eneloop Pro-High-Capacity Nickel Cadmium AA Rechargeable Batteries and Rayovac Rechargeable Nickel Cadmium AA Batteries. The AGM battery was chosen for the inverter's architecture based on factors.

The AGM battery is depicted in the following figures:

48 Volt AGM Battery Pack State of Charge	
Level	Voltage
100%	52.00 Volts
90%	51.10 Volts
80%	50.00 Volts
70%	49.20 Volts
60%	48.60 Volts
50%	48.20 Volts
40%	47.80 Volts
30%	47.24 Volts
20%	46.64 Volts
10%	46.04 Volts
0%	42.00 Volts

Figure 3.2: AGM Battery State of Charge Chart (Electric scooter parts, 2022).

Figure 3.2 shows the state of charge of AGM Batteries. At the green state of charge levels, the battery will have normal output power, at the yellow state of charge levels the batteries will have moderately diminished output power. At the red state of charge levels, the batteries will have severely diminished power output (Electric scooter parts, 2022).

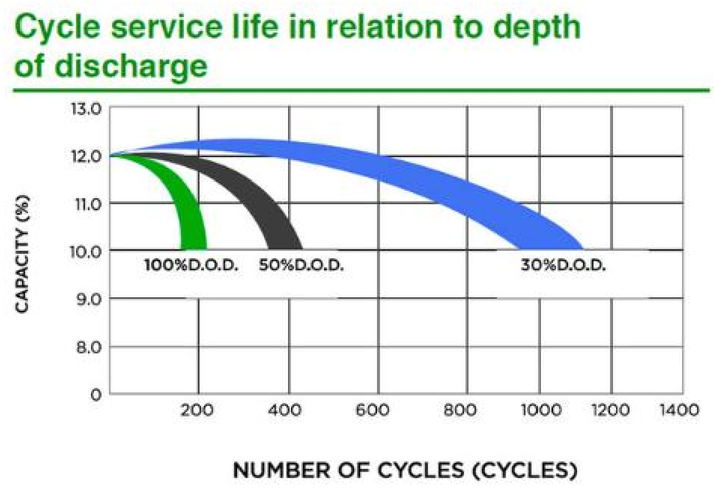

Figure 3.3: Depth of Discharge(DOD) Versus Life Cycle

3.3 INVERTER DESIGN

Two 12V 65AH AGM batteries were linked in series for building the inverter, which was designed and built. Thus, a 24V 65AH DC supply was produced, which was used to power the inverter's circuits. To guarantee that the inverter's circuitry operates efficiently and that the inverter functions optimally, additional parts were installed.

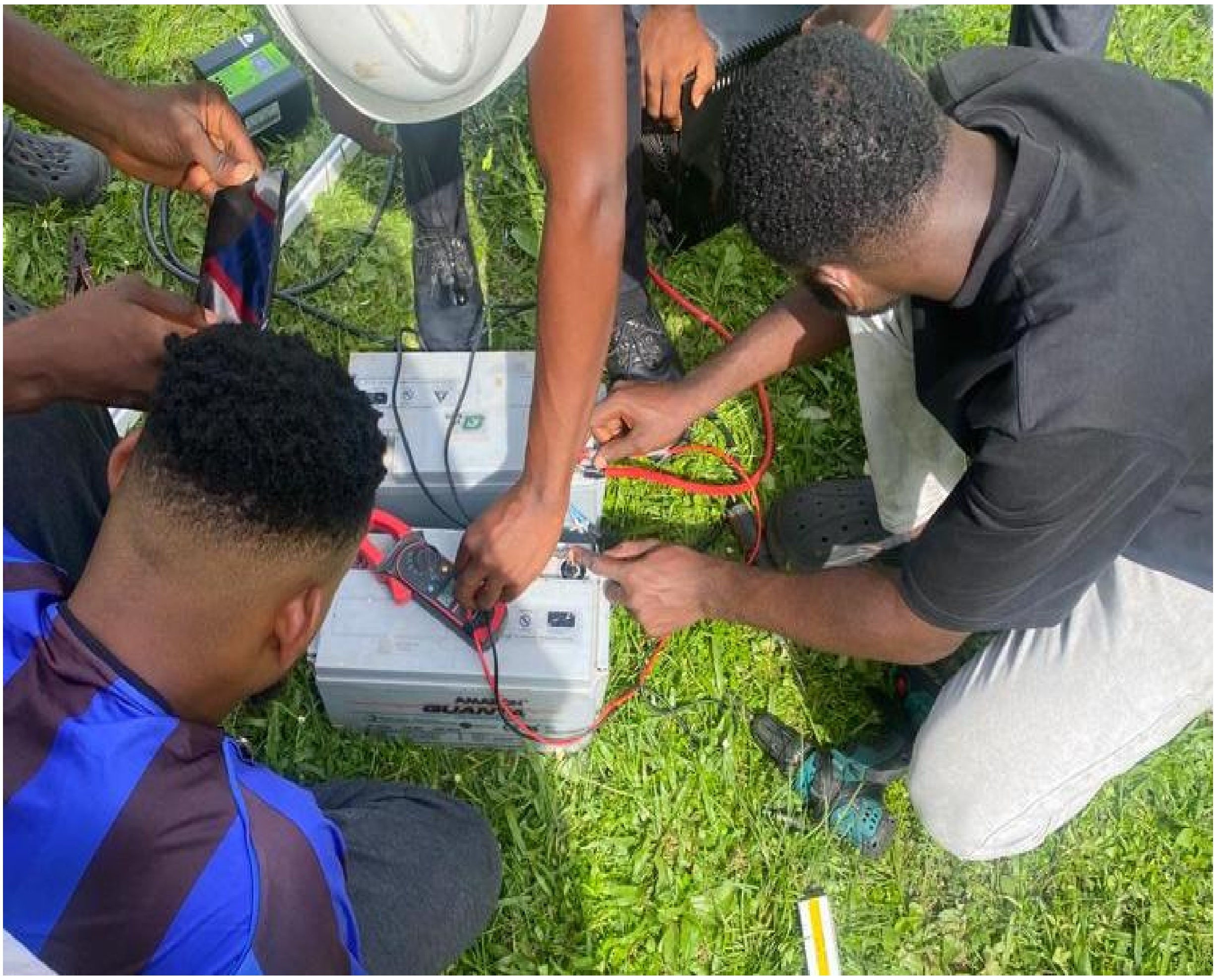

Figure 3.4: AMG Battery connected in series (Godswill, 2023)

CHAPTER FOUR

RESULTS AND DISCUSSION

An AGM (absorbed glass mat) battery from Amaron Quanta with a 24V and 65AH rating powers the inverter system. The 24V voltage rating on this battery indicates that electricity at that voltage is what it is meant to supply. The battery's amp-hour capacity, or how much energy it can hold, is indicated by its 65AH rating power supply for the inverter that is reliable. ACGM batteries are a great option suitable for use with the inverter because of their high energy density and low self-discharge rate.

Figure 4.1: Battery in use (energy mall)

According to Gurkaynak et al, (2007), using this battery to power the inverter system will offer a dependable and continuous power source for applications. Depending on the specific requirements of the inverter system, the battery's 24V rating is also. It is important to remember, however, that a variety of factors might affect how well the battery in the inverter system performs. These variables include the battery's state of charge, the surrounding temperature, the pace of battery depletion, and the particular load requirements of the inverter system. To ensure that the battery is performing at its best and to spot any potential issues, it might be necessary to carefully check its performance. To ensure long-term performance and reliability, proper battery care is also necessary. This may entail following any manufacturer provided maintenance guidelines, routinely checking the electrolyte level, maintaining a clean battery, and so on. By keeping the buttery in good condition, it is possible to increase its lifespan and make sure that it keeps giving the inverter system dependable electricity. Overall, if the inverter system's specific requirements are met and the battery is properly maintained and operated, selecting an AGM battery with a rating of 24V and 65AH to power an inverter system is a reasonable decision. By carefully evaluating the factors that may have an impact on the battery's performance and making an effort to maximize its use, it is feasible to guarantee that the battery will continue to supply the inverter system with dependable and stable power over time.

A 26V charger is used to charge the AGM battery in order to prolong its life and safeguard it. There are a number of potential advantages to using a charger with a voltage rating higher than the battery's typical voltage (in this case, 24V). One possible benefit is that the battery can be charged more quickly when charged at a higher voltage, which may be desired in some applications. By reducing the length of time the battery spends in the "sulfated" condition, which can happen when the battery is left depleted for a long time, higher charging voltages would also help to extend battery life (Ellis et al, 2011).

Because it might be able to provide more power when fully charged, charging the battery at a higher voltage would also improve its overall performance (Ellis et al, 2011).

It is important to remember, though, that charging a battery with a voltage that is too high may also be hazardous. For instance, overcharging a battery with a high voltage can lead to overheating, which reduces lifespan and performance (Ellis et al, 2011). Additionally, it is crucial to ensure that the battery is charged properly and not at an excessively high voltage

Therefore, using a 26V charger to charge an AGM battery is a good alternative if the charger is appropriate for the battery and does not cause it to be charged at an excessively high voltage This will protect the battery's life and enable it to live longer. By carefully choosing the charger and taking care of it, you can increase the battery's performance and lengthen its lifespan.

The AGM battery is used to provide constant power over an extended period of time and to perform reliably until it is around 80% discharged. To continue supplying electricity at this point, the battery must be recharged.

The battery may be able to provide a reliable supply of power for the inverter system over an extended period of time as a result of being used in this way. AGM batteries are a great option for applications that require a consistent power source because to their high energy density and low self-discharge rate (Gurkaynak et al. 2007). It can be possible to further increase the battery's lifespan and guarantee that it continues to function dependably throughout time by only discharging the battery to 80% or more before recharging it. But it's crucial to remember that a variety of things might affect how well the inverter system's battery performs. These variables include the battery's state of charge, the surrounding temperature, the pace of battery depletion, and the particular load requirements of the inverter system. To ensure that the battery is performing at its best and to spot any potential issues, it might be necessary to carefully check its performance. For a battery to work and be reliable over the long term, proper maintenance is necessary. This can entail performing routine electrolyte level checks, maintaining a clean battery, and performing any maintenance recommended by the manufacturer Instructions. By keeping the battery in good condition, it is possible to increase its lifespan and make sure that it keeps providing dependable power to the inverter system. As a result, using an AGM battery to provide consistent power over an extended period of time and to operate dependably until it is 80% or more discharged may be a wise choice, providing the battery is handled and maintained appropriately and the unique requirements of the inverter system are taken into account. By carefully evaluating the factors that can affect the battery's performance and making efforts to maximize its use, it is possible to guarantee that the battery provides the inverter system with dependable power for a prolonged period of time.

CHAPTER FIVE

FINDINGS, CONCLUSION AND SUGGESTIONS FOR FUTHER STUDIES

5.1 FINDINGS

During the research the following findings were made

1. the reviews showed how the various factors influenced the battery's performance.

2. the deep cycle battery was suited for the design.

3. on testing the 24V AGM battery, it gave optimum satisfaction.

4. the accurate discharge rate could not be gotten because immediately load added to the inverter, it ran the battery down. It was then discovered that the 24V AGM battery provided was bad.

5.2 CONCLUSION

In order for an inverter system to function effectively and consistently, selecting the right battery is essential. The performance of a battery in an inverter system can be influenced by a variety of factors, some of which may be interconnected. When choosing a battery to be used in an inverter, it's important to take into account a number of factors, including temperature, charge level, maintenance, life expectancy, cyclic stability, safety, environmental impact. recharge time, discharge rate, compatibility with the inverter, battery type, size and weight, and durability. The correct battery must be chosen in order for an inverter system to run efficiently and consistently. Numerous variables, some of which may be connected, may have an impact on a battery's performance in an inverter system. Temperature, charge level, maintenance, life expectancy, cyclic stability, safety, environmental impact, recharge time, discharge rate, compatibility with the inverter, battery type, size and weight, and durability are all important considerations when choosing a battery to be used in an inverter.

5.3 SUGGESTIONS FOR FURTHER STUDIES

The design, construction, and testing of this 24V inverter system yielded positive results, particularly regarding the suitability of AGM deep-cycle batteries. However, to further optimize inverter design and battery efficiency, the following areas are recommended for future research:

Controlled Load and Discharge Rate Analysis: Because the accurate discharge rate could not be perfectly isolated during this project due to immediate load application, future studies should implement controlled, stepped-load testing. This would allow for precise mapping of the AGM battery's discharge curve and true runtime under highly regulated conditions.

Comparative Analysis with Lithium-Ion Technology: While the 65AH Amaron Quanta AGM batteries provided optimum satisfaction for this specific architecture, subsequent studies could build a parallel 24V system using Lithium Iron Phosphate (LiFePO4) deep-cycle batteries. This would provide a direct comparison of efficiency, depth of discharge resilience, and long-term cost-effectiveness.

Impact of Thermal Variance on System Efficiency: Temperature was identified as a key variable influencing battery performance. Future research could test this exact inverter setup under varying environmental temperatures to quantify how extreme heat or cold specifically affects the lifespan, charge level, and output stability of the AGM batteries.

Integration of Smart Battery Monitoring Systems (BMS): Future iterations of this project could incorporate microcontroller-based, real-time monitoring systems. Integrating an loT-capable BMS would allow for continuous data logging of the State of Charge (SOC) and Depth of Discharge (DOD), ensuring the battery is never accidentally depleted past the recommended threshold, thereby maximizing its life expectancy.

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