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Construction of a Mini Submersible Water Pump

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ABSTRACT

Water pump is a device used in moving water from one place to another, through the influence of solar energy converted to electrical which set the DC motor into mechanical action to pump water to the intended destination. The main focus is how to minimize excess cost in energy demand require in supplying water to a desired places and its economic challenges. The effect of rising price of petrol in Nigeria becomes a critical issue, especially in the provision of basic energy need in our rural community. "Water is life" as it is usually said, but the cost of obtaining a sufficient water for our domestic use and irrigation of farm land has pose a serious concern, especially where machineries are to be employed for continue supply of water. The overall power consumption of any equipment plays a vital role in cost of ruining it. In this paper, a mini motorize pump was designed using a locally sourced stepper motor and a recycled plastic materials were used to fabricate the suction blades and casing. The motor and blade was coupled to a shaft that is capable of lifting water to a height of about 10 m with less power consumption. The pump can operate at a minimum power of 6 volt 15 amps of battery or 12 volt 20 amps solar panel. The flow rate depends on the power rating.

Key words: *Moving water, rural community, irrigation, motorize pump and minimum power*

INTRODUCTION

The need for efficient and sustainable water pumping solutions has become increasingly important in various industries, including agriculture, municipal water supply, and environmental remediation. Traditional pumping systems often rely on fossil fuels or grid electricity, contributing to greenhouse gas emissions and operational costs. Recent advancements in renewable energy technologies, particularly solar power, have paved the way for innovative pumping solutions (Adewale et al 2022). Water pump is a device used in moving water from one place to another, in which this paper focus on how to minimize excess cost in energy, as the effect of rising price of petrol in Nigeria becomes a critical issue, especially in the provision of basic energy need in our rural community. "Water is life" as it is usually said, but the cost of obtaining a sufficient water for our domestic use and irrigation of farm land has pose a serious concern, especially where machineries are to be employed for continue supply of water. The overall power consumption of any equipment plays a vital role in cost of ruining it (Olatunji, 2019). In this research, a mini motorize pump was design using a locally sourced materials were used to fabricate the pump.

Submersible Solar water pump is an electronic pump system in which the power is provided by solar panel or dc power bank.

The overall power consumption of any equipment plays a vital role in cost of ruining with the intention to limit at maximum the waste of energy, to clean up our environment and to avoid the abusive and unethical exploitation of our natural and forest resources, and also to improve and increase efficiency in energy production. Several ways to protect nature as developing renewable energies, have been investigated (Ogunleye *et al* 2021). The work is designed to alleviate the challenges inherent in pumping water from one particular place to another in the rural areas. It has great applicability in water borehole systems, irrigation, building and bricklaying activities, palm oil and groundnut oil industries and other industries that deal with fluid. The power for the pump can either come from manual pedalling or the dc motor. It uses centrifugal force to pressurize, transfer or circulating water or other liquids. The device find a wide range of applications in various industries. People commonly use them in portable water systems for camping and outdoor activities, as well as in aquariums and fish tanks for water circulation and filtration. DC water pumps are vital in solar water systems, efficiently transferring water from wells to storage tanks with renewable energy some people employ these pumps to create decorative fountains, automated plant watering systems, and hydroponic setups. They are invaluable due to their compact size, low power usage, and versatility in inefficient water pumping tasks. The advantage of DC pump Compared with AC water pumps driven by 120v, 220v, 240v, 380v AC motors, DC water pump has advantages of low running cost, safety, high efficiency, low noise, portable, etc. (El-Kabeery, 2018). The efficiency of the submersible pump depends on the motor type, pump design, and operating conditions (El-Gohary, 2018).

Problem Statement

Conventional submersible pumps face limitations in terms of energy efficiency, size, and environmental impact. These pumps often require high power inputs, leading to increased energy costs and carbon emissions. Furthermore, their large size and weight make them difficult to install and maintain, particularly in remote or hard-to reach locations.

Aim and objectives

The main aim of this research was construct a submersible pumping machine that can operate using solar energy.

The objectives are:

To install mini DC motor into solar power pump

To fabricate a submersible system to pump water from wells or reservoirs.

To create sustainable energy pumping system that will alleviate the growing energy demand of our community.

To serve as platform for the promotion of green energy sustainability.

METHODOLOGY

Materials employed to build a solar-powered DC water pump are: Assorted DC motor, stepper DC, stainless quarter rod, wire stripper, solar panel, PVC pipes fittings, battery, drill knife, soldering iron, multimeter, pliers, and PVC gum

Design Procedures

A DC motor was attached to a small base or housing of the mini pump, then a pump chamber was connected to the motor shaft. Attached to the motor shaft right inside the pump chamber was the impeller. At the outlet side of the pump chamber, a valve was installed. Finally, the motor was then connected to the power source and a switch was introduced (optional) to control the operation of the pump (Fig 1).

Figure 1: Schematic design of mini submersible pump.

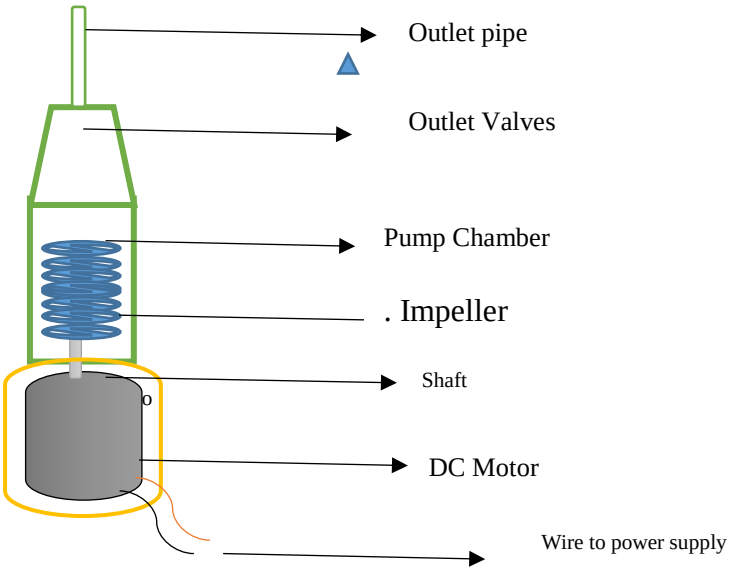
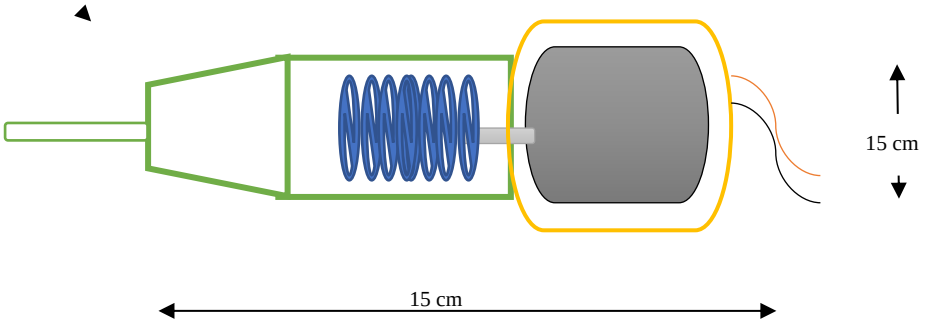


Fig 2: Showing design of mini submersible pump and its dimension



The complete system comprises of a solar panel array, charge controller, battery bank, DC motor, pump, and control unit. Solar panels convert sunlight into electricity, stored in batteries for night time or cloudy day operation. The charge controller regulates battery charging, preventing overcharging. The DC motor drives the pump to lift water from the source. A control unit manages system operation, including pump ON/OFF, and protection mechanisms.

Principle of operation

The submersible pump design take into account, water depth, flow rate, and head requirements. Other key components include the impeller, diffuser, motor housing, and shaft. Material selection is crucial for durability and corrosion resistance. Stainless steel or bronze are common choices. Impeller and diffuser design, impacts efficiency and head generation.

The motor power output aligns with pump requirements such as permanent magnet DC motors which offer high efficiency and reliability; the capacity, location and the tilting position of the solar panel to intercept maximum radiation to obtained optimal energy generation of the system. The magnitude of voltage, current, torque, and speed subject water unto centrifugal force to pressurize, transfer or circulating water or other liquids to the desired destination. Waterproofing and insulation are essential for submersible operation.

The Battery capacity determines storage for night time or extended cloudy periods. Battery type (lead-acid, lithium-ion) influences efficiency, lifespan, and cost. Sufficient capacity prevents deep discharge, prolonging battery life.

The charge controller prevents battery overcharging and undercharging. MPPT (Maximum Power Point Tracking) technology maximizes solar energy utilization. Controller size matches solar panel and battery bank specifications. The basic control system includes float switches for automatic operation based on water level. Advanced systems incorporate pressure sensors, flow meters, and remote monitoring capabilities. Microcontrollers can optimize pump operation and energy efficiency.

Site assessment includes water source depth, flow rate, required head, and solar radiation. System components are selected based on these parameters. Proper grounding, cable routing, and pump installation ensure safety and efficiency.

Components connection and wiring should be orderly secured and properly installed according to design specifications. System testing verifies performance and identifies any issue.

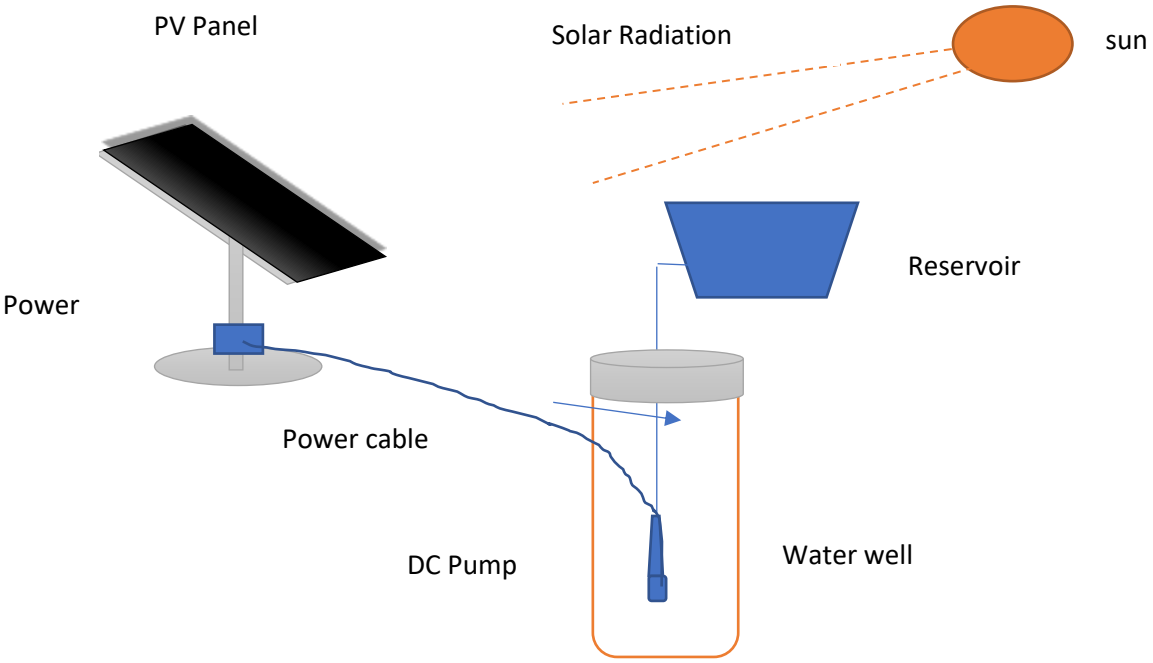


Figure 3: Schematic Diagram of complete mini submersible pump system

RESULT

The mini pump was successfully constructed and tested. Below are the pictorial view of the finished work

Plate.1: showing impeller under construction

Plate 2: showing dc motor connected to the impeller

Plate 3: Showing Mini pump completed

Plate 4: Testing under 6v

Plate 5: Testing under 12v

Table 1: Showing flow rate at a given distance and voltage

Head (m)	Flow rate (L/min)	DC (volt)
1	15	3
3	7	3
5	4	3
1	15	6
3	10	6
5	12	6
1	18	12
3	15	12
5	12	12

Key:

Head: The vertical distance the pump needs to lift the water.

Flow Rate: The volume of water the pump can move per minute.

DC: The amount of volt consumes.

DISCUSSION

The successful constructed pump was subjected unto range of voltage 3, 6 and 12 volts and the flow rate (amount of water dispense in litre per minute at each range of voltage) were measured (Table 1). Amount of water dispense depend on the head lengths and voltage applied to the system. From the table, it shows that as the head increases, the flow rate decreases, and the power consumption increases and this is typical for most submersible pumps.

CONCLUSION AND RECOMMENDATION

At demonstration DC submersible water pumping system it was observed that the machine was effectively and reliable to pump water from a depths of about 5-10 meters with an efficient flow of water. The system's components, including the pump, motor, controller, and submersible housing, were carefully selected and assembled to ensure optimal performance and durability.

Potential areas for future improvement include, increasing efficiency, reducing cost, enhancing durability. Overall, the developed system offers a promising solution for water pumping applications in various settings, particularly where access to AC power is limited.

In addition, further testing be conducted under various operating conditions to assess the system's performance and durability, cost-benefit analysis be carry out to evaluate the economic viability of the system compared to traditional AC-powered pumps. Consideration be given to scaling up the system for larger-scale water pumping applications.

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