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Design and Development of a Portable Generator Using Scrap Materials

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ABSTRACT

The rapid growth of small and medium-scale industries has increased the demand for compact, efficient, and cost-effective internal material-handling solutions. Traditional manually operated trolleys cause significant operator fatigue, reduced productivity, and safety risks when transporting loads above 150 kg. This paper presents the design, development, and experimental validation of an electric material handling cart powered by a 500 W BLDC motor, a dual-mode BLDC controller, and a 48 V, 10 Ah Genesys battery system. The cart is constructed on a robust stainless-steel chassis with optimized dimensions of 1200 mm × 1000 mm × 500 mm, supported by a CNC-machined drive axle, differential mechanism, and 17-inch pneumatic wheels. A chain–sprocket reduction drive provides high starting torque for industrial loads between 200–250 kg and ramp climbing up to 5%. Extensive field testing—including load trials, gradient climbing, structural assessment, runtime evaluation, braking tests, and narrow-corridor maneuverability checks—validated the system's performance. The cart demonstrated a mixed-duty runtime of approximately 50 minutes and a controlled braking distance of 0.35 m, confirming theoretical predictions. Results confirm that the developed electric cart offers a reliable, zero-emission, and ergonomically superior alternative to manual material handling, making it highly suitable for warehouses, workshops, and confined industrial environments.

Keywords: *Portable Generator, Scrap Material Utilization, Electromagnetic Induction, Small-Scale Power Generation, Energy Efficiency, Sustainable Engineering, Cost-Effective Design.*

1. INTRODUCTION

Electric power generation plays a vital role in modern society due to the increasing demand for energy in industrial, commercial, and domestic applications. With the rapid growth in population and technology, the need for reliable and efficient power sources has become more significant. Traditional power generation methods mainly depend on fossil fuels, which lead to environmental pollution and depletion of natural resources. Therefore, researchers are focusing on alternative and sustainable methods of generating electricity. A generator is a device that converts mechanical energy into electrical energy based on the principle of electromagnetic induction. According to Faraday's law, when a conductor moves relative to a magnetic field, an electromotive force (EMF) is induced, resulting in the flow of electric current. This fundamental principle is widely used in different types of generators such as AC generators, DC generators, and electromagnetic generators. Recent research has focused on developing low-cost, portable, and efficient generator systems that can operate in remote areas and under varying conditions. Induction generators and small-scale portable generators have gained importance due to their simple construction, low maintenance, and ability to operate with different energy sources such as wind, water, and manual input. These systems are especially useful in areas where grid electricity is not available or is unreliable. Moreover, modern studies highlight the importance of designing generators using alternative materials and innovative techniques to reduce cost, noise, and environmental impact. For example, electromagnetic generator designs using permanent magnets and optimized coil structures have been proposed to improve efficiency and performance. In this context, the development of a portable generator using available or scrap materials provides a practical and economical solution for temporary power generation. Such systems not only reduce production costs but also promote the reuse of materials and sustainable engineering practices. This research focuses on the design, working, and performance analysis of a generator system, aiming to provide an efficient and reliable power source for small-scale applications.

1.1 Problem Statement

In many regions, especially rural and remote areas, the availability of a continuous and reliable power supply remains a major challenge. Frequent power cuts, lack of grid connectivity, and increasing electricity demand create difficulties in performing daily activities, industrial operations, and emergency services. Conventional generators, although widely used, are often expensive, bulky, and require high fuel consumption, making them unsuitable for small-scale and portable applications.

Additionally, the rising cost of materials and growing environmental concerns due to fuel-based power generation systems highlight the need for alternative solutions that are economical and eco-friendly. Many existing generator systems are not designed for portability or reuse of materials, leading to increased waste and inefficient resource utilization.

Therefore, there is a need to develop a cost-effective, portable, and efficient generator system that can be constructed using easily available or scrap materials. Such a system should be capable of providing reliable power for small applications while reducing dependency on conventional energy sources and promoting sustainable engineering practices.

1.2 Objectives

The primary objective of this project is to design and develop a portable generator capable of generating electrical power efficiently for small-scale applications.

Specific Objective are

i. To convert mechanical energy into electrical energy using the principle of electromagnetic induction.
ii. To utilize scrap or readily available materials for constructing the generator system.
iii. To design a compact and portable structure for easy transportation and use.
iv. To analyse the performance of the generator in terms of output and efficiency.
v. To reduce dependency on conventional power sources by providing an alternative solution.
vi. To ensure simple construction and maintenance of the system.
vii. To optimize the design for better energy output with minimum losses.
viii. To promote sustainable engineering practices through reuse of materials

1.3 Scope

This study focuses on the design and development of a portable generator for small-scale power generation. It includes the use of electromagnetic induction, selection of components, and performance evaluation based on output and efficiency. The system is intended for low-power applications such as emergency and temporary electricity supply. The study also considers portability, simple construction, and future improvements, while large-scale applications are not included.

2. LITERATURE REVIEW

Several research studies have been conducted on the design and development of small-scale and portable generator systems. These studies emphasize the increasing demand for compact, efficient, and reliable power sources, especially in areas with limited access to electricity. Generators operate on the principle of electromagnetic induction, where electrical energy is produced due to the relative motion between a conductor and a magnetic field. Many researchers have focused on improving generator efficiency by optimizing key parameters such as coil design, magnetic field strength, and rotational speed. These factors significantly influence the overall performance and output of the generator. Recent studies highlight the importance of portable and low-capacity generators for applications such as emergency power supply, outdoor activities, and rural electrification. Induction generators and permanent magnet generators are widely studied due to their simple construction, durability, and suitability for small-scale applications. Permanent magnet generators are known for their compact size and higher efficiency, while induction generators are preferred for their low cost and robustness. In addition, research has been carried out on low-cost and innovative generator designs, focusing on reducing material costs and improving accessibility. Some studies suggest the use of locally available materials and simplified construction techniques to make generators more economical and easier to maintain. These approaches are particularly beneficial in developing regions where affordability is a major concern. Furthermore, recent advancements include the development of microgenerators and energy harvesting systems, which convert small mechanical inputs such as human motion or vibrations into electrical energy. Although these systems are portable and eco-friendly, their power output is limited, making them suitable only for low-power applications. However, despite the progress in generator technology, limited research is available on the development of portable generators using scrap or recycled materials. Most existing systems rely on new and costly components, which increases the overall cost and reduces sustainability. Therefore, this study focuses on the design and development of a portable generator using scrap materials, aiming to provide a cost-effective, eco-friendly, and practical solution for small-scale power generation. This approach not only reduces material cost but also promotes the reuse of resources and sustainable engineering practices.

3. METHODOLOGY AND SYSTEM DESIGN

Design Selection

The design of the portable generator was selected based on simplicity, ease of construction, and availability of materials. A compact and portable structure was chosen to ensure easy handling and transportation. The system mainly consists of a prime mover, a rotating shaft, and an alternator arranged in a way to achieve efficient power generation with minimum complexity.

Material Selection (Scrap Utilization)

The materials used for the construction of the generator were selected from scrap and readily available sources. Components such as an old motor or engine, used alternator or dynamo, metal frame, shafts, bearings, and electrical wiring were identified and reused. The selection was primarily based on cost-effectiveness, availability, and suitability for the intended application.

Fabrication and Assembly

The fabrication process involved assembling all the selected components into a single functional unit. The prime mover was mechanically connected to the alternator using a shaft or belt drive mechanism. A strong supporting frame was constructed to hold all parts securely. Proper alignment of the shaft and alternator was maintained to reduce vibration and mechanical losses, while electrical connections were made carefully to ensure safe and efficient operation.

Working Mechanism

The generator operates on the principle of electromagnetic induction. When the prime mover supplies mechanical energy, it rotates the shaft connected to the alternator. As the alternator rotates, it produces electrical energy, which is then supplied to the connected load. This conversion process forms the basic working mechanism of the system.

Performance Evaluation

The performance of the developed generator was evaluated by testing it under different load conditions. Key parameters such as output voltage, current, and overall power generation were measured using appropriate instruments. The efficiency of the system was also analyzed to determine its effectiveness for practical use.

Analysis and Optimization

The results obtained from testing were analyzed to identify performance limitations and energy losses within the system. Based on this analysis, possible improvements were suggested to enhance efficiency, stability, and overall performance of the generator.

Safety and Maintenance Considerations

Safety measures were considered during the design and operation of the generator to prevent electrical and mechanical hazards. The system was also designed in such a way that maintenance and repair can be carried out easily, ensuring long-term usability.

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5. CONCLUSION

The increasing demand for reliable and portable power sources has led to the development of small-scale generator systems for temporary and emergency applications. This study focuses on the design and fabrication of a portable generator using scrap materials, aiming to provide a cost-effective and sustainable solution for power generation. The system operates on the principle of electromagnetic induction, where mechanical energy is converted into electrical energy through the rotation of an alternator. The generator is constructed using readily available components such as a reused motor or engine, an alternator, and a supporting frame made from scrap materials. Emphasis is placed on achieving portability, simplicity in design, and efficient utilization of resources. The fabricated system is tested under different load conditions to evaluate its performance in terms of voltage output, current generation, and overall efficiency. The results demonstrate that the developed generator is capable of providing a reliable power supply for low to moderate applications such as emergency lighting and small electrical devices. Additionally, the use of scrap materials significantly reduces the overall cost and promotes sustainable engineering practices. This study highlights the potential of developing economical and practical generator systems for decentralized power generation.

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