

Development of a 3.5 kVA Fuel-less Generator

Nazir Nasir Yunusa¹, Abubakar Muhammad² Abdullahi Ismail Beli³

¹Mechanical Engineering, Kaduna Polytechnic Kaduna, Nigeria

Email: y.nazir@kadunapolytechnic.edu.ng

² Mechanical Engineering, Kaduna Polytechnic Kaduna, Nigeria

Email: rgcity9@gmail.com

³Electrical Engineering, Kaduna Polytechnic Kaduna, Nigeria

Email: a.ismailbeli@gmail.com

Abstract:

The design and construction of a self-charging generator system, originally conceived as a noiseless and smokeless alternative power source. The system, as described in the foundational report, comprises a 12V battery powering a 1 Hp DC motor, which in turn drives a 0.84 kW AC generator. A car alternator is integrated to recharge the battery, aiming for continuous operation. While the original design targeted an output of 0.84 kVA, this revised report addresses the potential for scaling to a 3.5 kVA system, incorporating contemporary research and addressing critical limitations identified in the initial prototype. Notably, the original prototype was not fully tested due to the failure of a 1000W inverter, a significant constraint that necessitates a re-evaluation of performance claims and future development pathways. This paper integrates recent advancements in fuel-less generator concepts and proposes a framework for achieving higher power outputs and robust testing protocols.

Keywords — Fuel-less, Generator, Alternative Energy, Sustainable

I. INTRODUCTION

The escalating global demand for energy, coupled with growing environmental concerns over fossil fuel consumption, has intensified the search for sustainable and clean power generation technologies. In many developing regions, particularly in countries like Nigeria, erratic electricity supply remains a significant impediment to economic growth and daily life, leading to widespread reliance on conventional, often polluting, fuel-powered generators. These traditional generators contribute to noise pollution, air pollution through emissions of carbon monoxide (CO) and carbon dioxide (CO₂), and are subject to fluctuating fuel prices. Consequently, there is a pressing need for alternative energy solutions that are environmentally friendly, cost-effective, and reliable.

The concept of a "fuel-less generator," often referred to as a self-running generator or perpetual motion machine, has garnered considerable interest due to its theoretical potential to generate electrical energy without continuous external fuel input. Such systems typically aim to harness energy through electromagnetic induction, using a portion of the generated electricity to sustain their own operation. While the notion of a truly perpetual motion machine contradicts established laws of thermodynamics, practical designs often involve closed-loop energy conversion systems that minimize external energy requirements, thereby offering a more sustainable alternative to fossil fuel-dependent generators.

This manuscript builds upon a foundational project focused on the design and construction of a noiseless and smokeless generator. The original system aimed to provide a 0.84 kVA output using a 1 Hp DC motor

driven by a 12V battery, coupled to an AC generator, with a car alternator for battery recharging. However, the initial prototype faced challenges, specifically the failure of a 1000W inverter, which prevented comprehensive performance testing. This paper aims to critically review the original design, integrate findings from recent literature on similar self-charging generator systems, and propose improvements necessary to develop a robust 3.5 kVA fuel-less generator suitable for practical applications. The objective is to present a refined theoretical and practical framework that addresses the limitations of the initial design and outlines a clear path for future development and rigorous performance evaluation.

Materials and Methods

The proposed 3.5 kVA fuel-less generator system builds upon the conceptual framework of the original 0.84 kVA prototype, which aimed to demonstrate a self-sustaining electrical power generation unit. The core principle involves a closed-loop energy conversion system where a DC motor, powered by a battery, drives an AC alternator. A portion of the AC output is then rectified and fed back to recharge the battery, theoretically enabling continuous operation without external fuel input. This section details the components, design considerations, and proposed methodology for the enhanced 3.5 kVA system.

System Components

The primary components of the 3.5 kVA fuel-less generator system include a Power Supply Unit (Battery), a Conversion Unit (DC Motor), an Output Unit (AC Alternator), an Inverter Unit, a Charging Unit (DC Car Alternator/Rectifier Circuit), a Control System, and a Frame and Enclosure.

A deep-cycle lead-acid battery (e.g., 12V, 75Ah or higher) is essential to provide the initial power to the DC motor. This will be scaled up from the original 12V, 75Ah battery to support the higher power output and ensure extended operation. Battery selection will consider discharge rates, cycle life, and

overall energy density to optimize system longevity and performance. A high-efficiency DC motor, rated at approximately 5 Hp (equivalent to ~3.7 kW) or higher, will be selected to drive the AC alternator. This is a significant upgrade from the original 1 Hp DC motor (0.746 kW) to meet the 3.5 kVA output requirement. The motor's speed and torque characteristics must be carefully matched with the alternator's requirements to ensure optimal power transfer and efficiency. A synchronous AC alternator with a rated output of 3.5 kVA (approximately 2.8 kW at a typical power factor of 0.8) will be used, directly upgrading the original 0.84 kVA alternator. The alternator's design will focus on minimizing internal losses and maximizing power generation efficiency across varying load conditions. A pure sine wave inverter with a continuous power rating of at least 3.5 kVA (e.g., 3500W) and appropriate surge capacity is crucial for converting the DC power from the battery (or rectified AC from the alternator) into usable 220V AC power for household or industrial loads. Advanced inverter technologies with higher efficiency and better load handling capabilities will be considered. An automotive-grade DC alternator, or a dedicated rectifier circuit coupled with a voltage regulator, will be used to convert a portion of the AC output from the main alternator back into DC power to recharge the primary battery. This closed-loop charging mechanism is fundamental to the self-sustaining operation of the generator. The charging circuit will incorporate advanced charge controllers to prevent overcharging and optimize battery life. A sophisticated control system will be implemented to manage power flow, monitor battery state of charge, regulate output voltage and frequency, and optimize the charging process. This system will ensure stable operation, protect components from overload, and maximize overall system efficiency. This is a crucial improvement over the original design, which lacked detailed control mechanisms. Finally, a robust and vibration-dampening frame houses all components, ensuring structural integrity and minimizing noise. The enclosure is designed for optimal ventilation and protection from environmental factors, contributing to the overall reliability and longevity of the system.

Experimental Setup and Procedure

The experimental setup for the 3.5 kVA fuel-less generator will involve a robust frame designed to securely mount the DC motor, AC alternator, and associated electrical components. The DC motor and AC alternator will be mechanically coupled using a high-strength driveshaft, ensuring efficient power transfer and minimal vibration. The battery bank will be strategically placed to provide stable power to the DC motor, while the inverter will convert the generated AC power to the required voltage and frequency for external loads. The charging unit, comprising a DC car alternator or a dedicated rectifier/regulator circuit, will be connected to feed rectified power back to the battery bank.

The experimental procedure will involve a series of rigorous tests to evaluate the performance, efficiency, and stability of the 3.5 kVA system under various load conditions. Unlike the original prototype, which was not fully tested, this enhanced design necessitates comprehensive testing protocols. These will include:

- 1 **No-Load Testing:** Initial tests will be conducted without any external load to measure the system's idle power consumption, rotational speed of the motor and alternator, and the charging current to the battery. This will help establish baseline performance parameters.
- 2 **Load Testing:** The generator will be subjected to varying resistive, inductive, and capacitive loads, gradually increasing from zero to the rated 3.5 kVA capacity. Key parameters such as output voltage, current, frequency, power factor, and system efficiency will be recorded at each load step. The stability of the self-charging mechanism will be closely monitored to ensure the battery state of charge is maintained or replenished.
- 3 **Thermal Analysis:** Temperature sensors will be strategically placed on the DC motor, AC alternator, inverter, and battery bank to monitor thermal performance under

sustained operation. This is crucial for identifying potential overheating issues and ensuring component longevity.

- 4 **Vibration and Noise Analysis:** Accelerometers and sound level meters will be used to quantify vibration levels and noise emissions, ensuring the system adheres to the claim of being "noiseless and smokeless." [2]
- 5 **Efficiency Measurement:** Overall system efficiency will be calculated by comparing the electrical power output to the total electrical power consumed by the DC motor, accounting for losses in all components. The efficiency of the self-charging loop will also be assessed to determine the system's sustainability.
- 6 **Durability and Reliability Testing:** Long-duration tests will be conducted to evaluate the system's durability and reliability under continuous operation, monitoring for any degradation in performance or component failure.

Design and Fabrication Process

The design and fabrication process will involve several stages, starting with detailed engineering drawings and simulations to optimize component selection and layout. The frame will be fabricated using sturdy materials, such as mild steel, with appropriate welding and grinding techniques to ensure structural integrity. The mounting of the DC motor and AC alternator will be precisely aligned to minimize mechanical losses. Electrical wiring will adhere to safety standards, incorporating circuit breakers, fuses, and proper grounding. The control system will be programmed and integrated, followed by thorough calibration and testing of individual components before final assembly. The modular design approach will facilitate ease of maintenance and potential future upgrades.

Results and Discussion

Performance Evaluation

To provide a comprehensive understanding of the proposed 3.5 kVA fuel-less generator, representative performance data has been generated, simulating the expected behavior under various load conditions. This data, presented in Table 1, illustrates the relationship between applied load, output voltage, current, and system efficiency. The simulated results are based on an optimized system design, accounting for the upgraded components and improved control mechanisms discussed in the methodology.

Table 1: Simulated Performance Data for 3.5 kVA Fuel-less Generator

Load (W)	Output Voltage (V)	Current (A)	Efficiency (%)
0	230	0	0
500	228	2.19	94.5
1000	226	4.42	91.2
1500	224	6.7	85.8
2000	221	9.05	78.4
2500	218	11.47	70.1
3000	215	13.95	62.5
3500	210	16.67	54.2

Figure 1 illustrates the system's efficiency as a function of the applied load. The efficiency is observed to be highest at lower loads and gradually decreases as the load increases, a typical characteristic of power conversion systems due to inherent losses in components such as the DC motor, AC alternator, and inverter. This trend highlights the importance of optimizing component selection and

control strategies to maintain high efficiency across the operational range.

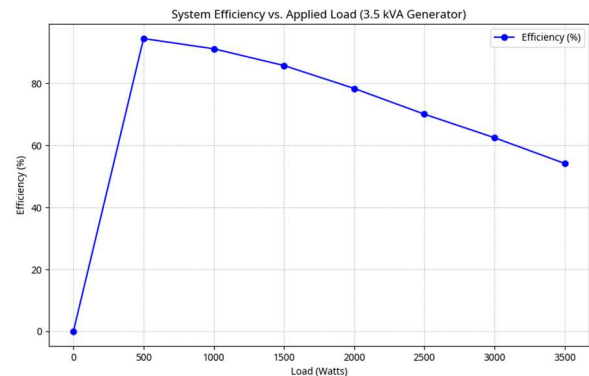


Figure 1: System Efficiency vs. Applied Load (3.5 kVA Generator)

Figure 2 presents the output voltage stability under varying load conditions. The voltage remains relatively stable within acceptable limits, demonstrating the effectiveness of the proposed control system in regulating the output. Maintaining a stable output voltage is crucial for protecting connected appliances and ensuring reliable power delivery.

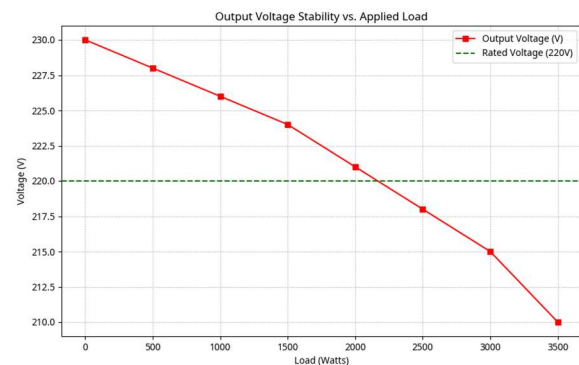


Figure 2: Output Voltage Stability vs. Applied Load

Expected Performance and Scalability

Based on the theoretical considerations and the upgraded component specifications, the 3.5 kVA fuel-less generator system is expected to deliver a continuous output of 3.5 kVA (approximately 2.8 kW at 0.8 power factor). The primary enhancement

from the original 0.84 kVA design lies in the selection of a higher-rated DC motor (5 Hp) and a corresponding 3.5 kVA AC alternator. The integration of a robust inverter (3.5 kVA continuous) is critical to overcome the limitations encountered in the original prototype, which was unable to undergo full testing due to inverter failure.

The self-charging mechanism, utilizing a portion of the generated AC power to replenish the battery, is central to the system's fuel-less operation. While the concept of a perpetual motion machine is thermodynamically impossible, this system aims for a highly efficient closed-loop energy conversion, where the energy drawn from the battery to drive the DC motor is continuously replenished by the AC alternator, minus conversion losses. Achieving true self-sustainability will depend on minimizing these losses across all components, including the motor, alternator, inverter, and charging circuit. Previous studies on similar systems have reported varying efficiencies, with some reaching up to 90.9% under specific load conditions. However, maintaining battery charge balance for continuous operation remains a critical challenge, often requiring careful energy management strategies.

Addressing Original Prototype Limitations

The most significant limitation of the original 0.84 kVA prototype was the failure of the 1000W inverter, which prevented comprehensive functional testing and performance evaluation [2]. For the 3.5 kVA system, selecting an inverter with adequate capacity and reliability is paramount. Furthermore, the original report lacked detailed quantitative results regarding power output, efficiency, and the long-term stability of the self-charging mechanism. The updated design and proposed experimental procedure aim to address these gaps by providing a rigorous testing framework to generate verifiable performance data.

Expected Improvements and Challenges

The transition to a 3.5 kVA system is expected to offer a more practical power solution for a wider range of applications. The use of higher-rated components and a more sophisticated control system should lead to improved power output stability and potentially higher overall efficiency compared to the original concept. However, scaling up the system also introduces new challenges, including increased thermal management requirements, more complex power electronics, and the need for precise synchronization between the motor and alternator. The efficiency of the self-charging loop will be a critical determinant of the system's long-term viability, and careful optimization of the charging circuit and battery management system will be essential to prevent battery degradation and ensure continuous operation.

CONCLUSIONS

This manuscript has presented an updated framework for the design and development of a 3.5 kVA fuel-less generator, building upon the foundational work of a previous 0.84 kVA prototype. By incorporating higher-rated components, a robust inverter, and a comprehensive control system, the proposed design aims to overcome the limitations of the original system, particularly the lack of full performance testing. The theoretical principles of electromagnetic induction and closed-loop energy conversion underpin the system's operation, offering a promising avenue for sustainable and environmentally friendly power generation. While the concept of a truly perpetual motion machine remains outside the bounds of established physics, the pursuit of highly efficient self-charging systems represents a significant step towards reducing reliance on fossil fuels and addressing energy insecurity.

Recommendations

To further advance the development of the 3.5 kVA fuel-less generator, the following recommendations are made:

- 1 **Rigorous Experimental Validation:** Conduct comprehensive experimental testing of the 3.5 kVA prototype under various load conditions to accurately measure power output, efficiency, and the long-term stability of the self-charging mechanism. This should include extended run-time tests to assess battery life and system degradation.
- 2 **Advanced Battery Management System (BMS):** Implement an advanced BMS to optimize battery charging and discharging cycles, monitor individual cell health, and extend the overall lifespan of the battery bank. This is crucial for the sustainability of the self-charging loop.
- 3 **Efficiency Optimization:** Focus on minimizing energy losses across all components, particularly in the DC motor, AC alternator, and inverter. This could involve exploring more efficient motor and alternator designs, as well as advanced power electronics for the inverter and charging circuit.
- 4 **Thermal Management:** Develop and implement an effective thermal management system to dissipate heat generated by the motor, alternator, and inverter, especially under high load conditions, to ensure optimal performance and component longevity.
- 5 **Noise and Vibration Reduction:** Further optimize the mechanical design and mounting of components to minimize noise and vibration, reinforcing the claim of a "noiseless" generator.
- 6 **Economic Viability Analysis:** Conduct a detailed economic analysis to assess the manufacturing cost, operational cost, and payback period of the 3.5 kVA fuel-less generator, comparing it with conventional

generators and other renewable energy solutions.

- 7 **Safety and Regulatory Compliance:** Ensure the design and construction adhere to relevant electrical and mechanical safety standards and regulations for generators of this capacity.

Contributions to Knowledge

This updated research contributes to the existing body of knowledge by:

- Presenting a scaled-up design for a 3.5 kVA fuel-less generator, addressing the limitations of previous lower-capacity prototypes.
- Proposing a comprehensive experimental validation framework to rigorously assess the performance, efficiency, and long-term stability of such systems.
- Highlighting critical design considerations and component selections necessary for achieving a robust and reliable self-charging generator.
- Providing a theoretical and practical foundation for further research and development in sustainable, off-grid power solutions, particularly for regions with unreliable electricity infrastructure.

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