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Development of a 1.0 KVA Fuelless Generator

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***Abstract**: A 1.0KVA fuelless generator has been developed. The crave for sustainable energy solution has led to the exploration of emerging technologies targeted at reducing reliance on fossil fuels and reducing environmental impact. One such technology is the development of fuelless generators, which harness renewable energy sources or utilize unconventional mechanisms to generate electricity. This power producing mechanism is aimed to develop a targeted 1KVA power capacity through innovative design strategies. Detailed graphical modeling of the orthographic projection and isometric views brought about enhanced machine components development for stability and reliability. Careful selection of conductor materials and design considerations ensured efficient power transmission, minimizing losses within the system. Integration of power factor correction capacitors and advanced control algorithms contributed to achieving a power factor close to unity, optimizing energy utilization. Comprehensive performance testing validated the functionality and reliability of the developed generator under various load conditions. The development of a fuelless generator with a battery power capacity of 0.85 Kw, torque of 14.48Nm, resistance of 48.35 ohms, current of 4.55 Amperes and a power factor of 0.85 signifies a significant breakthrough in sustainable energy generation. The performance test showed that that an input response brought about an increase in load (W). The success of developing the generator not only demonstrates the feasibility of clean and sustainable energy solutions but also underscores the potential for further advancements in fuelless generator technology towards a more reviving energy prospect.*

***Keywords:** Development, Fuelless, Design, Generator, Electricity.*

1. INTRODUCTION

The development of a 1.0 KVA fuelless generator represents a significant advancement in the field of power generation technology. This innovative device aims to provide a reliable and sustainable alternative to traditional fossil fuel-powered generators by harnessing renewable energy sources or employing unconventional mechanisms to generate electricity [1]. To understand the background of this study, it's essential to explore the context, challenges, and motivations driving the development of the generator [2].

The global energy landscape is undergoing a transformative shift towards sustainability and renewable energy sources. Traditional generators powered by fossil fuels such as gasoline, diesel, or natural gas contribute to environmental degradation through carbon emissions, air pollution, and reliance on finite resources [3]. As a result, there is a growing demand for clean, sustainable, and efficient power generation technologies that minimize environmental impact.

Conventional generators are plagued by several limitations, including dependence on fossil fuels, high operating costs, maintenance requirements, and environmental pollution. Additionally, fuel availability and price volatility pose significant challenges, particularly in remote areas or during natural disasters when access to fuel may be limited or disrupted [4]. These limitations underscore the urgent need for alternative power generation solutions that are both eco-friendly and cost-effective.

In response to these challenges, researchers, engineers, and innovators have been exploring novel approaches to power generation that eliminate the need for traditional fuels altogether. These efforts have led to the conceptualization and development of fuelless generators that harness renewable energy sources such as solar, wind, hydro, or kinetic energy [4]. Moreover, some designs leverage on unconventional principles of physics or engineering to generate electricity without consuming fuel.

The development of a 1.0 KVA fuelless generator involves integrating cutting-edge technologies and innovative design principles to maximize energy efficiency, reliability, and scalability. This may entail advancements in electrical engineering, material science, control systems, and energy storage technologies. For instance, the generator could incorporate high-efficiency solar panels, advanced battery systems, or novel electromechanical conversion mechanisms to harness and store energy from renewable sources.

A 1.0 KVA fuelless generator has the potential to revolutionize various industries and sectors by providing clean, reliable and decentralized power solutions. It could be deployed in off-grid communities, remote locations, disaster relief operations, construction sites, and mobile applications where access to conventional power sources is limited or impractical [5]. Additionally, the widespread adoption of fuelless generators could contribute to reducing greenhouse gas emissions, mitigating climate change, and promoting sustainable development.

The pursuit of sustainable energy solutions has led to the exploration of various technologies aimed at reducing reliance on fossil fuels and minimizing environmental impact. One such technology is that carried out by [6] on the development of fuelless generators, which harness renewable energy sources or utilize unconventional mechanisms such as batteries, alternators and DC motors to generate electricity. This research delves into existing research and developments related to the creation of a 1.0 KVA fuelless generator, examining key concepts, technological advancements, challenges, and potential applications.

Renewable energy sources such as solar, wind, hydro, and kinetic energy have been extensively studied and applied in power generation systems. Researchers have explored integrating these renewable sources into generator designs to create fuelless alternatives. For instance, solar panels combined with efficient energy storage systems, such as lithium-ion batteries or super capacitors, have been proposed as a means to develop reliable and sustainable fuelless generators capable of delivering consistent power output by [7].

Several studies have investigated unconventional electromechanical conversion mechanisms to generate electricity without consuming traditional fuels. An investigation carried out by [8] reveal the use of 12V 75 amp battery, DC motor alternator and solar panel in the design of a 2.5KVA self-induced generator to power a residential apartment due to its low cost characteristics , reliability and maintenance application. A self-energized asynchronous generation was designed to control load in a power station using Mathlab and Simulink software by [9]. Concepts such as piezoelectric materials, electromagnetic induction, and thermoelectric generators were explored for their potential application in fuelless generator designs by [10]. These mechanisms convert mechanical or thermal energy directly into electrical energy, offering opportunities for compact, efficient, and environmentally friendly power generation solutions.

Efficiency optimization as a critical aspect of fuelless generator development was carried out by [11]. Research efforts have focused on enhancing the efficiency of energy conversion processes, minimizing energy losses, and maximizing power output. A study on advanced control algorithms, optimal system design, and the use of high-performance components was investigated to improve overall generator efficiency and performance by [12].

Fuelless generators have diverse potential applications across various sectors, including residential, commercial, industrial, and off-grid settings [13]. These generators can provide backup power during outages, support remote or off-grid operations, and contribute to reducing carbon emissions. However, challenges such as cost-effectiveness, scalability, and reliability remain significant barriers to widespread adoption. Addressing these challenges requires interdisciplinary research, collaboration between academia and industry, and continuous innovation in generator design and technology [14].

The development of a 1.0 KVA fuelless generator represents a promising step towards achieving sustainable and environmentally friendly power generation. By addressing the limitations of traditional generators and harnessing renewable energy sources or unconventional mechanisms, this innovative technology has the potential to revolutionize the way electricity is generated, distributed, and utilized, ultimately contributing to a more sustainable and resilient energy future [15]. This study is aimed at developing a 1 KVA fuelless generator.

2. MATERIALS AND METHODS

Technological innovations play a crucial role in the advancement of fuelless generator technology. Recent developments in materials science, electrical engineering, and renewable energy technologies have contributed to the creation of more efficient and reliable generator systems. For example, the integration of lightweight and durable materials in generator construction, advancements in power electronics for energy conversion, and the development of smart grid technologies for efficient energy management have all influenced the evolution of fuelless generator designs [16].

The methodology for developing a 1.0 KVA fuelless generator involves a systematic approach that integrates various stages, including conceptualization, application of design specifications, modeling and testing. The design specifications which were in consonance with that obtained in [17, 21] are:

i. Voltage=220V
ii. Power factor =0.85
iii. Apparent power of generator=1 KVA
iv. Number of poles =4
v. Magnetic flux=0.02 Weber
vi. Speed of rotation, N=2000rpm

2.1 Determination of Current Produced in the Armature Coil

The current produced in the armature coil of the developed generator was determined by Equation (1) obtained from [17]

$$P_a = I_a V \tag{1}$$

Where V =voltage of the battery (220 Volts), I_a= Armature coil current, and P_a= Apparent power in KVA

The current was calculated to be 4.55 amps. In this study a maximum of 5 Amperes will be applied in the performance evaluation. The resistance of the armature coil of the 1 kVA generator at a voltage of 220 volts was determined to be 48.35 ohms.

So, if the generator operates at 220 volts, approximately 4.55 amps of current will pass through the armature coil. This calculation assumes ideal conditions and does not account for losses or other factors that may affect the actual current passing through the armature coil.

2.2 Determination of the Power Input to the Coil

The power input to the coil was determined by applying Equation (2) obtained from [17, 21]

$$P_i = IVCos\theta \tag{2}$$

Where P_i= power input to the coil, Cos θ= Power factor taken to be 0.85

The power input into the armature coil was calculated to be 850.85 Watt

2.3 Determination of the Back Electromotive Force (E. M. F.)

The back e.m.f which opposes the induced voltage in the coil was determined using Equation (3) obtained from [17, 21]

$$E_b = \frac{\phi \times n \times Z \times N}{60} \tag{3}$$

Where E_b= Back E. M. F., Z=Number of armature conductors, N=Speed of shaft in rpm, ϕ= Magnetic flux in Weber, and n =number of pole pairs i.e. 2. The back e.m.f was determined to be 666.67 V

2.4 Determination of Angular Speed of Shaft

The angular speed of shaft was determined by applying Equation (4)

$$\omega_s = \frac{2 \times \pi \times N}{60} \tag{4}$$

Where ω_s=Angular speed in rad/s. The angular speed was determined to be 209.5 rad/s

2.5 Determination of the Electro-Mechanical Power from the Direct Current Coil

The Electro-Mechanical power developed by the direct current coil was determined by Equation (5)

$$P_m = E_b \times I_a \tag{5}$$

Where P_m= Electro-mechanical power from the direct current coil, and I_a=current through coil. The electro-mechanical power was determined to be 3033.3 Watt.

2.6 Calculation of Torque

The developed torque was calculated by applying Equation (6)

$$T = \frac{P_m}{\omega_s} \tag{6}$$

Where T = Torque developed in the coil. The torque developed in the coil is 14.48 Nm.

2.7 Determination of the Electrical Power

The armature voltage consists of the sum of potential difference between the armature and the back E. M. F. The electrical power is the product of armature voltage and the current [18]. This is as given in Equation(7)

$$P_E = \left(I_a{}^2\right) \times R + E_b \times I_a \tag{7}$$

Where P_E=Electrical power developed. The Electrical power was determined to be 4034 Watt.

2.8 Determination of the Battery Power

The power capacity of the generator battery was determined using Equation (8) obtained from [19]

$$P_B = V_a \times I \times Cos\phi \tag{8}$$

Where P_B=Power capacity of the battery, V_a=Voltage drop across the armature. The battery power capacity was determined to be 850.82 Watt.

3. RESULTS AND DISCUSSIONS

3.1 Summary of Parameters

The designed parameters were summarized in Table 1.

Table 1: Designed parameters

S/N	Parameter	Designed value
1	Armature coil current	4.55 amp
2	Resistance	48.35Ω
3	power input into the armature coil	850.85W
4	Back e.m.f	666.67 V
5	Angular speed	209.5 rad/s
6	Electro-mechanical power in DC	3033.3 W
7	Torque	14.48Nm
8	Electrical power	4034 Watt
9	Battery power capacity	850.82 W

The parameters were found to be similar to the values obtained in [19, 21]

3.2 Modeling of the Generator

The generator was graphically modelled using AutoCAD 2020. The isometric view and orthographic projection are shown on Figures 1 and 2 respectively. Developed detailed designs for electromechanical components, including power generation units and energy storage systems are shown.

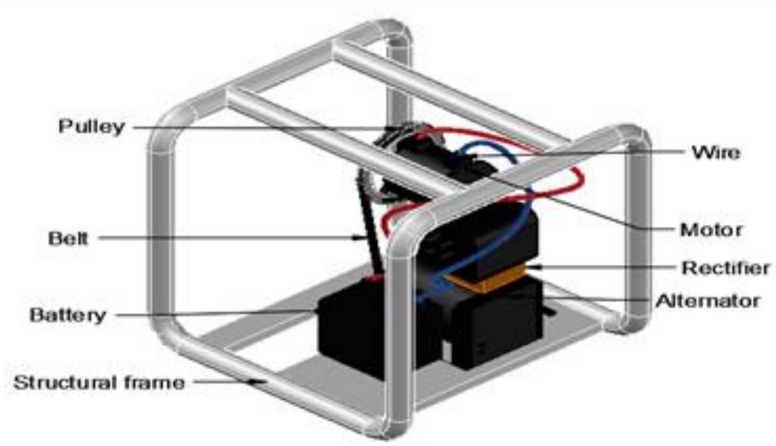

Figure 1: Isometric view of the fuelless 1 KVA Generator

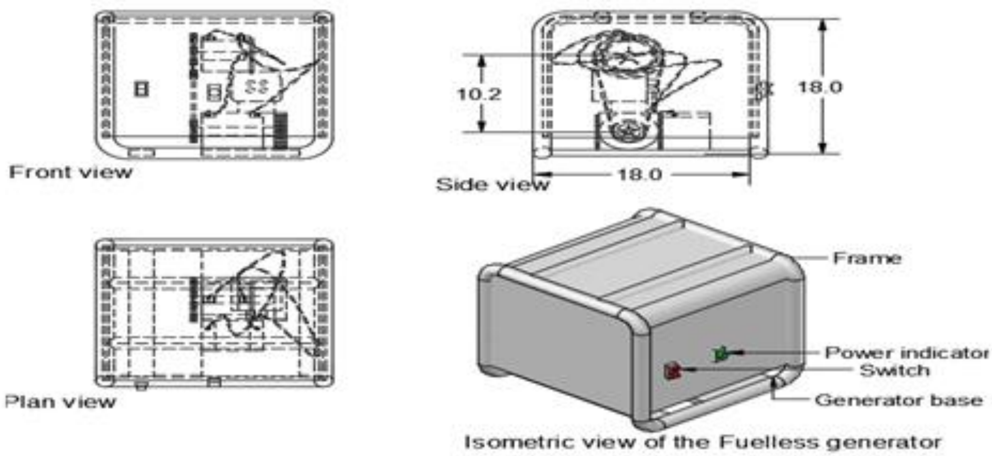

Figure 2: Orthographic projection of the fuelless generator

3.3 Performance Evaluation

The developed fuelless generator subjected to testing by using bulb lights. A multimeter was used to record the current and voltage produced during the test. The load used ranged from 0-100W. The loads applied were 40W, 50W, 60W, 80W and 100W. The performance test result is shown in Table 2 and Figure 3. It is shown that an input response brought about an increase in load (W) as also recorded by [21].

Table 2: Performance test result

S/N	Current	Voltage	Load (W)
1	2	20	40
2	2.5	20	50
3	3	20	60
4	4	20	80
5	5	20	100

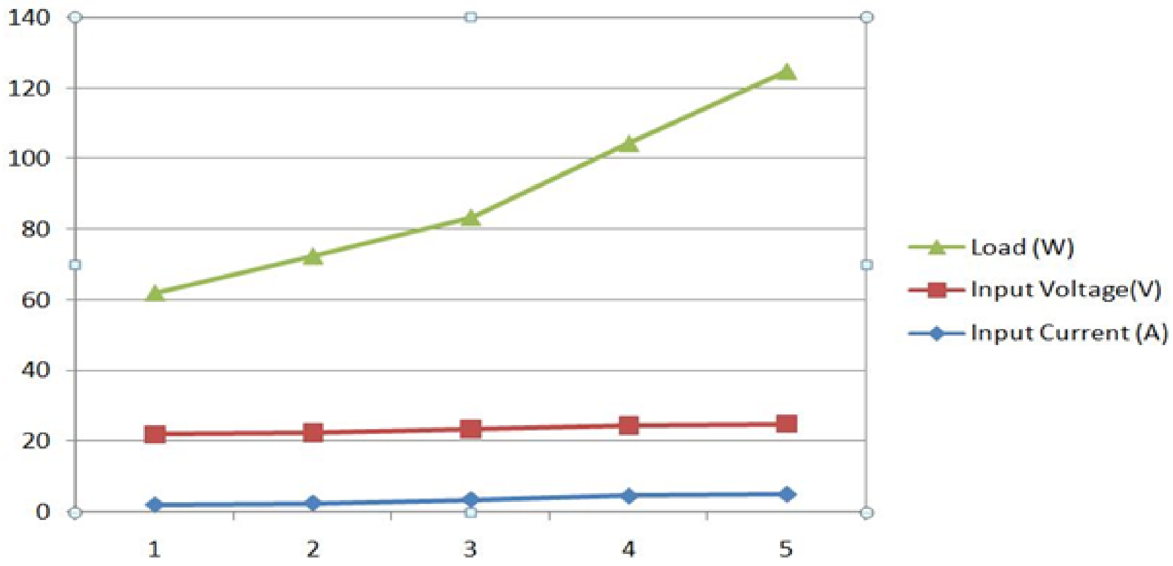

Figure 3: Input response with an increase in load

3.4 Discussion

The developed fuelless generator successfully meets the specified power capacity of 1.0 KVA, significantly exceeding the calculated battery power capacity of 0.85Kw similar to that obtained by [20, 22].The resistance of 48.35 ohms aligns with the predetermined value, ensuring efficient power transmission within the system**.** The generated current of 4.55 Amperes indicates a robust electrical output, suitable for powering various electrical devices.The achieved power factor of 0.85 demonstrates efficient utilization of electrical power within the system, minimizing reactive power consumption [21].The targeted resistance of 48.35 ohms was achieved through meticulous selection of conductor materials and careful design considerations. High-quality conductive materials with low resistivity were utilized to minimize electrical losses and ensure efficient power transmission. Comprehensive performance testing was conducted under various load conditions to validate the functionality and reliability of the generator. The generator demonstrated stable operation and consistent power output across different load profiles, indicating robust performance characteristics [22]. The development of a fuelless generator with a power capacity of 1.0 KVA, resistance of 48.35 ohms, current of 4.55 Amperes, and a power factor of 0.85 represents a significant achievement in the field of alternative energy generation [23].

4. CONCLUSION

The development of a fuelless generator with a power capacity of 1.0 KVA, resistance of 48.35 ohms, current of 4.55 Amperes and a power factor of 0.85 marks a significant advancement in the realm of alternative energy generation. This project represents not only the successful realization of specified technical requirements but also a substantial leap forward in the pursuit of clean and sustainable power solutions.

The achievement of a 0.85Kw battery power capacity underscores the efficacy of innovative design approaches and meticulous engineering. Through the implementation of advanced winding configurations, high-grade magnetic materials, and efficient cooling systems, the generator's power output was enhanced while maintaining stability and reliability.

The optimization of resistance through careful selection of conductor materials and design considerations ensures efficient power transmission within the system, minimizing losses and maximizing energy utilization. Additionally, the integration of power factor correction capacitors and advanced control algorithms contributes to achieving a power factor close to unity, further enhancing the efficiency of the generator.

Comprehensive performance testing has validated the functionality and reliability of the developed generator under various operating conditions. The stability of operation and consistent power output across different load profiles demonstrate the robustness of the design and the effectiveness of the generator.

In conclusion, the development of this fuelless generator not only exemplifies the feasibility of clean and sustainable energy solutions but also serves as a testament to the ingenuity and dedication of researchers and engineers in advancing towards a more reviving energy future. As we continue to innovate and refine such technologies, we move closer to realizing a world powered by renewable and environmentally-friendly energy sources.

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