Design generator of magnetic power (Based on gap rotor-stator motor magnet)

S H Susilo*, Z Jannah, K Kasijanto and S Adiwidodo

Department Mechanical Engineering, State Polytechnic of Malang, Malang, Indonesia

*shadis172.gh@gmail.com

Abstract. The paper discusses magnetic power generators; if a conductor moves across the magnetic field, a voltage difference will occur at the ends of the conductors. The voltage rises as it approaches the area and vice versa, so electricity arises in cycles: positive - zero - negative - zero. In this study utilizing the rotation of a magnetic motor caused by the unbalance repulsive force between magnets. The design of the tool starts with designing a generator model that will be made. The design of generators is based on calculations obtained through the reference of generator design. The generator design uses magnets instead of anchor coils on the rotor (source of magnetic flux) and copper wire coils as anchor coils on the stator. This design considers rotor and stator parameters, including the distance between magnets, rotor diameter, rotor plate thickness, area of a magnetic area, number of stator coils, number of stator windings, and stator coil dimensions, and calculate generator output power. Tool testing is done to obtain data from tools that have been made. In testing the comparison of the results obtained from the study of the target to be achieved, if the results have not yet reached the target, then improvements are made to the results obtained as expected. Tests were carried out with no load and burden. The results showed that the rotor speed in the generator design could be achieved by determining the number of rotor poles, the generator voltage is influenced by the flux density produced by permanent magnets and the number of stator windings.

1. Introduction

The increasing demand for energy in line with population growth and the increasing development of science and technology encourages the development of renewable energy. Many studies have been conducted to anticipate the shortage of energy sources, starting from the utilization of energy derived from natural resources such as water, wind, geothermal, and solar. However, it is still not enough to meet the enormous energy needs, so innovations are needed to meet these needs [1–5]. As an alternative energy, it has been developed that comes from magnets that are used as electricity generators. This electric generator uses magnetic force as rotating energy, resulting in rotation. Magnets used are induction magnets or permanent magnets [6,7]. Electrical energy conversion technology is increasingly innovative to facilitate humans in doing work. The innovative electrical energy conversion technology cannot be separated from the energy source [7–9]. Energy must have a flexible value in terms of energy that can be converted to various other forms of energy; this type of energy is called electrical energy. Electrical energy is energy produced from various types of energy. A generator is needed, produced by an electric generator [10–13].

One of the most critical problems in finding solutions in Indonesia is the electricity crisis. Many natural resources are renewable and can be used to produce electrical energy [3,7,8], both natural sources
such as solar heat, geothermal, wind, and water as well as physical materials such as permanent magnets, pressure differences and the effects of gravity. All of these can be utilized based on scientific analysis and experiments to obtain real results [14–17].

Countries in Asia, Europe, and America have developed electricity generation from renewable energy sources as a form of thought and concern for the increasingly troubling electricity crisis. We know that reserves of non-renewable energy sources such as oil and natural gas will be increasingly depleted to meet the world's energy demand quota while restoring them will take a long time. With the discovery of high technology by researchers, it is more comfortable and more extensive to apply, especially the optimization of energy generation systems from renewable sources[6,18–20].

The application of high technology as a step to optimize the yield of a power generation system with renewable energy is a form of compensation for the small discharge of the energy produced. We know that the release of energy generated from renewable energy generation is relatively smaller than the release of energy from non-renewable sources [21]. However, the system's optimization is expected to produce electrical energy with a discharge that is no less large, or at least the community can be independent by having a local power plant that can meet their electrical energy needs independently [22–24].

Therefore, using the concept of permanent magnets as electricity generators utilizes magnetic fields to produce rotations in electric generators. In producing the rotation of an electric generator, a permanent magnet is positioned as the stator or rotor [18].

A generator is an electrical machine that works based on motion / mechanical energy, which then converts it into electrical energy used in everyday life. The generator uses the Faraday experiment's principle, which rotates the magnet in a coil or vice versa when the magnet moves in a coil, there is a change in the magnetic flux (change in the distribution of the magnetic field) in the coil. It penetrates perpendicular to the coil so that a potential difference arises between the ends of the coil (generating electricity); this is due to changes in magnetic flux [25]. The magnetic flux can be changed by moving the magnet in the coil or vice versa by utilizing other energy sources, such as wind and water, to rotate the turbine blades to move the magnet. If a conductor moves across the magnetic field, there will be a voltage difference at the ends of the conductor [26,27]. The voltage increases as it approaches the field and vice versa so that electricity occurs in cycles: positive - zero - negative - zero (AC voltage). In a DC generator, the direction of the current when the negative voltage is reversed by a split ring mechanism so that the cycle changes to positive-zero - positive - zero (DC voltage). Many studies have been carried out on the use of permanent magnets to drive electric generators, but this research has not yet been fully achieved, so it is necessary to design an electric generator based on the magnetic motor rotor-stator gap resulting output [28–30].

2. Theory

2.1. Definition of magnets
Magnets are objects that have a magnetic field. Objects that can attract iron or steel are called magnets. Magnetic materials are widely used in equipment, including electric bells, telephones, dynamos, electric measuring instruments, compasses. Magnets are made of iron, steel, and metal alloys. Magnets are made up of tiny magnets with the same direction (arranged in an orderly manner), which are called basic magnets. Magnets have two poles, namely: north (N) and south (S). The magnetic pole is at the end of the magnet with the highest magnetic strength.

Neodymium magnets are the most potent types of permanent magnets. Neodymium magnets, also known as NdFeB, or Neo magnets, are a type of rare-earth magnet made from an alloy of neodymium metal. Tetragonal Nd2 Fe14 B has a very high uniaxial crystal structure of magnetocrystalline anisotropy (HA ~ 7 teslas). This compound gives the potential to have a high coercivity, that is, resistance to magnetic damage.

The magnetic characteristics of NdFeB are better when compared to other permanent magnets, such as Ferrite, Alnico, and Samarium Cobalt. The BHmax that is owned can range from 30 MGO to 52
MGOe. Because it has high magnetic characteristics, in its application, NdFeB magnets have small dimensions and volume. In some applications, these magnets can replace the use of Samarium-Cobalt magnets, especially those at temperatures less than 80 oC [31].

2.2. Permanent magnet electric generator
A magnetic, electric generator consists of several permanent magnets that are arranged in such a way either on the rotor or stator so that there is a repulsive force between the two that continues continuously, causing continuous rotation until the magnet is strong enough to repel and rotate the rotor.

In the 1980s, China invented magnetic field technology and succeeded in making free energy devices in which one unit measuring 150cm x 120cm x 80cm can produce about 5 KW of power. The way this free energy machine works only uses magnets as the main driving force, this tool is without batteries, without electricity, and without fuel, can move continuously at high speed, is stable and is very strong in thrust or pull so that it can play a dynamo 1000 watts to 5000 watts of electricity.

Thomas E. Bearden et al., 2013, with US patent number 6362718A have made two models of electric transformers powered by permanent magnets. This tool uses 6 watts of the electrical input to control the magnetic field path that comes out of a permanent magnet. By sending a magnetic field, first to the output coil, and then to the second output coil, and by repeatedly and quickly like ping-pong, the device can produce 96 watts of electrical output with no moving parts. Bearden refers to his device as a Moving Electromagnetic Generator (MEG), or in other words, a stationary magnet generator. Jean-Louis Naudin has duplicated the Bearden set in France. The basic principles of this tool were first disclosed by Frank Richardson from the United States in 1978. Troy Reed, also from America, has made a particular magnetic fan model that heats up when it rotates. The device absorbs the same amount of energy to rotate the fan, whether it generates heat or not.

3. Methods
The process of making this generator is done by preparing the tools and materials first. The first thing in making this generator is to make a magnetic motor to drive the generator. This process is carried out with great care and precision because the magnets’ placement must be accurate so as not to lock the magnetic force. So that the rotating motion of the rotor runs typically, without any motion locking process.

Tool testing is carried out to obtain data from the tools that have been made. In testing, a comparison of the results obtained from the research is carried out against the target to be achieved, if the results have not reached the target, then the equipment is repaired until the results are as expected. The test is carried out with no load and load of 1 100 W lamp and a 350 W drilling machine connected in parallel to determine the output power of the generator that has been made. Analysis of the test result data is then carried out to obtain the optimal design.

Generators can be made by utilizing the repulsive and attractive forces between magnets. Magnets are used with neodymium material, which has very high magnetic strength. The generator is made using a motor, namely a magnetic motor. This magnetic motor uses a rotor and stator system. The unbalanced amount of repulsion and pull forces is able to move the rotor, resulting in magnetic motor rotation. The unbalanced amount of repulsion and pull forces using three magnetic groups on the rotor. Whereas in the stator, the magnetic arrangement is close together but with different distances between the magnets. Figure 1 and 2 show design of permanent magnet motor rotor and stator.

To produce rotation, the rotor and stator are close to one axis using a shaft. In the rotor part, the meeting between the non-magnetic plate and the shaft is given to place the bearing holder so that the rotor can rotate, resulting in motor rotation. The rotating magnetic motor can move the generator rotor. The arrangement of the generator rotor is a magnet-core-magnetic motor. The core is inside the copper wire coil—Single-axis magnetic power generator axis with a magnetic magnet motor. The shape of the magnetic motor is cylindrical, consisting of two plates containing a permanent magnet. The on-off of the magnetic motor depends on the distance between the plates containing the magnet. Magnetic, electric generator, the rotor is driven by a magnetic motor. The magnetic motor itself consists of a magnetic
arrangement configuration between two plates/cylinders. Each part of the magnetic plate has a different magnetic arrangement. The first plate has a magnetic configuration as the driving plate, while the second plate is the driven plate. The magnets’ arrangement in the first plate is spaced, and the distance differs from one magnet to another, but they are regular. At the same time, the arrangement of the two magnetic plates forms a magnetic group and coincides. However, the distances between magnetic groups are the same. This permanent magnet motor is designed by making the rotor and stator parts all of the magnets with a specific configuration to produce rotation without any external energy or fuel. The rotation of this magnetic motor will rotate the core (generator rotor) so that the presence of a 16 pole copper wire will produce an electric motion. This electromotive force will produce an electric voltage.

![Figure 1. Design of permanent magnet motor rotor.](image1)

![Figure 2. Design of a permanent magnet motor stator.](image2)

4. Results and discussion

The generator design designed in this research is a permanent magnet generator. The permanent magnet generator, which is designed, is a modification of the permanent magnet flywheel. This generator rotor frame is designed using a resin composite that is integrated with the flywheel. The arrangement of the permanent magnets is adapted to the modified flywheel construction. The permanent magnets used are of the neodymium type, comprising 21 magnets arranged around the stator. Replacement of permanent magnets is intended to increase the output power of the generator. The stator used is a stator that has 1 (one) number of slots with a circular winding direction of 24100 windings.
Figure 3 shows the permanent magnet generator uses an induction motor in its test. This induction motor is used as the initial drive of the generator, connected to the pulley and the v-belt. In the installation, the induction motor and generator are fitted with a pulley, which is then attached to the v-belt on the pulley. The rotating motion of the magnetic motor rotor makes the magnets in the generator rotor cut the stator magnetic field, causing an electric potential (voltage) difference in the windings.

Generator testing is carried out at a variation of the stator rotor magnetic motor gap of 10 mm - 35 mm with an increase in the distance of 5 mm to obtain accurate data. Generator testing is carried out with no load and 100 W lamp power connected in parallel to determine the maximum voltage, current, frequency, and output power, from the test results, obtained the following data.

| Gap (mm) | Voltage (V) | Current (A) | Frequency (Hz) | Power (W) |
|----------|-------------|-------------|----------------|-----------|
| 10       | 224         | 36          | 59.6           | 5483.52   |
| 15       | 224         | 32          | 58.5           | 4874.24   |
| 20       | 224         | 30          | 57.2           | 4569.6    |
| 25       | 222         | 27          | 55.2           | 4075.92   |
| 30       | 222         | 24          | 54.1           | 3623.04   |
| 35       | 218         | 20          | 53.2           | 2992      |

Table 1. The test is unloaded.

4.1. Relationship Gap (mm) to voltage in a unload test

Figure 4. Relationship Gap (mm) to voltage in a unload test.
Figure 4 shows that the generator voltage has decreased in line with the increase in the stator-rotor gap (mm). The lowest voltage is obtained at a gap of 35 mm with a no-load voltage value of 218 V. When the distance gets closer between the rotor-stator motor, the voltage also increases. The voltage increases significantly according to the closer the magnetic motor stator rotor gap. The highest voltage in this unload test is obtained at a frequency of 53.2 Hz with a voltage value of 224 V. When the magnet gets closer, what happens is the higher the repulsion force, but with the tilt angle that has been set, a rotational motion will arise, and this is increasingly The closer the rotation speed accelerates. This rotational motion is also due to the magnetic levitation force. This rotational motion causes the generator rotor to rotate and produces an electromotive force. This electromotive force causes the generator output voltage to arise.

4.2. Relation of the gap to a frequency in a unload test

![Figure 5](image1.png)

Figure 5. Relation of the gap to a frequency in a unload test.

Figure 5 shows that the generator frequency has decreased in line with the increase in the stator-rotor gap (mm). The smaller the gap between the rotor and the magnetic motor stator, the higher the generator frequency. This frequency is influenced by the period of rotation of the rotor to the generator stator. Moreover, this has to do with the number of turns and permanent magnets. The smaller the magnetic motor gab, the higher the motor rotation so that the generator rotor rotation is more significant and results in a higher magnetic flux, this causes the frequency to be greater. The highest frequency is in a 10 mm gap, with a value of 59.6 Hz.

4.3. Relationship of the gap to power in a unload test

![Figure 6](image2.png)

Figure 6. Relationship of the gap to power in the unloaded test.
Figure 6 shows that the generator power has decreased in line with the increase in the stator-rotor gap (mm). The lowest power is obtained at a gap of 35 mm with a no-load voltage value of 2992 W. When the gap is closed between the rotor-stator motor, the voltage also increases. The power increases significantly according to the closer the rotor-stator magnet motor gap. The highest power in this unload test is obtained at a frequency of 59.6 Hz with a voltage value of 5483.52 W. When the magnet gets closer, what happens is the greater the repulsion force, but with the tilt angle that has been set, a rotational motion will arise, and this is getting The closer the rotation speed accelerates. This rotational motion is also due to the magnetic levitation force. This rotational motion causes the generator rotor to rotate and produces an electromotive force. This electromotive force causes the generator output voltage to arise.

Table 2. Loaded testing.

| Gap (mm) | Voltage (V) | Current (I) | Frequency (f) | Power (P)= Vx I x cos Θ (W) |
|----------|-------------|-------------|---------------|-------------------------------|
| 10       | 202         | 18          | 52            | 2981.52                        |
| 15       | 200         | 16          | 47            | 2624                          |
| 20       | 198         | 14          | 45            | 2273.04                        |
| 25       | 196         | 12          | 39            | 1928.64                        |
| 30       | 194         | 11          | 34            | 1749.88                        |
| 35       | 190         | 9           | 30            | 1402.2                         |

4.4. Relation of the gap to voltage in a unload test

Figure 7 shows that the generator voltage has decreased in line with the increase in the stator-rotor gap (mm). The lowest voltage is obtained at a gap of 35 mm with a voltage value with a load of 190 V. When the distance is getting closer between the rotor-stator of the motor, the voltage also increases. The voltage increases significantly according to the closer the magnetic motor stator rotor gap. The highest voltage in this loaded test is obtained at a frequency of 52 Hz with a voltage value of 202 V. When the magnet gets closer, what happens is the higher the repulsion, but with the tilt angle that has been set, a rotational motion will arise, and the closer it is to accelerate. Rotation round. This rotational motion is also due to the magnetic levitation force. This rotational motion causes the generator rotor to rotate and produces an electromotive force. This electromotive force causes the generator output voltage to arise.
4.5. Relation of the gap to current in a loaded test

![Relation of the gap to current in a loaded test](image1)

Figure 8. Relation of the gap to current in a loaded test.

Figure 8 shows that the generator frequency has decreased in line with the increase in the stator-rotor gap (mm). The smaller the gap between the rotor and the magnetic motor stator, the higher the generator frequency. This frequency is influenced by the period of rotation of the rotor to the generator stator. Moreover, this has to do with the number of turns and permanent magnets. The smaller the magnetic motor gap, the higher the motor rotation so that the generator rotor rotation is bigger and results in higher magnetic flux. This causes the frequency to be greater. The highest frequency is in a 10 mm gap, with a value of 52 Hz.

4.6. Relation of the gap to a frequency on a load test

![Relation of the gap to a frequency on a load test](image2)

Figure 9. Relation of the gap to a frequency on a load test.

Figure 9 shows that the generator frequency has decreased in line with the increase in the stator-rotor gap (mm). The smaller the gap between the rotor and the magnetic motor stator, the higher the generator frequency. This frequency is influenced by the period of rotation of the rotor to the generator stator. Moreover, this has to do with the number of turns and permanent magnets. The smaller the magnetic motor gap, the greater the motor rotation so that the generator rotor rotation is bigger and results in greater magnetic flux. This causes the frequency to be greater. The highest frequency is in a 10 mm gap, with a value of 52 Hz.
4.7. Relationship gap (mm) to power (watts) on a load test

Figure 10 shows that the generator power has decreased in line with the increase in the stator-rotor gap (mm). The lowest power is obtained at a gap of 35 mm with a no-load voltage value of 1402.2 W. When the distance between the rotor-stator motor voltage also increases. The voltage increases significantly according to the closer the magnetic motor stator rotor gap. The highest power in this load test is obtained at a frequency of 52 Hz with a voltage value of 2981.52 W. When the magnet gets closer, what happens is the higher the repulsion force, but with the tilt angle that has been set, a rotational motion will arise, and the closer the rotation accelerates. Rotation. This rotational motion is also due to the magnetic levitation force. This rotational motion causes the generator rotor to rotate and produces an electromotive force. This electromotive force causes the generator output voltage to arise. The power value increases as the stator rotor gap get closer. The load test found that the power value is lower than the unloaded test at the same gap distance. This happens because some of the generated voltage loses voltage on the load. The addition of load when the generator is inactive condition will generally make the generator rotational speed decrease. This will also have an impact on decreasing the frequency and decreasing the generator output voltage. The reason is that the load served will generate a current, which then passes through the stator winding resulting in a magnetic field in the opposite direction to the rotating field of the rotor so that the rotation of the rotor becomes restrained. However, in the research that has been carried out using this permanent magnet generator, when the load is applied when the generator is an inactive condition, the rotating speed of the rotor remains stable. The load on the generator is too small so that the current flowing in the stator winding only creates a small magnetic field and is unable to withstand the rotating speed of the rotor.

5. Conclusion

In this designed permanent magnet generator, the resulting output is influenced by several variables. The variables in question are the number of magnets and the strength of the resulting magnetic field, the number of a stator winding poles, the number of stator turns, the air gap between the stator and the rotor, the closer the air gap is, the higher the generator output will be—the more the number of turns and the number of poles, the higher the generator output voltage. The stronger the magnetic field, the higher the generator output voltage will be, this can be done by adjusting the air gap between the stator and the rotor and using a type of permanent magnet with high magnetic field strength. However, the stronger the generator's magnetic field will affect the generator's rotational speed. The permanent magnet generator that is made and tested in this study is capable of producing a minimum output voltage of 190 V at a 35 mm gap under load conditions. The highest output voltage is 202 V at a frequency of 59.6 Hz with an electric current of 18 A with a gap of 10 mm under load conditions. The output power
of the generator increases in proportion to the closer the gap is. The frequency of the generator increases in proportion to the increase in the gap, the closer the stator rotor of the magnet motor is, the resulting frequency will also increase, and vice versa.

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