Electric Generator

Electricity is almost a necessity today. Electricity is created everywhere using a few basic concepts; a magnet must pass about a coil of wire to produce electricity. This project helps determine the how different variables on a generator affect amounts of voltage produced. These variables include wire gauge, length of wire, magnetic strength, speed of rotation, and generator design.

The first AC generator, alternator, design built uses a coil of wire wrapped around a cylinder. The design was based on Beaty's generator. Through the center of the cylinder is a dowel rod with another beam attached perpendicular to it. On either end of the perpendicular dowel rod is a magnet. These magnets are placed with opposite poles facing outward to simulate one large magnetic. For consistency, the dowel through the center is connected to a motor which caused it to rotate (see figure 1). As to dowel spins, the magnetic field about the coil of wire changes. This creates an electric current as shown by Faraday's law.

Figure 1

The first variable tested was wire gauge. This uses the cylinder alternator design. Keeping the number of wraps around the cylinder constant, the wire gauge was changed between 22, 26, and 30-gauge. This was done using 10 wraps of wire and again with 20 wraps of wire. A small trend showed that the larger the diameter, the greater the voltage (see graph 1). This is consistent with the results obtained from Adkins and Harley which shows that voltage increases with wire diameter. The 22-gauge wire did not follow exactly this trend. This is possible because the magnetic reached the greatest voltage at those conditions, increasing the wire gauge would no longer have an effect.

| 10 wraps | | 20 wraps | |
|---|---|---|---|
| Gauge | Voltage (V) | Gauge | Voltage (V) |
| 30 | .008 | 30 | .012 |
| 26 | .010 | 26 | .014 |
| 22 | .008 | 22 | .014 |

Table 1

The next variable tested is how the number of wraps affects the voltage. Keeping the wire gauge constant, the cylinder was wrapped 10 times and again with 20 wraps. This was tested with each gauge of wire. With each of the wire gauges, the alternator with 20 wraps produced greater voltage. This too follows the trend stated by Adkins and Harley that the greater amount of wire used increases the voltage. They also show that the voltage eventually levels off as the length becomes greater, showing that a maximum voltage can be obtained and is not infinite based on the amount of wire.

| Gauge | Voltage of 10 wraps (V) | Voltage 15 wraps (V) | Voltage of 20 wraps (V) |
|---|---|---|---|
| 30 | .008 | - | .012 |
| 26 | .010 | .012 | .014 |
| 22 | .008 | - | .014 |

Table 2

The next variable tested was the magnetic strength. Generally, as magnetic strength increases the voltage increases (Beaty). The magnets on the end of the perpendicular dowel rod were exchanged from the ceramic magnets to a neodymium-iron-boron magnet. After testing each of the gauges with 20 wraps a drop in voltage was found as compared to the ceramic magnets. This is surprising because the magnetic field of the neodymium-iron-boron is greater than that of the ceramic and therefore should create a greater voltage. A hypothesis to this is that since the neodymium-iron-boron magnets are smaller in diameter that less of the wire actually comes in contact with the wire. So the design of the alternator was changed. The first design used a straw wrapped with 26-gauge wire with the same amount of wire as the cylinder with 10 wraps (see figure 2). The design was based on the fact that changing magnetic field can be translated and not just rotated (Wolfe). The 22-gauge wire was not used because it was not consistent with the theoretical results in previous tests. The small neodymium-iron-boron magnetic was placed straw and shaken. This caused the magnetic to move which created a changing flux, producing electricity. The voltage received however was still less than that of the ceramic magnetic in the cylinder alternator with 10 wraps. This is not nearly as unexpected, however, because the straw was shaken at a much slower rate that the ceramic magnets were spun on the motor. A second magnetic was then placed in the tube and shaken at relatively the same speed. This produced a voltage greater than twice the first with only one magnetic, proving that increasing magnetic field increases voltage (see table 3). Using the same design and two magnets, the amount of wire was doubled. This too more than doubled the amount of voltage.

Figure 2

| Length: | 7ft | 14ft |
|---|---|---|
| Number of magnets | Voltage (V) | Voltage (V) |
| 1 | 0.0019 | - |
| 2 | 0.0041 | 0.011 |

Table 3

The speed effect of speed on voltage was also tested. Using the cylindrical alternator with 20 wraps of 26-gauge wire and ceramic magnets, the speed of rotation was varied. First the dowel was first hand spun. Then it was spun using the motor. Finally the dowel was attached to the motor using different size gears. A larger gear was placed on the motor and a smaller gear was placed on the dowel. This caused the dowel to spin faster that just the 1:1 gear. Using these values it was found that as the rotational speed increases the voltage increases (see table 4). This is consistent with Beaty's statement that faster the magnets move about the coil the greater the voltage.

| | Voltage (V) |
|---|---|
| Hand spun | .007 |
| 1:1 gear | .014 |
| ~2:1 gear | .016 |

Table 4

CONCLUSION:

There are many factors in the creation of an electric generator. Wire gauge, length of wire, magnetic strength, speed of rotation, and design all play factors in the voltage output. In general, a larger diameter and greater wire length (more coils) produce more voltage. These amounts are limited by magnetic strength, however. Speed of rotation also effects the amount of voltage created, the faster the rotation the greater the voltage. Using a stronger magnet of the same size will produce a greater current. The design of the generator may have to change compared to the magnet's size. The closer the magnet is to the wire the greater voltage it will create, which is why the stronger yet smaller neodymium-iron-boron magnetic did not work as well as the larger ceramic magnetic in the cylindrical alternator. The straw generator with the neodymium-iron-boron magnetic works almost as well as the cylindrical generator with the same length and gauge wire even though the magnet in straw moves at much slower speeds. This is because the neodymium-iron-boron magnetic creates a stronger field and is in closer contact with the wire it moves about. Using this design with greater speeds and more wire can create a very efficient generator. Other generator designs were created but no further conclusions were made. The basic principle of rotating a magnet about a coil of wire is the basis of all power plants. The only thing different is the method of rotation, such as burning coal to produce steam or falling water to create the rotation. This is important field of study because the world runs on these basic principles to create electricity.

References:

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