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Sections 9 and H2

UPII Honors Project

Hydroelectric Generator

Energy is an essential part of life, and the ability to harness and manipulate energy is an area of growing importance. Magnetic, electric, and mechanical energy are all useful forms of energy. Our project is based on the construction of a device purposed to utilize all three—an electric generator. An electric generator works by employing the relationship between electricity and magnetism. Faraday's Law relates these two forces to the production of an electromotive force (emf). When a changing magnetic flux passes through a coil of wire, an emf is produced. If the coil of wire is appropriately connected, a current flowing through the wire can produce electrical energy which can be utilized for powering a device such as a light bulb. A simple electric generator works by pairing a circuit with a magnetic field source, and by using mechanical energy to rotate one with respect to the other—thus producing the emf and powering the light bulb.

A fun and simple way to demonstrate this ability to change mechanical energy into electrical energy is by creating what is perhaps one of the simplest generators possible. Conducting wire is wrapped around a small closed container such as a film canister, and its ends are removed of varnish and connected to a small led light. A small magnet is placed inside the container, thus supplying the magnetic field. If the container is shaken, then the magnet is moved with respect to the wire, the magnetic flux through the wire is changed through time, and an emf is produced. It can be considered positive reinforcement for the realm of physical science when the led lights up!

The greater part of our project is devoted to the slightly more complicated and perhaps more applicable hydroelectric generator. A hydroelectric generator works by utilizing the mechanical energy of moving water to create electric energy. (Victoria University of Wellington) The moving water forces a turbine to turn. In our project, this turbine is connected to a surface to which a magnetic field source is fixed. The four magnets fixed to this surface are placed in a circle alternating north and south poles. The turning of the turbine causes the magnet-containing surface to turn. A surface to which wire coils—alternating clockwise and counter-clockwise—are attached is placed facing the magnetic surface and is thus exposed to a changing magnetic field. The change in magnetic flux causes a current to flow in the wires. The wires are connected to a multimeter, and the voltage produced by this current is measured.

In our project, two aspects of the generators were varied—each of which pertained to the coiled wire. The first was wire gauge; three gauges of wire were used: 24, 28, and 32. The second variable was the number of coils; each generator contained coils of 25, 50, or 100 turns. Each gauge was tested with each number of turns, giving a total of nine generators. The generators were each tested under running water produced in a bathtub faucet.

Two trials were performed for each generator. The measurements observed for each were quite variable, and thus average values—not only between the two trials, but also for each individual trial—were obtained. The results were as follows. For the 24 gauge wire, the generator with 4, 25-turned coils produced a voltage of around 20 mV.

The coils with 50 turns produced 30 mV, and the coils with 100 turns produced 45 mV. For the 28 gauge wire, 25 turns produced about 15 mV, 50 turns produced 20 mV, and 100 turns produced 35 mV. Lastly, for the 32 gauge wire 25 turns gave 10 mV, 50 turns gave 15 mV, and 100 turns gave 25 mV.

Error in these measurements could have stemmed from an inaccurate multimeter or from the fact that the water tended to soak the cardboard surfaces holding the components in place. Regardless of the possible inaccuracies, two obvious trends still existed in the results. As the wire gauge increased, the voltage decreased. Even more evident was the increase in voltage as the number of turns increased. The latter increase appeared to be more exponential than the former, indicating that in the case of the hydroelectric generator the number of coils is likely more important than the wire gauge.

The production of energy is incredibly important in this age, and will likely become even more important in years to come. Finding ways to become more efficient and conservative with energy use and production is thus of the utmost importance. This truth makes small-scale projects such as our home-made hydroelectric generators not so small-scale in applicability. By utilizing a natural and renewable energy such as moving water to perform various types of energy-depended tasks, we are helping to promote the maintenance of our environment. (Boyle et al., 2004) (Davis et al., 2004) This idea is not limited to moving water—the mechanical energy for a generator could come from a great variety of sources, even including a bicycle! Further useful experimentation for our hydroelectric generator could include varying magnet size, strength, and distance from coils.

References

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Davis, Scott. Microhydro : Clean Power from Water. New York: New Society, Limited, 2004.

"Hydroelectric Generator | New Zealand Physics Teachers' Resource Bank." Victoria University of Wellington - Home Page. 23 Feb. 2009 <http://www.vuw.ac.nz/scpsdemos/demos/Circuits_and_Electromagnetism/HydroelectricGenerator/Hydroelectric.htm>.

Information on renewable energy, solar power cars, wind power and more at Re-Energy.ca. 23 Feb. 2009 <http://www.re-energy.ca/pdf/hydroelectric-generator.pdf>.