The Advantages to Micro-Hydro and Pico-Hydro Electric Energy

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Abstract

The portable hydroelectric generator is a device able to charge 5-volt devices through a Universal Serial Bus (USB) port. As the demand for energy becomes higher and higher, the world will need to start converting from non-renewable resources, such as oil and gasoline, to more renewable resources, such as wind, solar, timber, and hydraulic energy. The issue with these forms of energy is that they are not efficient and as a result, need to take up large amounts of land or water for them to work. The goal for the portable hydroelectric generator was to create a non-intrusive environmental device able to be fully submerged within a flowing stream and generate electricity through the spinning of a turbine, directly attached to a direct current (DC) motor creating an electrical difference. To accomplish this goal, the portable hydroelectric generator takes a circular shape with a 20.3 cm diameter for a compact transportable design with a 17.8 cm diameter turbine attached to it. With this design the portable hydroelectric generator was able to sustain a steady 5 watts of electrical energy being able to charge any 5-volt USB device off of a 3 meter per second flow rate of water. All in all, the portable hydroelectric generator is a down scaled prototype and could be upscaled to increase the power of the device for higher demands of energy.

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ABSTRACT

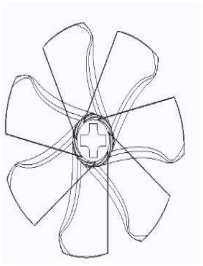
The portable hydroelectric generator is a device able to charge 5-volt devices through a Universal Serial Bus (USB) port. As the demand for energy becomes higher and higher, the world will need to start converting from non-renewable resources, such as oil and gasoline, to more renewable resources, such as wind, solar, timber, and hydraulic energy. The issue with these forms of energy is that they are not efficient and as a result, need to take up large amounts of land or water for them to work. The goal for the portable hydroelectric generator was to create a non-intrusive environmental device able to be fully submerged within a flowing stream and generate electricity through the spinning of a turbine, directly attached to a direct current (DC) motor creating an electrical difference. To accomplish this goal, the portable hydroelectric generator takes a circular shape with a 20.3 cm diameter for a compact transportable design with a 17.8 cm diameter turbine attached to it. With this design the portable hydroelectric generator was able to sustain a steady 5 watts of electrical energy being able to charge any 5-volt USB device off a 3 meter per second flow rate of water. All in all, the portable hydroelectric generator is a down scaled prototype and could be upscaled to increase the power of the device for higher demands of energy.

INTRO / GOALS / OBJECTIVES

The objective for the Portable Hydroelectric Generator (PHG) is to enable one to bring the device anywhere that moving water can be found and charge their portable electronic devices by connecting to the USB port attached to the PHG while it is in the moving water. These devices include, but are not limited to, phones, cameras, and rechargeable flashlights.

METHODS

The PHG was designed by first defining the essential and non-essential goals for the final product and narrowing these down to which of these goals were able to be obtained within the budget as well as the time span for the project. Once the goals for the PHG were finalized, each part had to be derived from calculations to ensure that each goal would be obtained within the PHG.



Turbine Torque:

T = torque

RPM = revolutions per minute

P = power

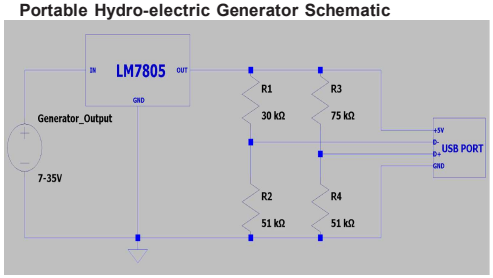
w = angular velocity

$T = P/w = 60P/(2\pi(RPM))$

$T = (60(7))/(2\pi(584)) = 0.11\ Nm$

The calculation shown above was done to configure how much torque was needed to spin the turbine at a specific angular velocity. Although this calculation alone is not beneficial, it was necessary in order to calculate other design parameters of the product, such as the turbine radius and generator power output. This is just a sample of the design calculations that were done in order to create the product and the circuit within the product, which can be seen below.

Portable Hydro-electric Generator Schematic

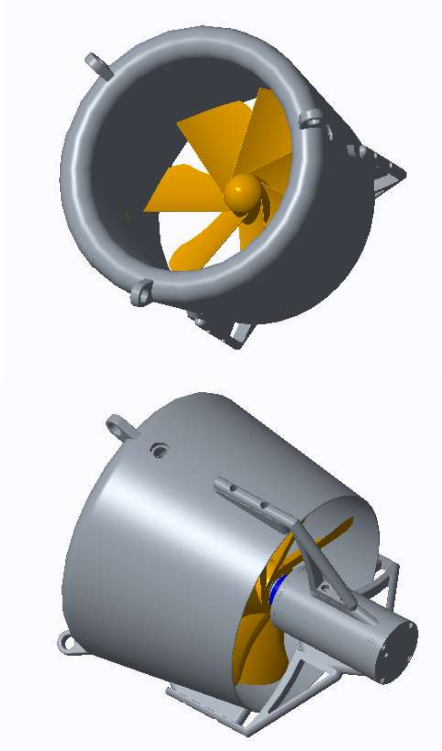


The figure above shows the circuitry inside the PHG going from the generator output to the USB port. The LM7805 was used to regulate the voltage and restrict it to a constant 5 Volts. The following four resistors are used to enable the fast charging setting within smart phones by connecting to the data inputs (D+ and D-) to allow for smartphones to receive more than only 0.5 A which it is restricted to if these voltages differ too far from these fast charging voltages.

RESULTS

The resulting product of the PHG is able to take a voltage potential of 7V – 35V from the output of the generator and turn it into a regulated 5V and 1A output into the USB port to allow for devices to be charged with a power output of 5W. This range of voltages can only occur if the water velocity through the turbine is greater than or equal to approximately 3 meters per second. When the water velocity drops below this magnitude, the circuit is shut off by the voltage regulator within it.

Final Product Assembled



The figures above are two auto-CAD generated views of the assembled Portable Hydro-electric Generator.

CONCLUSIONS

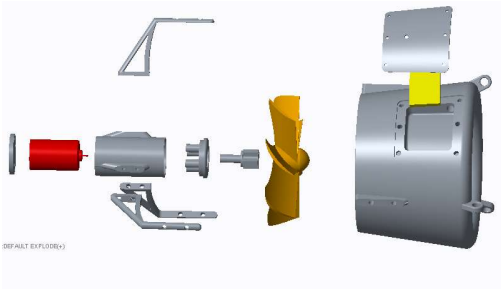
Although the Portable Hydro-Electric Generator has been limited to a constant 5V output, the generator in combination with the turbine and ducting was easily able to output voltages upwards of 50V in water velocities of 10 meters per second or more. This may not seem like a massive amount of energy generated, but this design can be upscaled to provide much bigger amount of energy with proportional ranges within the kilovolts.

RECOMMENDATIONS

Due to the time restrictions for the project, the device was not tested to be as efficient as possible. With more time one could do the following to potentially increase the efficiency of the PHG.

- Use a brushless generator instead of a brushed one
- Experiment with other turbine designs
- Reduce the friction between rotating parts around the generator

Exploded Assembly View of the Portable Hydro-Electric Generator



The figure above is a disassembled view of the final product in which had a low reproduction cost due to the utilization of 3D printing most of the parts. These parts were printed using ABS to ensure that they would not degrade and pollute the water source while the PHG is being used.

Acknowledgements

We would like to thank Western Carolina University funding this project.