CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

J0124

Project Title

Hydropower Unleashed: Design Elements of a Small-Scale Paddle Wheel Hydroelectric System

Abstract

Objectives/Goals

The goal of this project is to design a system to generate electricity from stream flow using a paddle wheel constructed from readily available, inexpensive materials and a permanent magnet generator (PMG). The idea is that the axle on the paddle wheel turns with the flow of the stream, and through a series of pulleys connected by belts, turns the shaft in the PMG to generate electricity. The objective is to make the paddle wheel turn as fast as possible with the least amount of friction to be able to generate electricity.

Methods/Materials

The hypothesis is that paddles with a cupped design, on a paddle wheel to be attached to a PMG, will make the paddle wheel turn faster from water flow than curved, unenclosed paddles. This hypothesis was tested in the shop simulating stream flow by directing hoses onto the wheel and measuring revolutions per minute (RPM) of an attached pulley, using a strobe light iPhone application. A bicycle wheel and cut sewer pipes were the materials used for the original wheel and paddle designs.

Results

The hypothesis was correct because the wheel with the cupped paddles spun 1.5 times faster on average (620/402 rpm) than unenclosed, curved paddles. This result indicates that the weight of the water in the paddle wheel contributes to the speed of rotation. A PMG was ordered based on these results. Once the PMG was attached, the torque needed to move the system was higher than anticipated and a wheel redesign was necessary. Specifications for the redesign were based on measurements made by attaching a string with a bucket to the pulley belt and determining how much water weight it took to move the pulley. This measurement established the final size of wheel and cupped paddles needed for the PMG. The redesigned system was tested at maximum water pressure in the shop, which rotated the PMG shaft to only 200 RPM.

Conclusions/Discussion

The next phase of this two-year project will involve setting up the system near a stream and directing sufficient water flow to turn the redesigned paddle wheel fast enough to rotate the PMG shaft to 1000 RPM or more in order to generate electricity. If successful and stable, a system like this could be used to generate electricity in rural areas with stream access such as Humboldt County where this prototype was created.

Summary Statement

This project tested for the most efficient design of a paddle wheel hydroelectric system utilizing pulleys and a permanent magnet generator with the ultimate goal of producing electricity from a stream.

Help Received

Local hardware store staff provided help choosing materials and Revolution Bicycles provided used bicycle chain. WindBlue Power Company provided technical PMG information. This project would not have been possible without the help of my father who guided me through the use of shop tools.