Fabrication of Small Hydro Power Turbine for Residential Applications

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Abstract

There were a few possibilities from which the group was looking into building a small stream turbine. After some researching, the group decided to go with a tub wheel and an alternator setup. From this decision, we went onto do some calculations to decide on what components we were going to need to make this project happen.

INTRODUCTION

There are many different ways for residential homes to obtain power. The main one is to purchase it from the power company and another way is to use solar panels and collect energy from the sun. Our idea is to take a small stream and create a little power plant to be able to create some energy so that a home owner does not have to purchase as much or any power from the power company [1].

BACKGROUND

The project has been to create a small hydro-electric plant to run off of a stream. So far we have come up with using a tub wheel design to spin an alternator. We have also chosen to use step gears between the alternator and the tub wheel to increase the rotational speed leading to the alternator to gain more power from every turn of the water wheel. We feel that this design will be a safe, cost effective, and reliable design [2].

COMPONENTS

A. Generator

The group has chosen to go with a single wire 12 volt alternator for the generator in our apparatus. The 12 volt alternator was regularly used on small diesel engines and requires 2100 rpm to run it. These are very common and simple to hook-up as they are not computer controlled or required to have input current to activate the rectifier, self-regulated, and are very durable. By using a single wire alternator, we can eliminate having to supply power to receive power. The alternator will either be able to charge up batteries so the power can be stored until needed, or it can just be sent straight through an inverter to convert the 12 volt D.C. current to standard household 120 volt. The 12 volt alternator will allow our turbine to produce more power in a typical situation (Figure 1).

Figure 1. The generator

B. Turbine

We chose to use a tub wheel design for our turbine. This design is proven to be effective since it can be found in many old grist mills across America. The tub design allows the water to come in from the top and run through a horizontal wheel driving the axial that leads to the generator. This horizontal wheel allows for a more compact design than a typical vertical wheel and should supply ample power. We also wanted to move away from the typical impellor style of turbine due to the low amounts of water and pressure supplied from a small stream or creek. From the flow rate equation (Q=VA) with an area of 0.35 ft^2 and the velocity varying depending on the location of where it is placed.

The first idea of a tub wheel design was to recreate a smaller version of the tub wheel featured in Figure 2 [3].

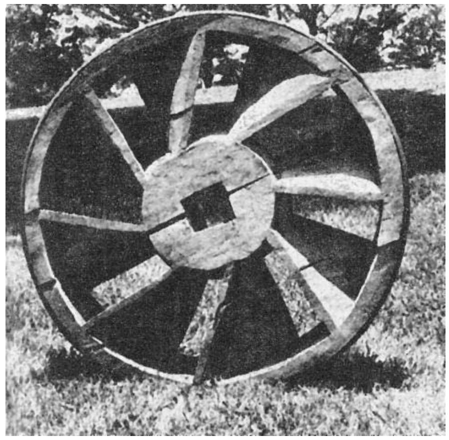

Figure 2. Tub wheel

We started assembling our wheel from cedar and eventually decided to redesign our wheel to be lighter, stronger, and more effective. We decided to build a two part tub wheel (shown in Figure 3) to remove a large amount of revolving weight. Our new design features an independent outside shroud that cuts a large amount of weight off the system and still effectively channels the water flow to run the system. We also decided to fabricate our new wheel with PVC pipe and galvanized sheet metal to make the system lighter, stronger, and also to last longer in the water (Figures 3 and 4).

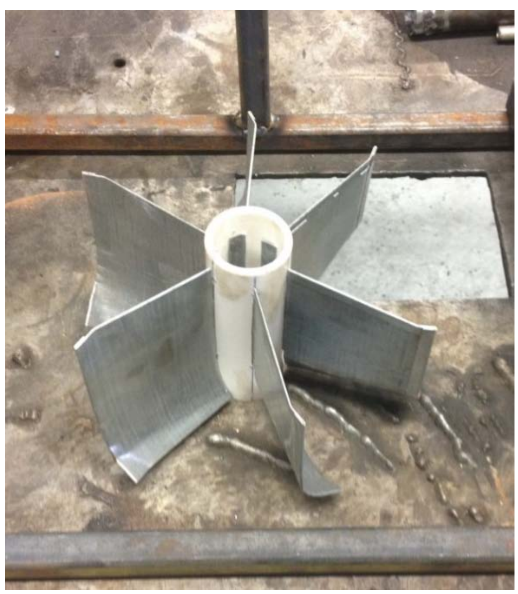

Figure 3. Fabricated tub wheel

Figure 4. The turbine and its casing

C. Frame and Drive system

After finishing our two main components, we had to find an effective way to mount them and connect them together. We fabricated a frame from ½” box steel tubing and mounted our alternator up away from the water input and output. We then mounted our 8” shroud centered our tub wheel in the frame. We decided to use two step gears to connect our tub wheel to our alternator to increase the running rpm speed. We used gears stripped from an old bicycle and ran a ½” pitch #40 chain to connect the two. The first gear is a 52 tooth ran to a 14 tooth gear creating a 3.7:1 ratio. By doing a simple speed ratio calculation using the equation $\omega_3=(N_2/N_3)*\omega_2$, the group came up with 565 RPM that the first wheel needs to spin. We ran a 1 1/4” drive shaft from the tub wheel with a pillow block bearing to hold it in position. The finished system can be seen in Figure 5.

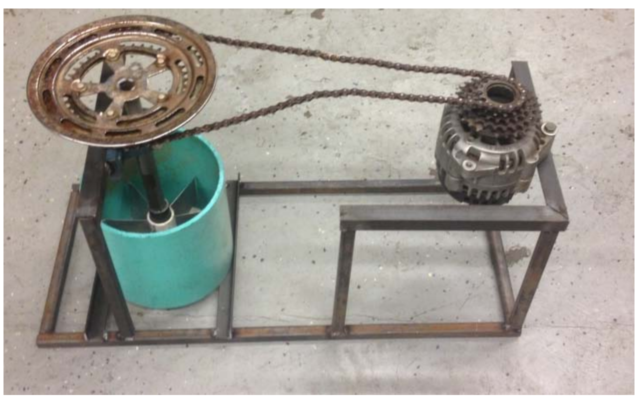

Figure 5. The assembled turbine and generator

D. Water Inlet

One crucial part of the system that is featured in Figure 6 is the water inlet system. Water is provided to the system by a section of 2-4” PVC that provides a large volume of water into the top of the tub wheel shroud. The optimal way to provide water to the system is to find a location of stream that has an elevation drop of around 4” per foot of stream for a water fall of around 15” height. This allows for the installer to build an effective intake system and pipe water to the unit with PVC pipe. We have decided that the optimal intake system is a 4-6” pipe with an angled grate screen to provide a self-cleaning water intake that will prevent brush and debris from entering the unit.

Figure 6. Inlet Tube

CONCLUSION

In conclusion, the team has created a small stream hydro plant that has the possibilities to provide power for a residential home. We feel that what we have created is a success, but we also feel that there are some areas of improvement. We look forward to testing our system and actually installing it in a stream to test its functionality. As in any project, we have also found areas upon which we can improve our design and look forward to making changes in our prototype to further improve the system’s efficiency. This was a great learning experience for us. We plan to further our research in the project and improve our design in the future.

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