SPIRAL TUBE

WATERWHEEL PUMP

A Laboratory Report

In partial fulfillment of the subject

Methods of Research

Presented to:

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Abstract

In most rural areas farmers have limited access to water and electricity. For all households there is need for continuous supply of electricity and water. In our study we have discovered that the device which is the spiral tube water wheel pump is one of the devices capable of tackling such problems. With the use of the said device, which has no harmful emission to the environment and is another source of conventional energy, the spiral tube water wheel pump can help in gathering water in a nearby stream easily and can assist in the production of electricity.

The spiral tube waterwheel pump is able to gather water a rate of 3.846 ml per second. The average household utilized 137 liters of water per day in which the device is capable of gathering within approximately 10 hours. The electricity produce by the system is dependent to the velocity flow of a stream or river.

The expected result of the design to pump water is satisfied. The pump water was tested by the researchers. In terms the expected electrical output of the design, it was not satisfied. The reason is due to the undersized driver pulley diameter, it should have exceeded the motor fan diameter.

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Introduction

Water is use in anything and everything we do. From household activities to industries or irrigation, abundant water supply is favorable. Since Philippines is an agricultural country and has an abundant water supply, this purpose is a must. Water is pump to the agricultural field using various pumps using electricity and other fuels, but these fuels are not in abundance and therefore makes it a costly affair (Croft, 2014).

An alternative solution to this problem could be a simple water wheel. The water wheel rotates with the energy of flowing water and thus omits the use of any kind of fuel. A water wheel consists of a large wheel basically made of wood or metal, and it consists of a number of blades or buckets arranged on the outer rim forming the driving surface. Water wheels have been used basically for agricultural purpose, lifting of water to a greater height since ancient times.

The design project is intended to produce electricity and gather water by the utilizing the energy produce by a flowing river or stream.

To design a waterwheel and the parameter related to it, we take the power input in consideration. (https://sciencing.com)

Power input formula:

Power(in) = (1/2)(density of water,p)(area of the blade, A)(velocity of flowing water,v)

Problem Definition

In most of rural area the farmers are facing problem of cut-off of electricity which is used to run the water pumps. For agricultural equipment there is need of continuous supply of electricity.

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The spiral tube water wheel pump, as per its name it include water wheel. A wheel on which the spiral tube mounted and it rotates due to force of water flow which is acting on the pedal of wheel. Due to the rotation of the wheel the spiral tube takes water in at one end of the wheel which is open is at the periphery of the wheel. This water passes towards the center of the wheel into the coil as per revolution of a wheel. From this center we get water discharge as outlet at desired head. The spiral tube water wheel pump is works on principle that2, "The water energy is converted into mechanical or kinetic energy and again kinetic energy is converted into water energy". Spiral tube is a pipe which wound over array or scoops of wheel and to generate coiled shape. It has simple in design to develop spiral tube water wheel pump and the shape of coil is manually generated. To increase head pressure each coil of the tube supp. As the paddles rotate the coil of poly pipe above the water, the lower part is immersed. The open end of the coil takes a small "gulp" of water every time it rotates orts.

Problem Scope

The main problem of this study is to make a cheap and efficient spiral waterwheel pump which can be use on rural areas. Specifically, this study attempts to answer the following questions:

1. Is it possible to harness electrical energy from the motion of the wheel?
2. Is it possible to gather water by the use of the waterwheel pump?
3. What voltage can the device produce?
4. How does this device work?
5. What relation does the voltage and kinetic energy?
6. What is the most efficient design of this device?

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Technical Review

The Spiral tube water wheel pump was constructed so the end of the outside pipe coil opened into a scoop. The inner coil led to the center of the wheel where it joined a rotary fitting at the axis of the machine. Figures 1 & 2 show an historical reference's representation of the pump. According from "A *Descriptive and Historical Account of Hydraulic and Other Machines for Raising Water"* by Thomas Ewbank, edition of 1849, New York City.

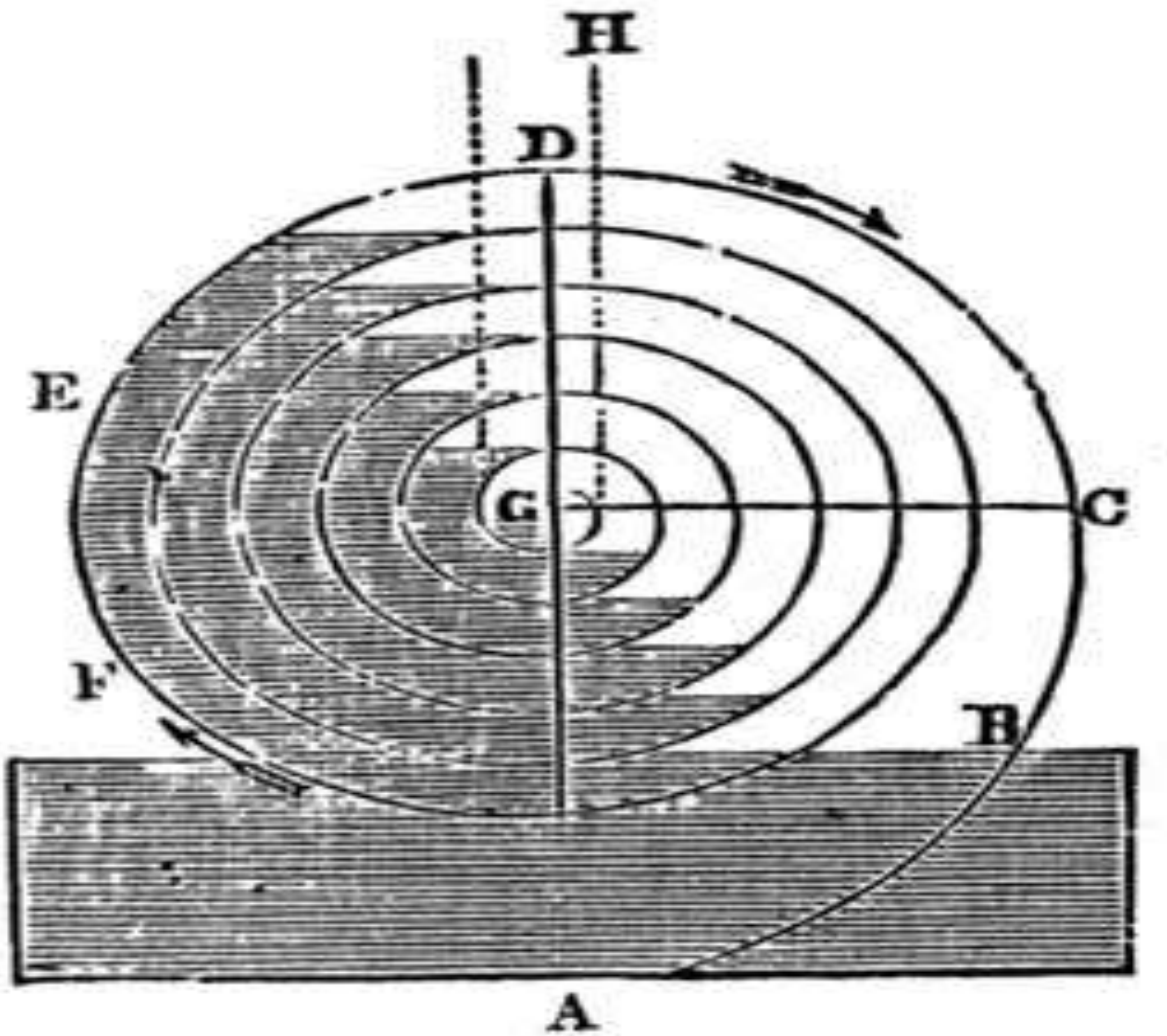

Figure 1.1: Historic Wirtz Pump—1842 drawing

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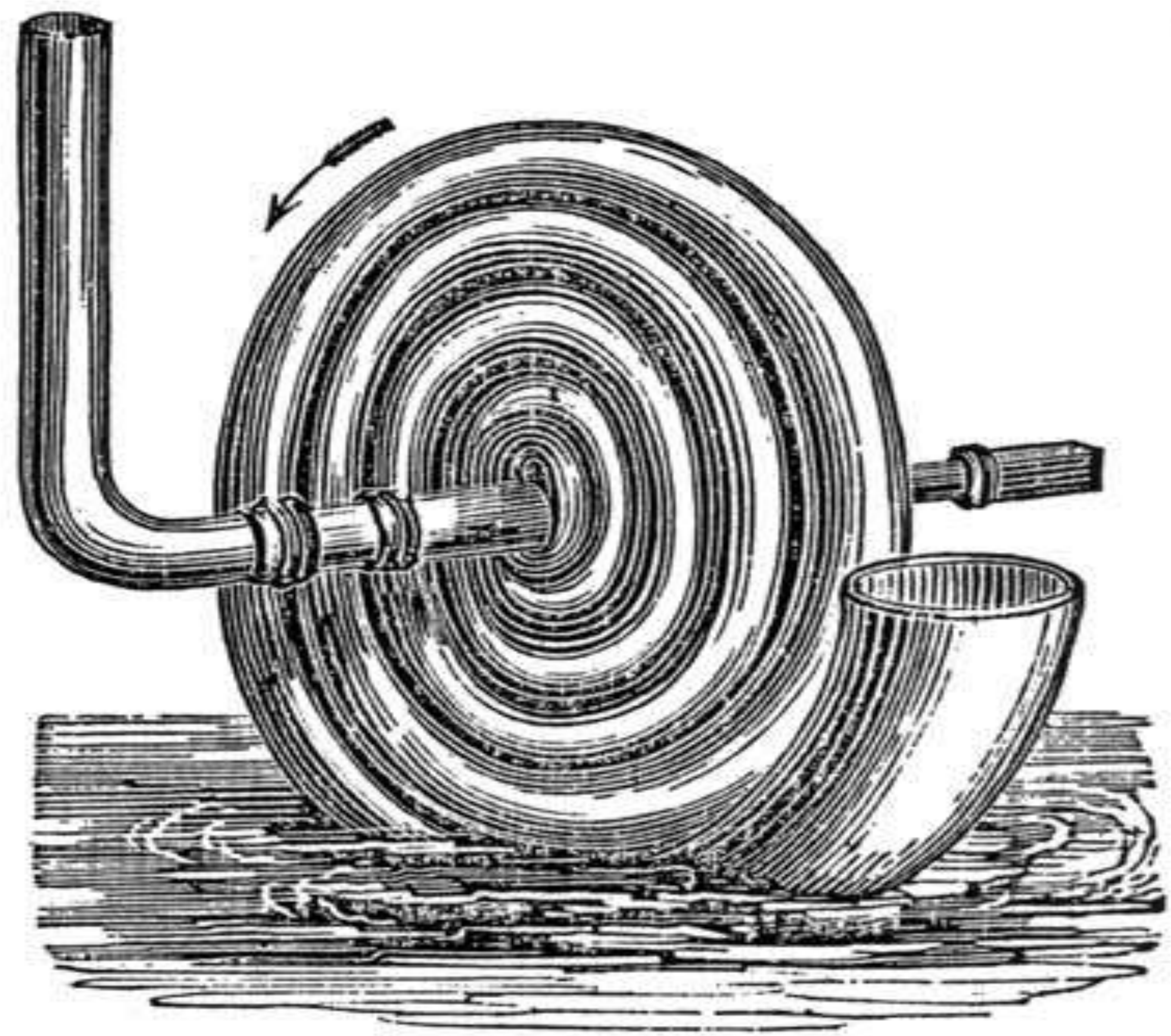

Figure 1.2: Historic Wirtz Pump—1842 drawing

The Spiral tube water wheel pump was constructed so that, with each revolution of the spiral, the

scoop collected one half the volume of the outer coil. As water was taken into the coils, each column of water transmitted the pressure through the air to the preceding column of water. In this way the water in each coil was displaced to provide a pressure head. A cumulative head was built up at the inner coils and was conveyed through the rotary fitting to an ascending delivery pipe.

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Design Requirements

Considering availability and affordability, the suitable material for the blades is GI sheets, due to the fact that the galvanized iron is coated with zinc making it corrosion resistant. (www.wenzelmetalspinning.com)

The more the number of blades, greater is the torque on the water wheel. But after a certain number of the blade, the torque decrease due to blockage of water by the subsequent. Therefore the number of blades should be a arrange in such a way that only one blade is fully immersed at a time. Therefore the number of blades is found to be 8 (www.scribd.com). Another major requirements is that the flow rate of water must be more than 1 m/s. (wikipedia.com)

Figure 1.3: Compact Disk and Popsicle Sticks

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The Popsicle sticks are place on the compact disk with each stick having equal distances with one another. The same procedure is done with the other compact disk and Popsicle sticks. The material in Figure 1.3 is one of the main components for the making of the wheel. It acts as the support for the blades.

Figure 1.4: Hose

The hose is coiled and fixed in the side of the water wheel. The other end of the hose is place in the shaft. The hose is use to scoop water during the rotation of the water wheel.

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Figure 1.5: Bearing

Figure 1.5 is a bearing which is a machine element that constrains relative motion to only be desired motion, and reduces friction between moving parts.(https://www.quora.com/What-is-the-purpose-of-a-bearing). The bearing is fixed in the plywood. In the design, the shaft is placed in the bearing which allows it to rotate smoothly.

Figure 1.6: Shoe Pipe

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Figure 1.6 acts as the shaft which is connected to the water wheel. With the help of the shaft the mechanical energy that the water wheel produced is transmitted along the design.

Figure 1.7: Wood Stand

The wood is made to be the frame of the project design, as what is seen in Figure 7. The wood as shown in Figure 7 will be the major foundation of the design.

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Figure 1.8: Connecting materials
Other necessities, use for sticking.

The materials shown in Figure 1.8 is used to connect important parts of the design and keep them in place to not allow any unwanted movements.

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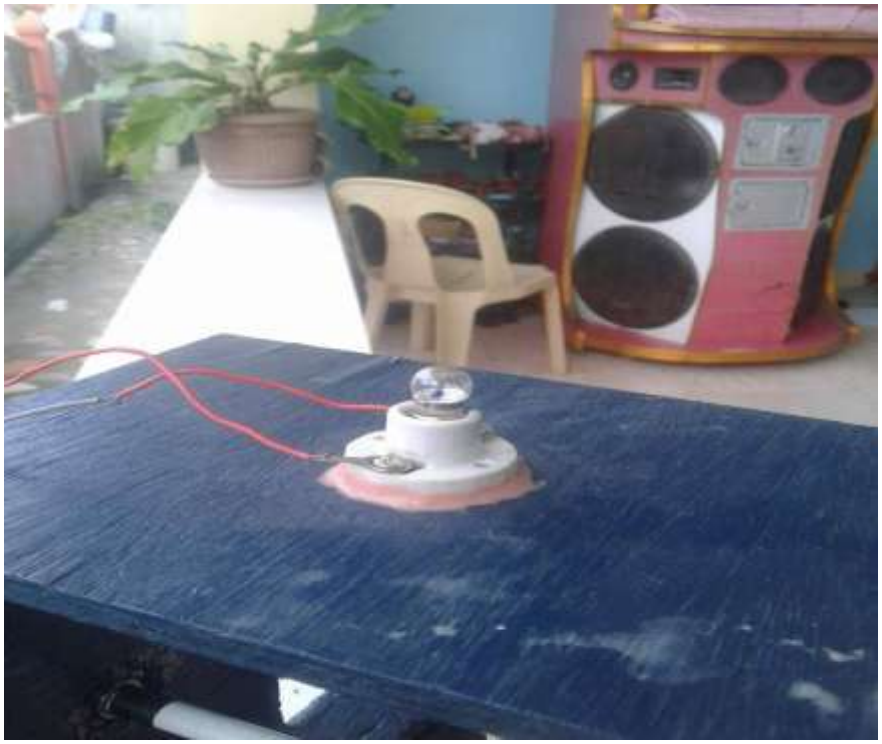

Figure 1. 9 Light bulb

The light bulb is place on the very top of the design project. The purpose of the light bulb
is to act as indicator of electrical flow..

Figure 1.10 Belt, Pulley and motor

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Shown in Figure 1.10 is the belt, pulley and motor. The belt and pulley transmits torque to the motor, torque is the key in producing electrical energy in the motor.

Table 1. Cost Analysis

Materials	Number of Units	Cost
SAE 101 ball-bearing	2	Php 90.00
0.4 in. hollow shaft	1	Php 00.00
Plywood	1	Php 00.00
All-purpose glue	1	Php 49.00
Wood frame	1	Php 00.00
Used compact disks	2	Php 00.00
Plastic popsicle sticks (1 pack)	1	Php 30.00
Nails	10	Php 00.00
Electrical tape	1	Php 00.00
Galvanized iron sheet		Php.00.00
Epoxy	2	Php 80.00
Light Bulb	1	Php 20.00
	TOTAL	Php 269.00

With the data presented above, the total cost on the fabrication and materials used in the creation of the design project is approximately Php 269.00. The materials used on the fabrication of the design project can be bought on the local market.

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THE RESEARCH METHODOLOGY

The study employed the use of experimental approach in collecting and analyzing data concerning the amount of water stored and the amount of electricity produce by the design project.

Method

The design project is intended to have an alternative source of gathering electricity and water by utilizing the power produce by the flowing water of a river and a stream. A prototype of the spiral water wheel will be designed and fabricated. Its performance will be tested on a flowing stream or river. Thus, the method in gathering and analyzing the data from testing of the design is by a quantitative manner. In this method, the total volume of water and total amount of electricity produce and gather is analyzed.

Apparatus

The testing of the design project requires the project design to be place in a flowing river. The design project included a light bulb which is seen in Figure 1.9 to be an indicator of electricity flow. The total power (watts) that the machine is able to produce is calculated manually. The manual calculation is found in the result section. Another tested component is the capability of the design project to gather water. This was tested by the help of a water container found at the end of the shaft. The experimental setup of the design during the test is shown on Figure 2.1.

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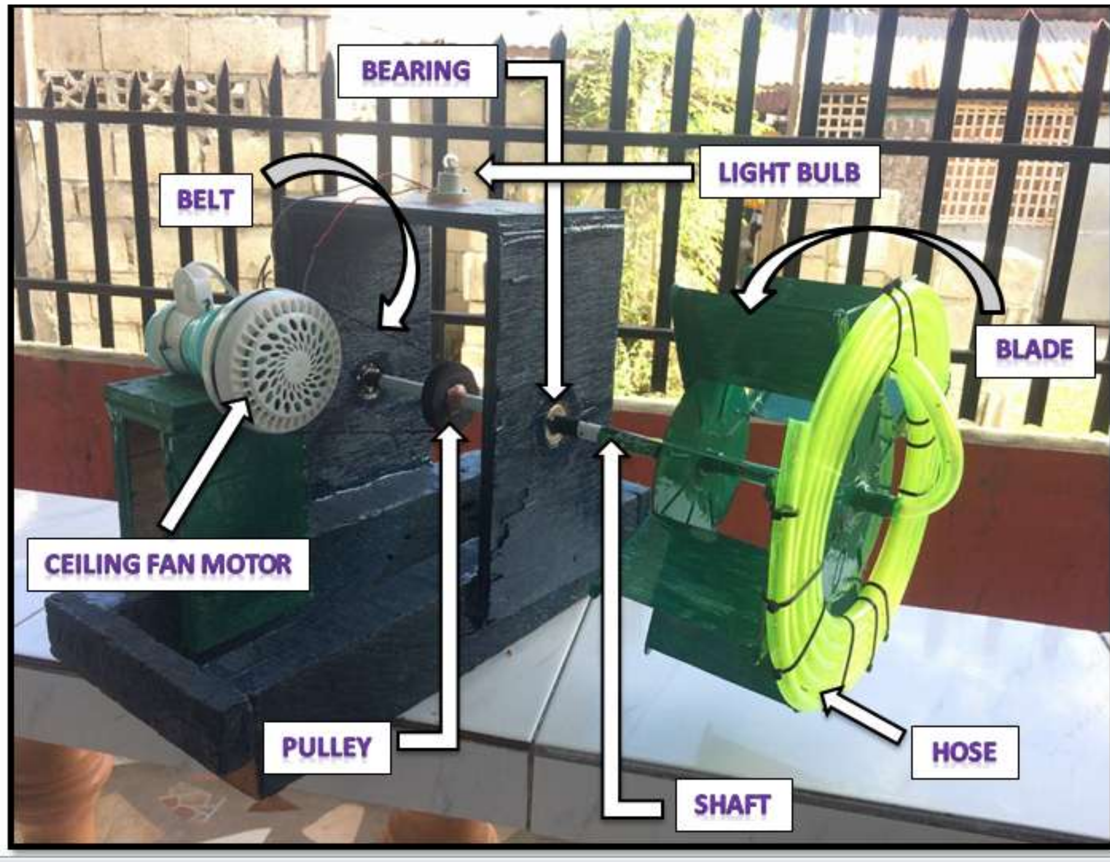

Figure 2.1: The Apparatus

The labeled parts were discussed in the design requirements section.

DESIGN DESCRIPTION

After much contemplation the researchers were able to come up with a solution which is applicable to the main problem at hand, "The Spiral Tube Waterwheel Pump".

Overview

A Spiral tube water wheel pump is works on principle that, "The water energy is converted into mechanical or kinetic energy and again kinetic energy is converted into

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electrical energy". Spiral tube water pump is a method of pumping water by using an undershot water wheel which has a scoop connected to a spiral tube. As the wheel turns, the scoop will alternatively introduce either water or air into the spiral tube. The pressure from the hydrostatic head generated from the column of water introduced by the scoop, is added to the pressure from previous scoops, and so as the wheel turns it will increase the water pressure with every turn of the spiral. The main characteristic of the spiral water pump is that it can pump water without the input of electricity or fuel. This project aims not only to deliver water in a specific area but also to generate electricity by converting mechanical energy to electrical energy. This will be done by providing an attachment of generators, pulleys and belts through the existing project which is the spiral tube water wheel pump.

Procedure

A 350 ml container is filled with water within 91 seconds, yielding a rate of 3.846 ml/sec during the first test. In the second test a similar rate was obtained which is 3.846 ml/sec with a container of 500ml. The volume flow rate can be achieved with respect to the capacity of the container and the time it took to fill up.

Detailed Description

A spiral water pump is basically used to pump water from a lower head to a higher head region. This pump uses a rotating pipe coil to pump water. Spiral pump is considered to be created in 1946 by H .A. Wirtz, of Switzerland. Wirtz invented the spiral pump to provide water to a higher head.

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The spiral tubes are filed to the wheel so that the spiral pipes rotate, as the wheel itself rotates. The water collector connected to the outermost end of the spiral tube gulps in a good1uantity of water and delivers this into the spiral tube as it rises above. This core of water passes through the spiral followed by a core of air as the wheel rotates. A new core of water is formed on every revolution, and a new core of air. Thus a series of cores of water and air are formed within each spiral pipe as the wheel rotates. Both spiral tubes deliver their water and air into the axle of the wheel and there it is led off through a water seal to a static rising pipe, which delivers water to the header tank. As the wheel revolves a pressure head develops within each coil of the spiral tube, water in the rising coils being higher than in the descending coils. These cores of water in the spiral tube compress the air between them as they travel around the spirals and both water and air are expelled under pressure into the axle. The flow of water up the static rising pipe is also accelerated by the compressed air escaping and expanding from the outlet at the axle of the wheel. This effect also helps to lift water to the header tank. Fig below shows a spiral waterwheel.

The flow of water pushes the waterwheel. This causes the wheel to rotate at a circular motion. The wheel is fixed at a shaft, a combination of a pulley and a belt is used to drive the motor. In this process the kinetic energy of the motor is converted to electrical energy.

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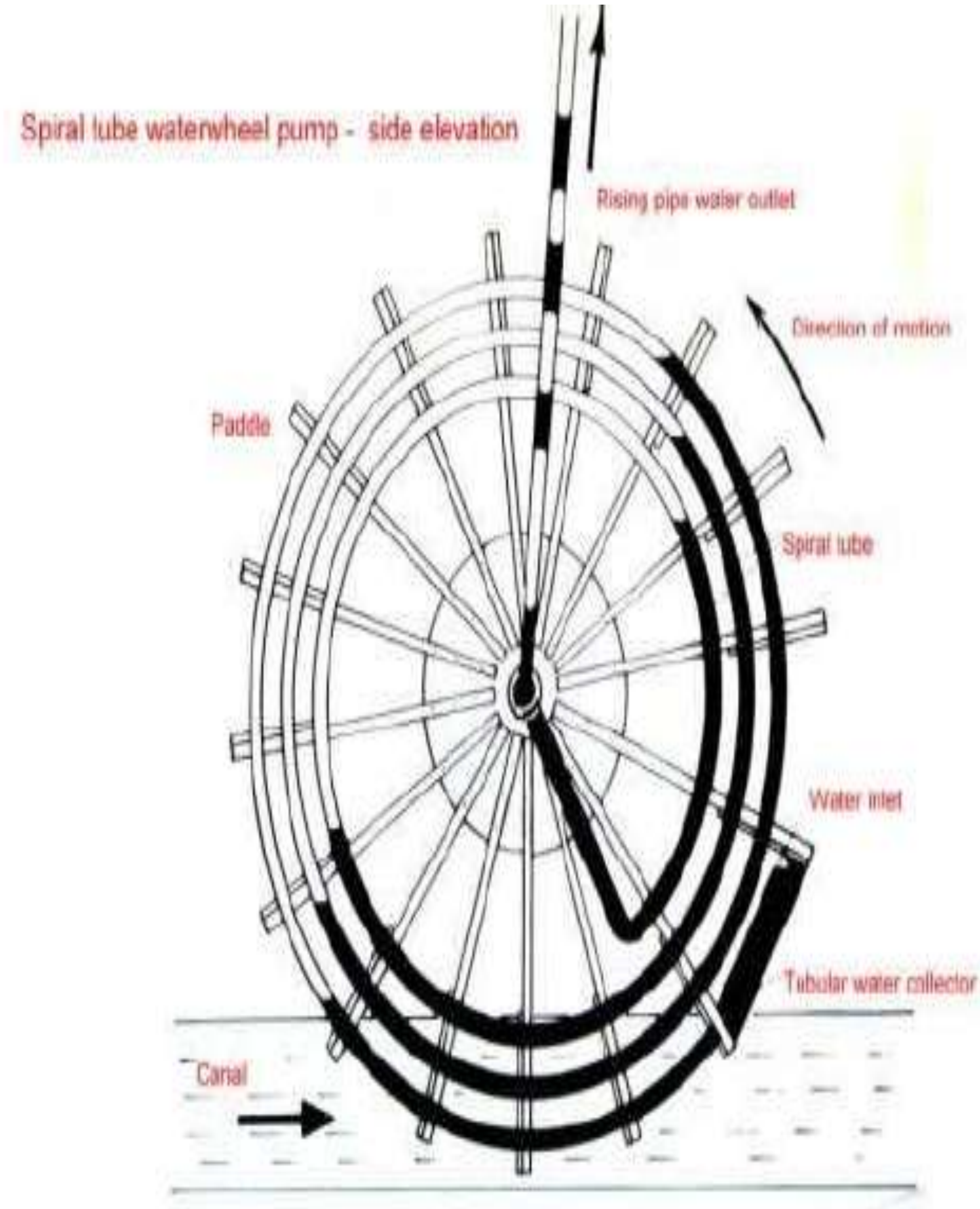

Figure 2.1. The waterwheel Pump

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Use

The design must be placed in a flowing river or a stream with at least a velocity of 1 meter per second. The tube will scoop the water which is connected to the shaft. The water is collected at the end of the shaft, with a container of choice. The power produced by the motor is transformed to the power stations.

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DISCUSSION

Evaluation

Through testing, it is verified that the project is working. The computations that were done are solely based on the functioning design project. The prototype of the design project will be presented to provide evidence of the design project's performance.

Overview

The design project was evaluated through experimental approach by testing the prototype together with hand calculations. The prototype is placed in flowing stream.

Table 3.1 Design Requirements

Requirements	Target Conditions	Methods
Must pump water	Total liters of water a household uses per day (137 Liters)	Experimental Testing
Must produce electricity	Enough to power a household	Experimental Testing

The design requirements are stated and presented above on Table 3.1. The first column from the left is the requirements of the design project. The second column is the target conditions and the third is the method of testing to evaluate the requirements.

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The average consumption of water of a regular household is 137 liters, the design is able to accumulate 137 liters of water in approximately 10 hours.

Prototype

The prototype purpose is to design a waterwheel to generate electrical energy and gather water.

Figure 3.1. The Prototype

The prototype is seen in Figure 3.1. The left photo is shown as a the prototype is finish and the photo is when the prototype is tested.

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Testing and Results

The water pushes the blades of the wheel which causes the wheel to rotate. When the wheel rotates the pulley, which is connected to the wheel, also rotates along with the wheel. The pulley then rotates the driven wheel of the motor. The motor produces mechanical energy which is then converted to electrical energy. The electrical energy is transmitted to the bulb which produces light.

Another result of the design is the water gathered. The hose is fixed in the wheel. The hose is coiled around the outside of the wheel. The rotation of the wheel caused by the river flow fills the hose, which rotates with the wheel. The hose is connected to the shaft. The other end of the shaft is connected to a container which collects the water gathered.

Table 3.2 Results of the Test

Volume flow rate of pump water	Power Input
3.846 ml/sec	1.357 Watts

The data in Table 3.2 is acquired with respect to the velocity of the stream.

The experimental results obtained above is the data gathered with respect to the work of the system. To calculate the gathered data the formula are necessary. These are the following formula;

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Computations;

1. **The Belt Length, L**

D_{pulley} = d = 2.4 in. (Diameter of Pulley)

D_{motor} = D = 3.6 in. (Diameter of Ceiling Fan Motor)

C = 6.5 in. (Center Distance)

$L = \frac{\pi}{2}(D + d) + 2C + \frac{(D-d)^2}{4C}$

$L = \frac{\pi}{2}(3.6 + 2.4) + 2(6.5) + \frac{(3.6-2.4)^2}{4(6.5)}$

L = <u>22.48 in.</u>

2. **RPM of the Ceiling Fan Motor, N_m**

r_{pulley} = 1.2 in. = 0.1 ft. (Radius of Pulley)

D_{motor} = 3.6 in. (Diameter of Motor)

V_w = 2.513 fps (velocity of flowing water)

V = 2πrN

$V_w = 2\pi r_{pulley} N_p$

$N_p = \frac{2.153\ \text{fps}\left(\frac{60\text{s}}{\text{min}}\right)}{2\pi(0.1\ \text{ft})}$

N_p = 205.6 rpm (RPM of Pulley)

$N_p\ D_p = N_m\ D_m$

$N_m = \frac{(205.6\ \text{rpm})(2.4\ \text{in.})}{3.6\ \text{in.}}$

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N_m = <u>137.067 rpm</u>

3. **Power input, P_{inp}**

   p = 1000 kg/m^3(Density Of Water)

   V_w = V = 2.513 fps = 0.7659624 m/s (Velocity of Flowing Water)

   L_{blade} = L = 3.9 in. = 0.09906 m (Length of blade)

   W_{blade} = W = 2.4 in. = 0.06096 m (Width of Blade)

   A = L x W

   A = 0.09906 m x 0.06096 m

   A = 6.0386976 x 10^{-3} m^2(Area of Blade)

   $P_{inp} = \frac{1}{2}(p)(A)(V)^3$

   $P_{inp} = \frac{1}{2}(1000\ kg/m^3)(6.0386976 \times 10^{-3}\ m^2)(0.7659624\ m/s)^3$

   P_{inp} = <u>1.357 Watts</u>

4. The yielded velocity of the water pump

   350 ml = the capacity of the container

   91 sec = the time required to fill the container

   $\frac{350ml}{91\ secs}$=**3.846** $\boldsymbol{\frac{ml}{sec}}$

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The higher the value of the velocity of the stream the higher the angular velocity of the wheel is produced. The contact area of the blades is taken in consideration for a higher amount of power.

Assessment

The expected result of the design to pump water is satisfied. The pump water were tested by the researchers. In terms the expected electrical output of the design, it was not satisfied. The reason is due to the undersized driver pulley diameter, it should have exceeded the motor fan diameter. The design can be improve to have a better performance.

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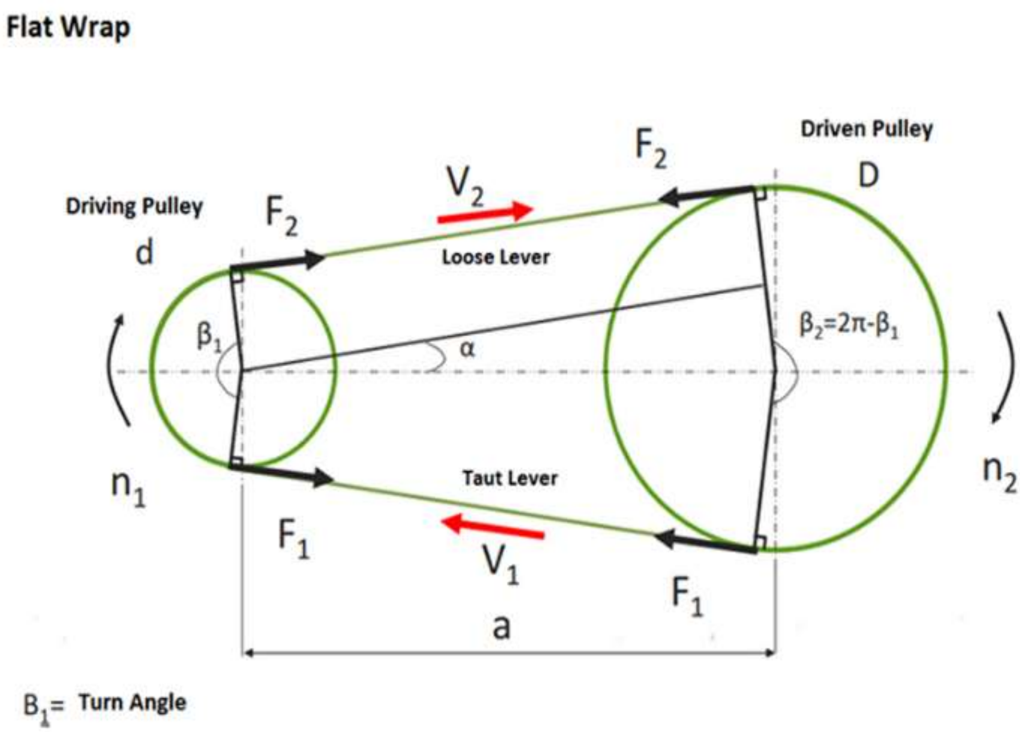
APPENDICES

The formula used:



Size	Formula
Wrapping Angle	$\beta_1 = 180 - \frac{180D}{\pi d}$
Belt Length	$L = 2\,a\cos a + \frac{\pi}{2}(d + D) + \frac{\pi a}{180}(D - d)$
Belt Length (practical)	$L = 2a + \frac{\pi}{2}(d + D) + \frac{(D - d)^2}{4a}$
Pulley Diameter	d $\approx (1200 \sim 150)\sqrt[3]{\frac{P}{n_1}}$ D=id
Belt Inclination Angle	$\sin\alpha = \frac{D-d}{2a}$ β_1=180-2a

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The standard metric unit of power is the **Watt**. As is implied by the equation for power, a unit of power is equivalent to a unit of work divided by a unit of time. Thus, a Watt is equivalent to a Joule/second. For historical reasons, the *horsepower* is occasionally used to describe the power delivered by a machine. One horsepower is equivalent to approximately 750 Watts.

Power = Work / time

or

P = W / t

The average speed during the course of a motion is often computed using the following formula:

$$\text{Average Speed} = \frac{\text{Distance Traveled}}{\text{Time of Travel}}$$

In contrast, the average velocity is often computed using this formula

$$\text{Average Velocity} = \frac{\Delta\,\text{position}}{\text{time}} = \frac{\text{displacement}}{\text{time}}$$

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AFFILIATION:

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  NORSU Chapter
  Regular Member

CHARACTER REFERENCES:

Engr. JOSEF VILL VILLANUEVA
Dean College of Engineering and Architecture
Negros Oriental State University (NORSU)
Main Campus II, Bajumpandan, Dumaguete City

Engr. ELIJAH SERATE
Mechanical Engineering Department Head
Negros Oriental State University (NORSU)
Main Campus II, Bajumpandan, Dumaguete City

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Ralph S. Salvador
Bag-ong Dalan, Dumaguete City, Negros Oriental
BSME Student
Mobile Number: 09059387038
Email Address: salvadorralph884@yahoo.com

CAREER OBJECTIVE:

Looking for an internship program in a company where I could learn under working professional Mechanical Engineer to gain knowledge and improvement of my skills by giving some input to the company.

PERSONAL DATA:

Date of Birth	:	July 28, 1996
Place of Birth	:	Brgy. Dawis, Bayawan City, Negros Oriental
Age	:	21
Gender	:	Male
Civil Status	:	Single
Height	:	5’6”
Weight	:	65 kg.
Nationality	:	Filipino
Religion	:	Roman Catholic
Language/s	:	Cebuano, Tagalog, English

EDUCATIONAL ATTAINMENT:

Tertiary: **Negros Oriental State University (NORSU)**
Kagawasan Avenue, Dumaguete City
Bachelor of Science in Mechanical Engineering
2012-2018

Secondary: **Dawis National High School**
Brgy. Dawis, Bayawan City, Negros Oriental
2008-2012

Primary: **Matias A. Fernando Memorial School**
47 Matias A.Fernando Ave. Angat Bulacan

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2002-2008

TRAININGS AND SEMINARS:

- Basic Safety and health orientation

SKILLS:

- Computer literate
- Good writing and oral communication skill
- Basic AUTOCAD drawing
- Familiarity with Geothermal Power Plant and Industrial Power Plant Machinery and their parts and function
- Welding Tools & Machining: Mills, Lathes, Drill presses, Grinders,
- Can work under pressure
- Can work with a team

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